Resilience Science Must-Knows

Nine things every decision-maker should know about resilience

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Resilience is the ability to live and develop with change and uncertainty. Hence, resilience is more than bouncing back. It is also about the capacities to cope, adapt, and transform in the face of change. This description of resilience is grounded in an understanding that **humans and nature are intertwined**, where human well-being and prosperity depend on the stability of the Earth system, and thus a **just and equitable world needs to operate within planetary boundaries**.

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Introduction

Resilience has become a central consideration across practice, policy, and business. It is increasingly integrated into public health strategies, private-sector risk management, corporate planning, development, and financial investment. This growing interest in resilience is not by chance. In recent years, the world has faced a variety of overlapping crises, from climate extremes and military conflicts to the COVID-19 pandemic and cascading disruptions in trade and food systems. Volatility is no longer an exception; it is the new norm.

Decision-makers across regions and sectors urgently need **clear, science-based, and actionable knowledge** to maintain the resilience of people and the planet and to ensure societies have the capacity to cope, adapt, and transform in order to thrive amid uncertainty. Yet, despite a wealth of research into the science of resilience, the findings often remain complex, making them difficult to translate into actionable insights for leaders outside the scientific community. The **Resilience Science Must-Knows** address this challenge head-on by distilling decades of cutting-edge resilience science into nine critical Must-Knows refined through dialogue with decision-makers.

Each **Resilience Science Must-Know** is intentionally broad. Together, they provide a shared understanding of the foundations of resilience that can guide decision-making and shape resilience strategies. This broad framing allows the Must-Knows to be applied across different sectors and scales. These top-level descriptions are meant to reflect the interconnected nature of complex systems and the volatile political, social, and economic realities within which they operate.

The nine **Resilience Science Must-Knows** are designed for decision-makers and implementers seeking to build and enable systemic resilience grounded in scientific research. This report targets decision-makers working at multiple scales and sectors, including community leaders, local and national governments, businesses, investors, donor organisations, and international institutions.

Grounded in science, shaped by practice

The **Resilience Science Must-Knows** are the product of an unprecedented collective effort undertaken by the global resilience research community. The report synthesises insights from multiple areas of resilience research and is informed by practice to ensure both scientific robustness and real-world relevance. They were developed through:

- Broad expert engagement: Over 120 resilience researchers from around the world contributed through a survey, capturing a diversity of expertise across sustainability science, social-ecological systems, climate adaptation, ecology, economics, governance, and more.
- Global editorial leadership: An editorial board of 20 leading resilience scholars—spanning different disciplines, regions, and schools of thought within resilience—guided the production process, ensuring its scientific rigour and inclusivity.
- Peer-reviewed literature: This work was enriched by a review of key rigorous and impactful research covering decades of resilience scholarship.
- Dialogue with decision-makers: Input from 162 leaders representing 134 organisations across policy, business, and civil society provided feedback on draft versions of the **Resilience Science Must-Knows**, helping align them with the realities of governance, investment, and practice.

This collective effort gives the **Resilience Science Must-Knows** unique legitimacy,

providing decision-makers with a trusted foundation for navigating an increasingly uncertain world.

From science to impact

This report is not an endpoint. In the next phase of our efforts—the **Resilience Road to Action**—we will work closely with decision-makers across a range of sectors, including food and agriculture, urban development, health, and finance, to translate the **Resilience Science Must-Knows** into actionable guidelines. The **Resilience Road to Action** will not prescribe actions for individual businesses or agencies but will offer **clear, evidence-based guidance** on what resilience looks like in practice within a given sector or context, tailored to specific challenges. This approach provides a **critical bridge between broad strategic framing and practical relevance**.

Figure illustrating the nine Resilience Science Must-Knows.

1 Resilience is critical for navigating accelerating risk

Rising crises, shocks, and inequalities are creating new challenges. Resilience offers pathways toward more just and sustainable futures for people and the planet.

Earth resilience at risk

For the past 12,000 years, the Earth's climate has been relatively stable. This period, known as the Holocene, allowed for human civilisations to flourish. Human activity is now the main force shaping the Earth's climate and its ecosystems, ushering us into the Anthropocene. Resource use, pollution, biodiversity loss, and emissions are all increasing exponentially. With seven of the nine planetary boundaries breached, we are crossing into unsafe territory for people and the planet. Intensifying climate and weather extremes are pushing forests, the ocean, and ice sheets close to tipping points. If crossed, these could trigger irreversible damage, threatening the foundations of humanity. Nature has buffered many human impacts: the ocean has absorbed around 90% of excess heat from rising greenhouse gas emissions, and marine and terrestrial ecosystems have captured roughly half of human CO_2 emissions. This is Earth resilience. But this safety net is fraying. Early reports show that the natural systems humans depend on are under severe strain.

When shocks ripple across systems

As Earth resilience erodes, the complexity of our deeply interconnected world allows risks to multiply and spread across systems. Shocks from extreme weather, disease outbreaks, or geopolitical crises have spread across sectors and borders, disrupting ecosystems, economies, and infrastructure in unexpected ways. Interconnectivity makes crises harder to manage and makes resilient systems more important than ever. Resilient systems help us prepare for uncertainty, cope with shocks, and avoid crossing critical tipping points.

Catastrophic events, such as Hurricane Katrina in 2005, the 2019–20 Australian bushfires, and the COVID-19 pandemic from 2020–2023,

show what can happen when governance systems are not prepared for the ripple effect of an unexpected event. For example, the COVID-19 pandemic began locally but quickly overwhelmed national healthcare systems and strained supply chains, particularly when it collided with other crises, such as locust swarms and flooding in the Horn of Africa. Global supply chains were also disrupted when the container ship Ever Given blocked the Suez Canal for six days in 2021. Both events had serious consequences for individuals, enterprises, and nations. The most vulnerable parts of the world are often those that are worst affected. Such crises show that a hyper-connected world is also a fragile one.

Resilience as necessity and opportunity

Our rapidly changing planet and hyperconnected world are moving us into a new risk landscape. This is why resilience is essential. Resilience helps societies learn from crises,

keep options open, and navigate the volatile conditions of the Anthropocene. Navigating this new landscape requires the adoption of systemic and forward-looking resilience strategies.

Resilience is necessary for strengthening capacities to cope, adapt, and transform in the face of change (see Must-Know #2).

Resilience can be specific to one type of disruption (e.g., flood preparedness in a city) or it can be general (the ability to handle a wide range of challenges). Importantly, specific and general resilience do not always go hand in hand. When resilience-building becomes narrowly focused on a particular disturbance, the strategy may work in the short term, but it runs the risk of causing the system to lose resilience in other ways. For example, research on rice-farming systems in Nepal and Spain shows how a narrow resilience focus on addressing relatively predictable social and environmental fluctuations has made the rice production sector vulnerable to other longer-term social-ecological changes.

Resilience does not just happen on its own. Governance systems should acknowledge the complexity of ecosystems, communities, and institutions, and act accordingly. While preparing for the unexpected, decision-makers need to be able to manage trade-offs (see Must-Know #7) and navigate competing values and goals. In addition to thoughtful management, resilience requires sustained attention and sufficient resources. In the absence of an immediate threat, policymakers may not recognise a future risk. In communities, ecosystems, and institutions alike, unused resilience capacities tend to fade because efficiency in the short term often trumps medium- to long-term preparedness. Fostering resilience for future crises takes planning and deliberate action. It is not passive or automatic but must be actively cultivated before we need it—waiting until then is too late.

Desirable and harmful resilience

While resilience is most often seen as a desirable property, the resistance of some systems to change—like industrial agriculture or fossil fuel economies—provides evidence for the harmful effects of resilience. Powerful political or economic groups or influential organisations with vested interests may prefer to protect the status quo and resist change, even if it reinforces inequality and social and ecological degradation. Recognising "undesirable" resilience makes it possible to focus attention on actively supporting systems, such as democratic institutions, equitable food systems, and healthy ecosystems, that can help drive social and ecological sustainability.

A century ago, the world's response to war, influenza, and economic depression produced both progressive transformations like welfare states and regressive ones like fascist regimes. Today's compounding crises—climate change, environmental degradation, geopolitical conflict, and risks from emerging technologies like artificial intelligence—also create conflicting forms of resilience. We must learn how to strengthen the resilience of systems that promote sustainability and justice and transform or dismantle those that harm people and the planet.

2 Resilience requires balancing the capacities to cope, adapt, and transform

Resilience is not just about bouncing back—it is about building the capacity to cope with shocks, adapt to change, and transform systems away from undesirable trajectories. Fostering resilience means finding the right balance between these capacities—coping, adapting, and transforming—while learning from crises and anticipating what is ahead.

The three capacities for resilience: coping, adapting, transforming

Resilience means coping with and navigating shocks and changes (see Must-Know #1) to enable systems to persist. This sometimes requires the ability to adapt to change or transform. Strengthening the resilience of systems that promote sustainability and justice requires a solid understanding of resilience's three core capacities: coping, adapting, and transforming (Box 1).

Coping capacity

Coping capacity is a system's ability to persist, or cope, by withstanding and recovering from shocks without major disruption. It is about protecting what matters most during a crisis so that life can carry on while avoiding a complete breakdown. A forest may regrow after a fire if its core ecological functions remain intact. A household can weather a drought with savings or strong support networks. Families often use emergency funds to buy food or repair property after a flood or drought. They may also rely on insurance, social transfers, or loans to buffer the impacts of crises, such as crop failures or medical emergencies. Social support networks—friends, family, or community organisations—can play a crucial role by offering shelter, food, or resources during events like hurricanes or economic downturns.

Coping capacity can also mean resisting unwanted changes. For example, many of Earth's life-supporting systems—like the Atlantic Meridional Overturning Circulation (AMOC), the polar ice caps, and the Amazon rainforest—need to maintain their ability to

cope with human-caused disturbances in order to persist as they are. If they cross dangerous tipping points, the result could be irreversible shifts in the Earth's climate and other natural conditions not seen for millions of years. Such changes would spell tragedy for the earth's human population and its natural ecosystems. For many marginalised communities, coping capacity means preserving ancestral practices or community bonds to protect against new or imposed pressures. Such forms of resistance are themselves important expressions of resilience.

Adaptive capacity

Adaptation means adjusting to new conditions while keeping the system's core functions intact. Adaptive capacity allows systems to learn and evolve in response to changing conditions.

Farmers, for example, adapt to climate change by switching to drought-resistant crops

or diversifying income sources to reduce vulnerability to climate-related shocks. Cities can develop and implement early warning systems, heat-health action plans, or green infrastructure to reduce their risks from extreme weather events. After floods or earthquakes, municipalities can update their zoning regulations or disaster preparedness plans, showing how flexible organisations are able to reorganise, learn from experience, and adopt new strategies for managing disruption in the future. Adaptive capacity can be strengthened by disseminating knowledge, improving access to information and teaching new skills. Educational campaigns, community-based adaptation projects, or organisational learning initiatives can all help people respond proactively to shifting conditions.

Transformative capacity

Sometimes, systems need more than minor adjustments if they are to be fit for constructing a more desirable future. In some cases, they need to fundamentally change. This is especially true when existing systems reinforce unjust and unsustainable trajectories or are no longer suited to new risk landscapes.

Transformation involves rethinking and redesigning how societies function, including how resources are used, how decisions are made, and how humans and nature interact. Phasing out fossil fuel dependence, reforming institutions that perpetuate inequality, or shifting to circular economies that regenerate rather than exploit, will require a creative reimagining of how things might be done. Designing new forms of transportation or reconfiguring consumption habits can forge a pathway towards the transformation of society and how it works.

Transformation is the hardest form of resilience to foster. While adaptation keeps current systems ticking over, transformation seeks to reconfigure existing relationships and power structures in new ways. Making this happen requires bold leadership, imagination, and inclusive collaboration (see Must-Know #9).

Balancing act: tensions, trade-offs, and synergies

As strategies, coping, adaptation, and transformation are deeply interconnected. Their interactions can produce positive synergies, create tensions, or imply trade-offs.

Coping can stabilise a system and give it time to adapt. Adaptation can extend the lifespan of a system through gradual adjustments. But without transformation, harmful or unsustainable systems are likely to persist. The choices different people, countries, and sectors make to prioritise one type of response over another can cause conflict with other parts of the system. For example, building flood protection in one part of a city may safeguard local residents but increase flood risks for those living farther downstream. Strengthening resilience means anticipating such trade-offs and managing them so that one group's resilience does not come at the expense of another's (see Must-Know #7).

Resilience capacity does not just need to be balanced within human systems. There are also important trade-offs to be made between human society and nature. For example, maintaining the coping capacity of Earth's life-supporting systems, like the Atlantic Meridional Overturning Circulation, requires transformative changes to social and economic systems, including shifting away from practices that drive climate and ecological breakdown.

Look ahead to build resilience

Resilience capacities are not static. They need to be continually tested, reimagined and developed. Ensuring resilience capacities are fit for purpose requires the foresight to anticipate possible new shocks and future changes (see Must-Know #4). While we cannot predict the future, we can create space for strategic imagination, reflection, learning, and collaborative preparedness—all of which are activities essential for inclusive transformative processes.

Visioning and scenario planning can help organisations and societies map, explore, and build different resilience capacities. These tools can help to unlock creativity and strengthen collective agency. They support adaptive management by allowing societies to test strategies, monitor the results, reflect on the outcomes, and then adjust their actions accordingly.

Box 1: Anticipating changing climates: strengthening resilience capacities

Restoring riverine systems in eThekwini, South Africa

The eThekwini Municipality, which includes the city of Durban (South Africa), has experienced significant flooding. In the early 2000s, Durban invested in climate adaptation efforts through its Municipal Climate Protection Programme, which gained cross-party political support because it linked climate adaptation with urban development. This initiative led to the development of the Transformative River Management Programme (TRMP), a long-term initiative to restore and manage over 7,000 km of Durban's rivers. The goal was to mitigate flood risk, enhance water supply, and strengthen ecological health.

It was the municipality's adaptive capacity that supported its efforts to restore Durban's river ecosystems and finance the construction of more robust bridges and drainage systems. However, because of the large-scale nature of the challenge and high levels of poverty, significant investment in transformative capacity was also needed. This meant bringing together diverse actors, including government agencies, community groups, and the private sector, to reimagine how local water systems could be managed differently. Actions included addressing the complex interdependencies between environmental and socio-economic risk. Local community members were capacitated to improve riverine ecosystems before flood events. Economic opportunities around water management were created. To reduce the loss of life during significant flood events, early warning systems were improved. Future priorities were strategised and planned collectively. When flooding occurred in the area in 2022, several of the urban settlements involved in the TRMP experienced lower levels of disruption compared with those that had not been involved.

Returning residential land to nature in Staten Island, New York

After Hurricane Sandy caused widespread damage to the north-eastern United States in 2012, New York City (USA) initiated an ambitious, though controversial, effort to transform coastal areas at risk from future storms fuelled by climate change. The state offered voluntary buyouts to homeowners in flood-prone communities, including an entire neighbourhood in Staten Island. Residents agreed to the buyout and relocated to a safer area. This former residential land has now been returned to nature.

The state-funded programme purchased qualifying properties at their pre-storm market value. Neighbourhoods like Oakwood Beach were then restored to wetlands, dunes, and parkland with the idea that these areas would act as a natural storm buffer. This major social-ecological transformation relied on anticipatory capacity, aligning social and economic vulnerability with political will and scientific assessment. Together, these abilities drove a landmark shift: restoring natural ecosystems while protecting vulnerable communities from future storm damage.

3 Investing in resilience today reduces costs tomorrow

The return on resilience investment far exceeds its initial cost. Investment in resilience protects and strengthens the social, economic, and ecological foundations that support long-term human well-being and prosperity.

Why investing in resilience makes sense

The evidence clearly shows that proactive investment in resilience makes financial and societal sense, especially when considering the cost of risk, disaster, and safeguarding resources. The exact return on an investment can vary by sector and context. Beyond ensuring adequate disaster management and preparedness, investment in resilience can generate wide-ranging dividends—supporting development, strengthening institutions, improving public health, protecting ecosystems, preventing conflict, and enabling more stable and equitable societies.

Despite these clear benefits, resilience investment remains underdeveloped. Short-term incentives, inadequate metrics, and institutional inertia all work against resilience financing. Economic frameworks often overlook natural and social capital. To understand why investment in resilience is important, it is essential to clarify what kind of "value" is at stake and how conventional measures often obscure the true returns resilience has to offer (see Box 2). Tackling these barriers is the key to unlocking the full potential of investing in resilience.

Protecting what matters, restoring what is lost, and creating what is needed

Investment in resilience primarily works to safeguard and restore value. It helps societies, economies, and ecosystems cope with shocks and disruptions. From a degraded baseline, it restores value by repairing natural and social capital that underpin prosperity. When business-as-usual is no longer viable, resilience investment can also create new forms of value—not by preserving the old system, but by

enabling transformative shifts to more just and sustainable ones. Clarifying these pathways to change is essential, since resilience is not just about coping with shocks and bouncing back, but also about adapting and transforming (see Must-Know #2).

Triple dividends: avoid losses, grow economies, strengthen societies

Resilience investment offers a "triple dividend." First, it helps lower the cost of a disruptive event. Investing in advance can prevent crises from escalating and reduce the damage and disruption when disasters or conflicts occur. Second, investment can stimulate economic growth. By lowering risk and strengthening institutions and infrastructures, resilience investment can create the positive conditions necessary for encouraging growth and development. Third, resilience investment can help to deliver social and environmental benefits, including improved public health,

increased biodiversity, strengthened social cohesion, and enhanced well-being across communities. Despite these self-evidently positive returns, the actual financial, ecological, and social gains from resilience investment have been poorly measured. Neither policy nor financial circles have yet provided robust figures for the potential savings a resilience investment might generate, thus perpetuating the false perception that an investment in resilience is likely to cost more than it is worth (see Box 2). The reality is likely the precise opposite.

Economic benefits

Resilience investment reduces the cost of disasters, conflicts, and climate shocks. For example, every dollar spent on disaster risk reduction and conflict prevention has been shown to save many times more in avoided recovery costs. However, more than reducing losses and costs, resilience investment can open pathways for adaptation and transformation. Investment can support the transition towards more just and sustainable systems. For instance, investing in renewable energy is not only a way to safeguard economies against volatile fossil fuel markets. It can also be a step towards a transformative low-carbon energy future. Similarly, investments in sustainable food systems or nature-positive solutions simultaneously improve food security, strengthen ecosystems, and open new economic opportunities.

Social benefits

Resilience investment generates vital social benefits. It protects communities from the impacts of climate change, conflict, and disasters and reduces the risks to lives, health, and well-being. By strengthening institutions and community networks, investment builds trust, social cohesion, cooperation, and the capacity to navigate uncertainty together.

For example, equitable water management and inclusive urban planning not only protect vulnerable populations from harm but also create the opportunity for fairer, healthier, safer, and more cohesive societies. In this way, resilience is not only about coping but also about addressing inequality and opening the door for justice-oriented transformations (see Must-Know #9).

However, resilience investment does not operate in a sociopolitical vacuum. Without an equity lens, an investment could run the risk of reproducing existing injustices or even creating new ones. Inclusive governance mechanisms and paying attention to power dynamics are essential if resilience investment is to benefit everyone and not simply to reinforce unequal systems (see Must-Know #7, #8, and #9).

A healthy planet: a precondition for economic and social benefits

Investing in resilience benefits the environment. Investment supports land management and conservation, protects biodiversity, and restores lost natural diversity. It enhances vital ecosystem services like water purification, pollination, and flood control. Investment also bolsters sustainable agriculture and forestry, reducing environmental degradation and promoting carbon sequestration. Sinking money into the natural world quickly ripples out into other social and economic benefits. Human activity is embedded in, and depends upon, the Earth's biosphere, itself the bedrock of civilisation. A healthy planet is not optional; it is a precondition for economic development, social justice, and sustainability.

Box 2: Value and ROI in resilience investment

Is it possible to calculate how much an investment in resilience might be worth? A common approach is to attempt to measure the return on investment (ROI). Traditionally, ROI has been calculated in narrow financial terms. Determining the value of resilience, however, requires a broader set of measures. This is because a resilience investment can generate not only a financial return but also forms of capital that are less easily measured—such as built, social, and natural capital—which together create value that enhances human well-being and promotes long-term prosperity.

Resilience science has done much to promote the understanding that a return on an investment can be measured in more than monetary terms. While human well-being has long been described as dependent on these three forms of capital (the built, the social, and the natural), research has increasingly shown that natural capital forms the foundation for human existence. The biosphere provides the life-support systems—from climate regulation to fertile soils and clean water—upon which economies and societies depend.

Conventional economic measures, like Gross Domestic Product (GDP), mask this reality. GDP overstates the economic value created by a country because it ignores the costs incurred by natural capital. For example, natural resources are systematically under-priced, driven by insecure property rights, and the market routinely fails to account for externalities like pollution and the presence of subsidies that encourage overconsumption. This leads to rapid resource depletion and weakens long-term resilience.

Another measure, which economists now frequently use to assess investments, is net present value (NPV), although there are disagreements about how benefits are discounted. While built capital is often discounted like other financial assets, many argue that discount rates for natural capital should be close to zero, because ecosystems provide irreplaceable services over long timescales. This has profound implications for resilience: if declining natural capital reduces the capacity to withstand shocks, investments that safeguard ecosystems generate dividends that endure across generations.

Seen from this perspective, resilience investment primarily generates value by protecting natural resources, functions, and states. They also restore value where environmental degradation has occurred and, in some cases, create new value by enabling transformative shifts to more sustainable and just social-ecological systems. Framing ROI through this wider lens helps clarify why resilience investments are not simply ways to lower costs but essential strategies for sustaining prosperity for future generations.

4 Resilience is a cycle of learning and innovation

Resilience is a cycle that demands continuous experimentation, learning, and innovation. Understanding resilience dynamics and the alternations between phases of rapid change and relative stability opens pathways to new and better futures.

Resilience is not an end goal but a process

Building resilience is not a one-time fix; it is an ongoing process that requires different ways of learning and doing during periods of rapid change, gradual change, and relative stability. As older systems that evolved under past conditions begin to fail in meeting current challenges, opportunities arise for new relationships and structures better aligned with present realities. Emerging systems have the potential to adapt and grow stronger through these transitions. This adaptive cycle creates opportunities to build resilience, but also introduces risks that must be carefully managed.

Rapid change: crisis as a catalyst for innovation

During phases of rapid change, such as the outbreak of a crisis, system resilience is weakened. As old practices and structures break down, a space is created where both risks and opportunities can emerge. Coping, adaptive, and transformative strategies are needed to respond effectively and support resilient approaches. Learning from past experiences can strengthen emergency responses and coping capacities. At the same time, new resources and strategies are likely to emerge, and innovative actors—such as entrepreneurs or visionary civil society leaders—can guide the system toward new adaptive and transformative pathways. For example, cities recovering from disasters, such as a major fire or a devastating earthquake, often implement zoning reforms, invest in more resilient infrastructure, and introduce new housing policies that transform urban systems. Periods of rapid change can also spark institutional innovation, such as the creation of new public agencies, the establishment of new emergency funds, or the implementation of water management frameworks. Disruption can create opportunities for experimentation in governance. These examples demonstrate how rapid-change phases can act as catalysts for innovation, opening space for novel ideas and new paradigms that depart from rigid, legacy approaches.

Weaving old and new knowledge for transformative pathways

Even though resilience is rooted in change and a forward-looking perspective, innovation around resilience does not mean discarding the past. Memory, past learning, and traditional knowledge have a vital role to play. When traditional or marginalised knowledge systems are ignored, blind spots can emerge and mistakes might be repeated. In contrast, combining old with new knowledge and practice can lead to the emergence of more inclusive and effective solutions. Mexico's production of agave for tequila spirit combines pre-Hispanic fermentation techniques

with European distillation methods and contemporary technologies. This collaboration demonstrates how combining old and new knowledge can create innovative approaches (see Must-Know #9).

Importantly, phases of rapid change also provide space for abuses of power by those seeking to consolidate control or exploit crises. Mindful leaders need to recognise these risks and ensure that systems remain transparent and inclusive, accommodating diverse perspectives and ideals. When diversity flourishes, a space is created for novelty and innovation (see Must-Know #5).

Gradual change: scaling and consolidating innovations while avoiding rigidity

During a period of gradual change, resilience is maintained by testing, scaling, and institutionalising any innovations that emerged during the period of rapid change. To effectively scale and develop these innovations, ongoing adaptation, close monitoring, continuous learning, and coordination across scales are essential. Over time, innovations can become standard practice.

But stability brings its own risks, especially rigidity. As innovations become institutionalised and entrenched, those benefiting from the status quo may resist further change. Systems can become "locked in", overly uniform, or too connected, which decreases resilience to future shocks. Breaking free from such rigidity requires coordinated efforts across local, regional, and global scales to dismantle outdated structures, restore diversity, and enable new cycles of innovation and learning.

During stable periods, resilience can be built quietly through ecological, social, and institutional practices. In old forests, steadily working over a period of decades to maintain biodiversity and healthy soils can reduce a forest's vulnerability to pests, fire, and climate shifts. Agricultural systems can also benefit from this slow resilience. Australian wheat farmers developed drought-tolerant varieties and adaptive technologies during stable growing seasons, thus enabling existing levels of production to persist despite gradual changes in soil salinity and fluctuating wheat markets. Social resilience can also be strengthened in this way. Strong community networks and local knowledge built during steady times can provide the capacity to cope when economic or environmental shocks to the system take place.

Leadership and anticipation: knowing when and what to change

Resilient leadership means knowing when to push for change, and when to focus on maintaining stability. Leaders looking to strengthen resilience are able to anticipate shifts, are willing to experiment with existing strategies, and are keen to combine old and new ideas (see Must-Know #2). This anticipatory capacity is key. Visioning and scenario-planning tools can help leaders explore alternative futures, spot trends, and challenge assumptions.

Understanding how innovation, experimentation, and continuous learning work within phases of rapid and gradual change is vital to creating more resilient and fair systems that avoid the traps of power, rigidity, and injustice. Approaching resilience in this way creates opportunities to spot new pathways, chart a course, and support change that leads to better futures.

5 Diversity is essential for resilience to thrive

Diversity is a cornerstone of resilience. This includes not only biodiversity but also the diversity of knowledge systems, cultures, practices, social structures, institutions, and livelihood strategies. Diversity is both a source of persistence, providing multiple options, and a source of adaptation, and transformation.

Why diversity matters for resilience

Resilience emerges from the interplay of different types of diversity. Each plays a distinct but interconnected role in strengthening the capacities of systems to cope, adapt, and transform (see Must-Know #2).

Diversity provides options and flexibility: if one pathway is blocked, another can be pursued. This is true in ecosystems, where multiple species perform different roles, and in societies, where varied skills, perspectives, and institutions provide people with ways to respond to challenges. In this sense, diversity acts like an insurance policy, preventing systems from becoming locked into a single, thus highly vulnerable, way of doing things.

At the same time, diversity is a source of novelty and innovation. In nature, genetic and species diversity fuel evolution, while in social systems, diverse actors, ideas, knowledge, practices, and cultures spark creativity and enable technological and social innovation. Together, these options and innovations make diversity a cornerstone of resilience. Different approaches can help systems both to persist in the face of shocks and to transform when new futures are needed.

Response diversity and redundancy keep options open

Response diversity describes the fact that different elements respond to shocks in different ways. In fisheries, for example, different species react differently to storms or temperature changes. A diverse fish stock, therefore, can help to stabilise the overall food supply and income for coastal communities. Such response diversity reduces vulnerability and helps communities to cope with uncertainty.

Redundancy can also work to strengthen resilience. Having multiple elements that serve similar functions means that if one element is lost, the others can continue to perform the function. Deliberate redundancy and response diversity can work together to ensure that each subsystem has a backup that responds differently to shocks and can thereby maintain key processes. In coral reefs, overlapping roles among grazing fish mean that, if one species is lost due to overfishing, others will still be able to control the presence of algae. In social systems, ensuring people have shared knowledge and similar skills can help to maintain key functions during crises such as war or natural disasters.

However, redundancy without complementarity—or when responses are too similar—weakens resilience. For example, excessive redundancy in management organisations can increase administrative costs, create power struggles between departments,

and produce conflicting rules. This can slow down decision-making and create bottlenecks in the system.

Resilience requires diversity in many forms

Functional diversity

Resilient systems are those that support different types of activity. For example, resilient agricultural systems use mixed cropping rather than single-crop methods. Growing different types of plant species provides more stable yields and reduces damage from pests and nutrient loss compared to single-crop farming. More broadly, landscapes that combine natural ecosystems with farmland attract more pollinators, mitigate erosion, and sustain ecosystem services.

Capital diversity

Capital diversity is about not putting all of your eggs in one basket. Financial resources and robust infrastructures are important for long-term resilience, but natural and social capital are equally vital (see Box 2). Societies that invest in ecosystems, institutions, health, and education—not just roads, buildings, and technologies—are more resilient overall. Failing to support these interdependencies can lead to environmental degradation, social breakdown, and economic instability.

Social diversity

A variety of social organisations, networks, norms, and practices can help systems deal with different types of problems. Social diversity can enhance people's ability to cope, adapt, and transform in the face of change. In Ethiopia, traditional burial societies (iddirs) cover funeral costs and strengthen community resilience by providing financial help, emotional support, and mutual aid to families during illness or death. Migration adds to social diversity, bringing new skills, types of knowledge, and connections that make communities more flexible and innovative. When rooted in both local traditions and enriched by new arrivals, social diversity becomes a key ingredient in resilience.

Cognitive diversity

Diverse perspectives, thinking styles, and problem-solving approaches—known as cognitive diversity—are especially valuable in times of uncertainty. Teams with varied cultural backgrounds and worldviews are more creative and better at finding innovative solutions. Groups like these are less likely to follow uniform patterns of thinking and are more likely to explore a wider range of possible solutions. This effect has been shown in universities, businesses, and governments, where diverse teams often outperform more homogeneous ones, even when the latter are highly skilled.

Safeguarding diversity is a necessity

Functional, capital, social, and cognitive diversity work together to create resilient systems. Despite its importance, key elements of diversity are under threat. Biodiversity, in particular, is declining faster than at any time in human history, with serious implications for the Earth's stability and human well-being. Safeguarding and fostering diversity in all its forms across ecosystems, societies, economies, and institutions is not just an aspiration but a practical necessity for building resilient futures.

6 Relationships among people and with nature build resilience

Resilience grows through relationships—between people, with nature, and within landscapes and ecosystems. These connections strengthen the flow of resources, knowledge, trust, and care. To support resilience in our changing world, development banks, investors, governments, businesses, and communities must invest in these relationships.

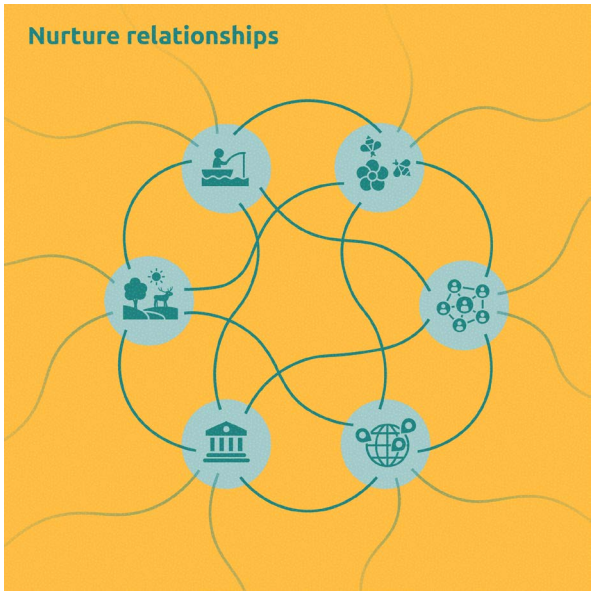
Relationships are the roots of resilience

The relationships people have with the world around them take many forms. People connect with each other through care, exchange, and learning. They develop strong ties to the natural world through leisure and commerce. Organisations work together across sectors and regions. Ecosystems are comprised of species movements and energy flows. Farmers, fishers, and gardeners can develop strong ties to local ecosystems as they tend to their environment in an uncertain world. When disaster strikes, individuals and communities rely on personal relationships and external networks for support and recovery.

The resilience of any system—whether a community, a forest, or a city—depends not only on what or who is connected but also on the quality of those connections. Strong, reciprocal relationships underpin vital elements of resilience: information flows, support, trust, and materials. These relationships also help to protect against shocks, foster learning, and coordinate action.

Stronger together: resilience through social ties

Social connections between people, households, communities, and organisations are a source of resilience. In times of stability, they help people access resources and opportunities. In times of crisis, these relationships become lifelines. Disaster research shows that both existing and new relationships play a crucial role in response and recovery efforts by offering emotional support, sharing knowledge, and coordinating action. Investing in social capital before a disaster occurs—promoting the trust, norms, values, and networks that are necessary for close and distant groups to connect—



strengthens the collective capacity people and systems need to respond to uncertainty and shocks.

Recognising and protecting positive social ties is an essential part of resilience. Policies and interventions should avoid disrupting positive relationships and instead find ways to strengthen them, especially those that make connections across different scales and levels of decision-making. Trusted leaders can help build and mobilise these connections.

Unfortunately, the benefits of social networks are not always shared equally. Discrimination, exclusion, and power imbalances often undermine cooperation and thwart efforts at relationship-building, risking the further marginalisation of already vulnerable groups (see Must-Know #9).

Connecting people and nature

The human relationship with nature matters deeply. For people like farmers, pastoralists,

or fishers, resilience comes from years of living with, observing, interacting with, and adapting to the natural world. These relationships are shaped by local knowledge, cultural practices, and the informal rules that govern how people manage ecosystems and respond to change. Research shows that communities with a strong relationship to nature respond better to environmental change. In the fishing communities on the Papua New Guinea islands, some fishers observed how different fish species adapted to environmental change. When they shared this knowledge with others, they created a new collective wisdom that helped the whole community to adapt and start fishing in new ways. These individuals, with their deep connections to nature, made transformative action possible. These strong social-ecological connections are a powerful tool for resilience and should be protected and encouraged.

Even in cities, where daily life is more separate from the rhythms of the natural world, human relationships with nature are important. They support mental and physical health, strengthen ecological values, and drive environmental action. Urban residents can strengthen social-ecological connections through nature-based education, cultural practices, or outdoor experiences in local parks and gardens. In our rapidly urbanising world, investing in ways to nurture these connections should be a particular priority.

Keep nature connected

Ecosystems also benefit from relationships and being connected. Ecological connectivity is essential because it sustains the natural systems that underpin human well-being. Connectivity ensures species can move and adapt so that they can access the resources they need to survive, even when natural conditions change. Connectivity maintains genetic diversity and supports key services like pollination and clean water.

Protecting a single species or an isolated patch of nature does not allow these connections to flourish. Efforts should be made to protect entire ecosystems. This includes restoring damaged environments, fostering biodiversity (see Must-Know #5), and ensuring the connectivity of landscapes and seascapes. Such efforts strengthen both nature and people, providing food security, enhancing resilience to climate change, and creating a healthier biosphere.

The paradox of connectivity

While connectivity is often beneficial, too much of it—especially across long distances—can threaten resilience and create new risks. Hyperconnectivity, driven by global trade infrastructures and land-use changes, has tightly linked the fates of highly dispersed regions. Disruptions within these co-dependent systems can have a ripple effect across borders. Just as isolated systems can collapse when faced with a challenge, systems that are too tightly linked, lacking redundancy or sufficient buffers, can suffer a cascading cycle of failure when things go wrong. Deforestation in one region can reduce rainfall in downwind regions. Global food systems can spread pests and diseases across borders. The 2008 global financial crisis demonstrates how disruption to a small number of tightly interconnected banks using a similar risk-management model allowed shocks to spread across the global financial system.

Connectivity can also cause harm when connections are imposed. For instance, colonial powers forced global connections that destroyed local languages, cultures, and relationships with nature, undermining deeply rooted resilience.

Building resilience, therefore, means striking a balance between connection and autonomy. Communities need the space to self-organise, make their own decisions, and adapt in ways that reflect their unique environments. Strong local agency—paired with well-thought-out regional and global connections—is key to navigating an increasingly interconnected and uncertain world.

7 Governing and negotiating trade-offs is key to resilience

Almost every decision involves trade-offs, and addressing these across scales, interests, and generations is vital to avoid unintended harms, prevent conflict, and build just, lasting resilience.

Every decision has a ripple effect

In today's hyperconnected world, decisions made in one place or time ripple out with consequences for people, places, cultures, and economies elsewhere and far into the future (see Must-Know #6). Almost every decision involves trade-offs—gaining one thing usually means giving up something else. Investing in one sector may reduce resources for others. Policies that benefit one social group may disadvantage another. Pursuing short-term economic gains through resource extraction can damage the environment that future generations depend on.

This raises difficult questions about how to weigh immediate needs in times of crisis against long-term sustainability (see Must-Know #3) and how to balance equity across generations and social groups—especially when the poorest and most vulnerable bear the greatest costs (see Must-Know #9).

Nature does not follow human boundaries

Our living planet adds another layer of complexity. Nature's boundaries rarely align with human-made political and administrative borders. Rivers flow across municipalities, forests cross national borders, and fish migrate across jurisdictions. This mismatch can lead to fragmentation, inefficiencies, and inertia. In addition, resilience challenges usually involve multiple stakeholders with varying capacities, interests, and values, which makes coordination more difficult and increases the risk of conflict.

Trade-offs should not be ignored, but carefully negotiated

When resilience-building projects ignore trade-offs, they do not work very well. They often benefit some groups at the expense of others. Levees, for instance, may protect one neighbourhood from flooding but worsen the risk downstream. National campaigns for food self-sufficiency—such as import bans or heavy subsidies—can undermine international cooperation and leave countries more exposed to global market shocks. In contrast, resilience thinking encourages trade-offs to be made explicit and negotiable. In Indian cities like Surat and Indore, dialogues among stakeholders negotiated a balance between flood protection and local livelihoods. In Lilongwe, Malawi, river restoration efforts combined ecological goals with the needs of informal human settlements. And in Accra, Ghana, planners, NGOs, and informal economy actors aligned infrastructure with housing rights and inclusion. These examples show that trade-offs are not removed but openly addressed through inclusive processes that strengthen resilience for whole systems.

Governance approaches to address this complexity

Resilience challenges cut across administrative boundaries, sectors, and time horizons. No single institution can manage them alone. This means that governance needs to reflect the natural systems and social processes it seeks to steward. For example, forests and rivers are socially and ecologically connected. Forests regulate water flows and water quality, while river systems shape and sustain forest ecosystems. Yet actors responsible for each are often siloed in different agencies or at different levels of decision-making. Resilient governance requires collaborative leadership that builds bridges across organisational divides, mediates conflicts, and creates the networks that sustain collaboration (see Must-Know #6). Collaborative, polycentric, and adaptive governance is better attuned to navigating trade-offs and building resilience.

Collaborative governance creates spaces where governments, communities, businesses, and civil society work together to share knowledge, identify and discuss trade-offs, and find common ground. Polycentric governance means that decisions are not concentrated in a single authority but spread across multiple, overlapping centres that can support each other and reduce the risk of system paralysis. Adaptive governance embraces change. As conditions shift and knowledge evolves, institutions must be able to adjust and seize opportunities for adaptation and transformation (see Must-Know #4).

When well-designed, these governance approaches help societies to coordinate their activities, negotiate trade-offs, balance competing interests, prevent conflict, and avoid fragmentation. However, societies must also be aware of the justice and power dynamics at work (see Must-Know #9). Inequalities in decision-making can constrain effective governance.

Beyond one-size-fits-all solutions

There is no universal blueprint for the governance of resilience. Different challenges demand different approaches. Long-term issues like climate change require durable institutions that build trust and shared values over time. Sudden crises, like wildfires or floods, call for rapid mobilisation, which works best when trust and relationships are already in place.

In some contexts, centralised structures can promote rapid decision-making. In others, informal collective action can respond more effectively. Resilient governance aligns centralised coordination with local initiative, tailoring responses to the scale, speed, and context of the challenge.

Simple formulas—such as handing control over entirely to governments, markets, or communities—rarely succeed on their own. What works in one place or time, or for one particular issue, may fail in another. However, legitimacy, fairness, and the quality of relationships between people and ecosystems are likely to shape positive outcomes (see Must-Knows #6, #8, and #9).

Resilient governance fits ecological realities, creates spaces for collaboration, supports learning and innovation, and meaningfully involves those closest to the problem. These principles can help anticipate, identify, and negotiate trade-offs, share benefits more fairly, and strengthen resilience.

8 Empowering agency unlocks resilience

Agency is key to activating core resilience capacities. Supporting and developing agency means enabling people and institutions to take intentional and grounded action—whether in anticipation of, or in response to, adversity.

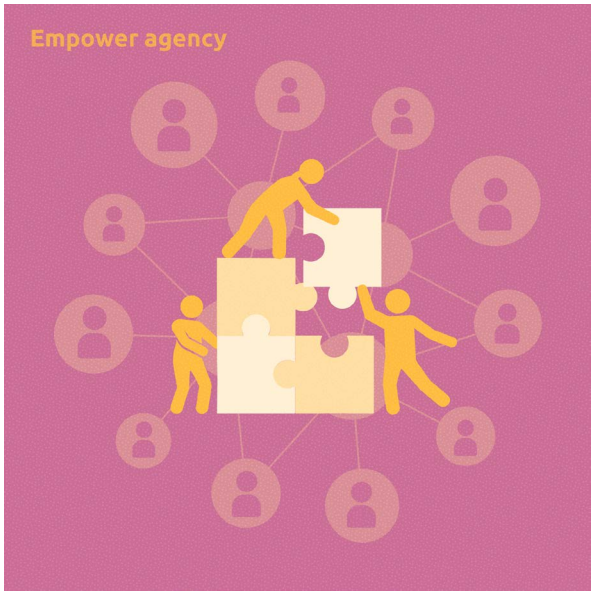
Resilience depends on empowered action

Agency is the capacity to make decisions and act on them. Exercising agency means having the freedom to access and effectively use knowledge and resources. Agency can be used at all levels of society—by individuals and households as well as communities, civil society groups, businesses, and governments.

For individuals, agency means believing you have the ability to act and the ability to influence change. In a collective context, agency manifests itself through shared visions, community organisation, and coordinated actions. Agency takes many forms—farmers proactively adopting new practices, communities organising for climate justice, or city councils investing in nature-based solutions.

Agency makes the capacities of coping, adapting, and transforming possible (see Must-Know #2). The stronger the agency, the greater the ability to act early, collectively, and intentionally. Believing in their power to act enables people and institutions to respond proactively—not just reactively—to disruption and change. They are able to choose when and how to cope, adapt, or transform.

With agency, people and institutions can prepare for floods, survive droughts, or transition away from declining livelihoods or outdated practices and legislation. For example, farmers can come together in cooperative arrangements to negotiate prices and conditions with retailers and thus increase their decision-making capacities within global supply chains. In times of geopolitical crisis, strong agency can help governments, businesses, and industries coordinate responses and adapt to disruption. However, when agency is concentrated in the hands of powerful actors, decisions may be skewed in their favour, thus highlighting the need to anticipate trade-offs and ensure inclusive, equitable responses (see Must-Know #7). Together, such expressions of agency enable people and institutions not just to cope with change but to shape it.



How to support agency

Agency does not automatically emerge—it must be supported. This often requires structural changes, power shifts, and policies that ensure equitable access to education, income, and other infrastructure resources (see Must-Know #2 and #9).

People and institutions cannot make good decisions and act upon them if they are disempowered, excluded, or constrained. Even where agency exists, this should not be used as an excuse for inaction. Some institutions cite strong community agency as a reason not to invest in them, assuming they are already

resilient. But this logic is flawed. Strong agency should be recognised and supported, not left to carry the burden alone.

Agency is strengthened through relationships

Agency is strengthened through relationships and networks (see Must-Know #6). Being well-connected—socially or professionally—can greatly boost people's confidence in their decision-making capacities and their ability to make a difference. This is especially important for excluded groups, such as young people, the disabled, women, or Indigenous communities.

Many important relationships are built through informal systems: local knowledge networks, social safety nets, or Indigenous governance structures. These systems are central to agency and resilience. If they are sidelined or weakened, the system's overall capacity to respond is reduced.

Hence, collective agency—organising for joint decision-making and action—is an important feature of resilience. Communities with high levels of autonomy, self-organisation, and local leadership recover from disasters more rapidly because they adapt more readily and are better able to drive transformative change.

Be aware of agency dynamics

Agency is not always distributed fairly. Internal inequalities—based on gender, wealth, ethnicity, religion, or age—can be exploited by powerful actors to serve their own interests. This can shift decision-making away from those most affected by social and ecological disruption and weaken resilience. If not carefully designed, resilience initiatives can unintentionally reinforce these inequities rather than resolve them (see Must-Know #9).

External actors can also erode local agency. For example, international mining or forestry companies may hold more sway with national authorities than local communities. When control over land is taken from local people, their ability to act is diminished.

Recognising these risks is essential to prevent conflict and ensure that agency leads to sustainable and just resilience.

9 Address power imbalances to foster equitable resilience

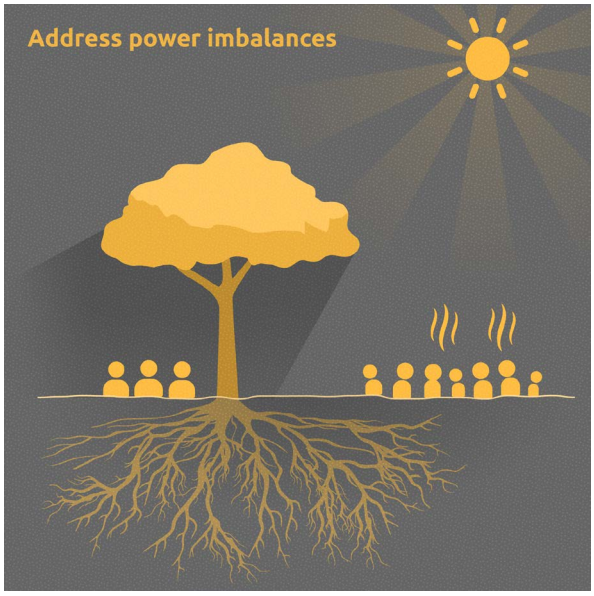
Building resilience requires directly addressing social inequalities, power imbalances, and historical injustices. Otherwise, resilience interventions risk reinforcing the very systems that cause vulnerability.

How inequalities undermine resilience

Social inequalities and power asymmetries shape the impact of a disruption or change process. Those without rights, with the least amount of power, are the ones most at risk. They have the fewest resources necessary to respond when disruption occurs. When resilience interventions ignore these dynamics, they may appear effective on the surface, but in fact they deepen exclusion, fuel distrust, and fracture the social connections and cooperation that underpin the kind of resilience needed to achieve sustainable and just outcomes. Initiatives that fail to recognise inequity become exploitative or ineffective, benefiting those already in positions of power while sidelining others.

This means that, while resilience initiatives are often presented as progressive and inclusive, they can often produce the opposite effect and unintentionally create winners and losers. For instance, urban climate adaptation projects may displace low-income communities in their construction of exclusive climate-friendly neighbourhoods. Similarly, large-scale conservation efforts can sideline the needs of Indigenous and other local actors who have stewarded these ecosystems for generations. Instead of driving real, transformative change, such initiatives risk undermining long-standing resilience practices. This can deepen existing inequalities, erode democratic processes, and promote conflict.

Equitable resilience, as a guiding principle, promotes actions that build resilience in fair and inclusive ways. It seeks distributional, procedural, and recognitional justice by ensuring equal protection from harm and fair access to benefits. At the same time, equitable resilience can also serve as a framework for analysis. It can help uncover the root causes of inequity and identify who is included in or excluded from decision-making, and understand how these dynamics shape unequal access to benefits and protection from harm.



Historical legacies shape resilience capacities and agency

Resilience is deeply influenced by inequalities rooted in history. Centuries of colonialism, slavery, racism, and economic exclusion have left many communities—particularly Indigenous, rural populations in the Global South—with limited resources and decision-making power. At the same time, those who have disproportionately contributed to environmental degradation—such as wealthy individuals, corporations, and industrialised nations—have the means and political influence to shield themselves from harm and influence the terms of change in their favour.

This uneven playing field gives rise to troubling patterns and paradoxes. Communities with real, lived resilience, including coping and

adaptive strategies built over generations, are sometimes overlooked or undervalued in formal resilience interventions. In turn, some systems—like the fossil fuel or mining sectors—are highly resilient, but in ways that cause environmental harm and social inequality. These imbalances must be acknowledged and addressed to ensure that resilience-building is fair, inclusive, and effective for all.

In many cases, actors who benefit from the status quo seek to resist change, maintain their privileges, and slow progress towards broader system transformation. When equity and justice are not placed at the centre of resilience interventions, this leads to unsustainable practices—such as overconsumption, poor environmental compliance, or natural resource exploitation—all of which can erode the long-term resilience of both ecosystems and communities.

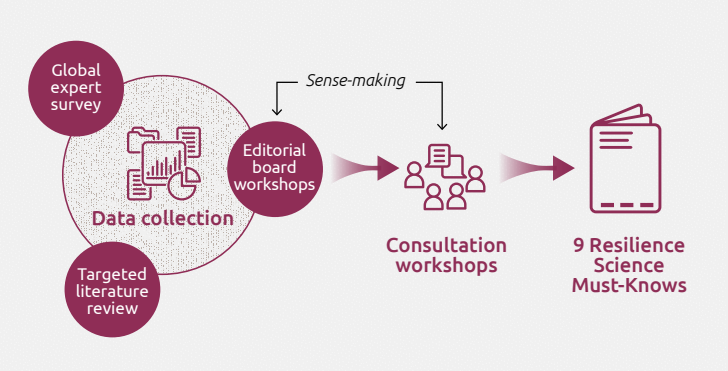
Centring equity and justice in resilience intervention

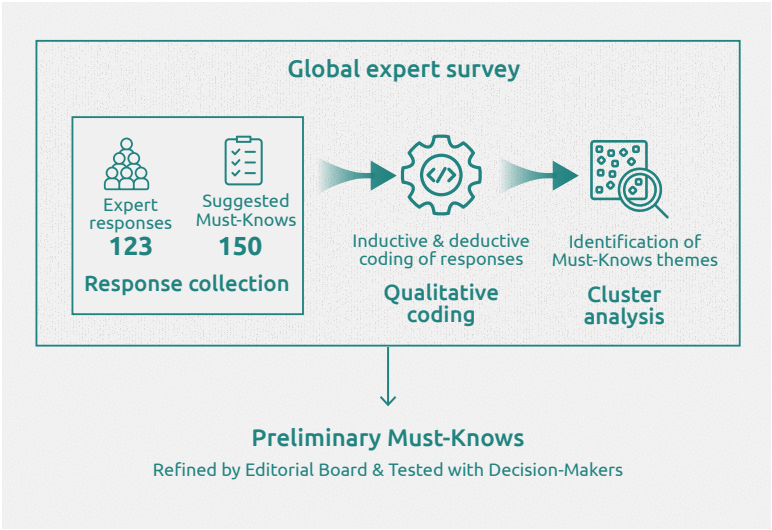
Equitable resilience should be placed at the centre of the strategies, actions, and innovations implemented to promote resilience. This involves addressing how risks, benefits, and harms are distributed and ensuring that decision-making processes are inclusive and meaningful, especially for those who have historically been excluded from them. It also requires acknowledging and valuing diverse kinds of knowledge and practices. Superficial fixes or compensation alone are not enough. Addressing structural inequities calls for more substantial, even transformative, shifts, confronting systems tied to historical injustices, resource-dependent economic models, and exclusionary governance.

Ultimately, equitable resilience is about ensuring that resilience serves all, and not just a few. It requires confronting uncomfortable truths, rethinking dominant narratives, and creating space for more inclusive, just, and transformative pathways toward a sustainable future.

How we developed the Resilience Science Must-Knows

To ensure that the **Resilience Science Must-Knows** are both scientifically robust and practically relevant, we followed a four-step process combining a global survey with resilience experts, targeted literature review, editorial board collaboration, and consultation workshops with decision-makers. This approach allowed us to move from broad expert insights to a final, actionable set of Must-Knows grounded in science and real-world needs.



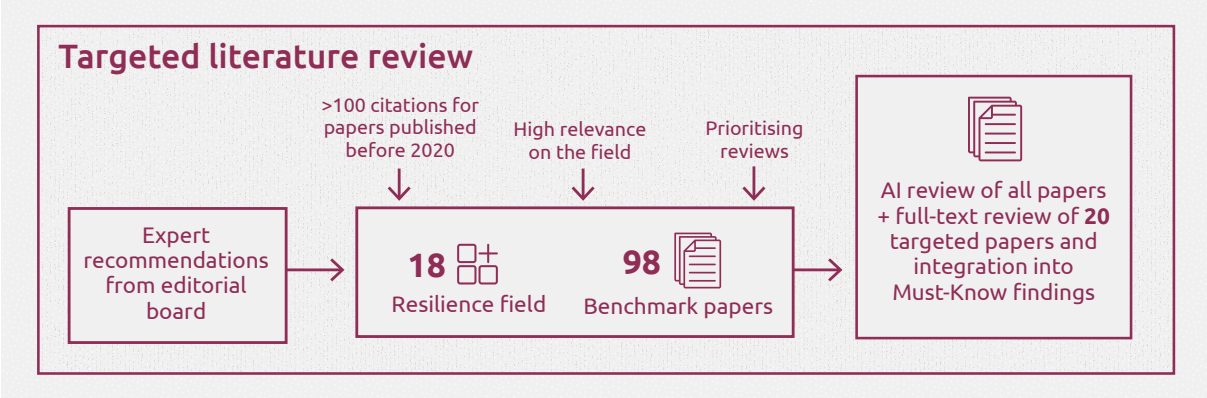


Global survey of resilience researchers

We surveyed 123 researchers from leading global institutions spanning sustainability science, social-ecological systems, climate adaptation, ecology, economics, and governance. They proposed 150 Must-Knows, from which we identified common themes through qualitative coding and hierarchical cluster analysis, resulting in 12 thematic groups. These were refined with input from the project team and Editorial Board and tested through consultation workshops with decision-makers.

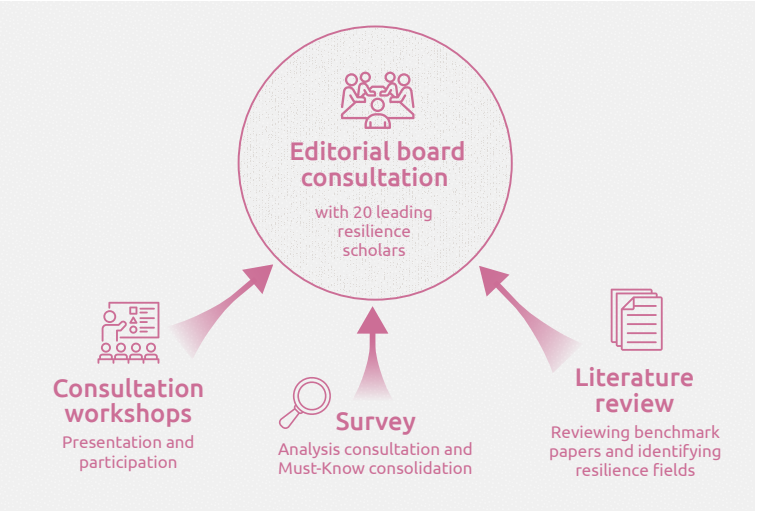
Targeted literature review

To anchor the Must-Knows in the latest resilience science, we reviewed 98 benchmark papers across 18 resilience fields. Papers were selected for their high impact and relevance, drawing on expert recommendations from the Editorial Board. Using the AI-assisted tool ELICIT, we extracted key insights, findings, and gaps.



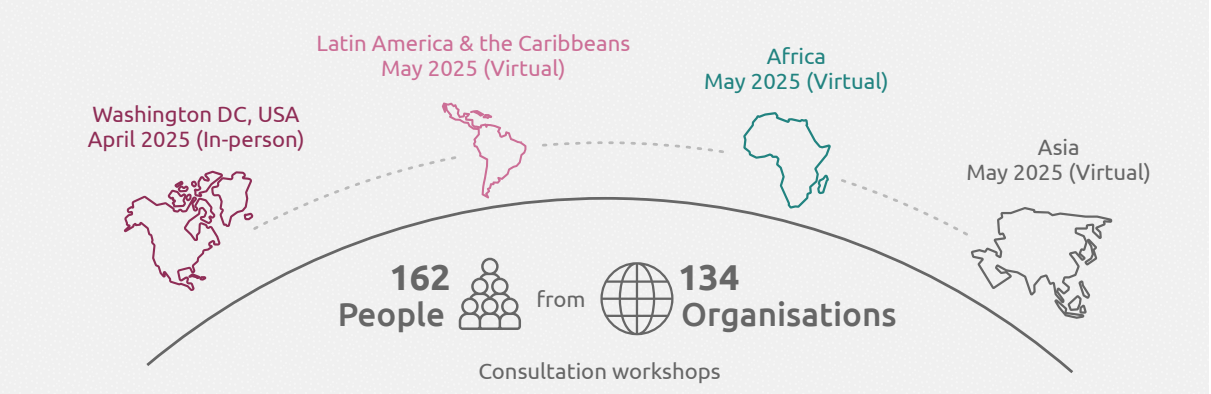
Editorial board process

An Editorial Board of 20 leading resilience scholars guided the process from start to finish. Representing diverse disciplines, regions, and schools of thought, they played a central role in shaping, analysing, and writing the Must-Knows. The Board met in seven workshops, including a three-day in-person session in Stockholm to consolidate drafts, form author teams, and develop the report.



Consultation workshops

To sense-check and refine the findings, we held four consultation workshops with 162 leaders from 134 organizations in policy, business, and civil society. These included an in-person workshop at the IMF Spring Meetings (Washington, D.C., USA) and three regional online sessions covering Latin America and the Caribbean, Africa, and Asia.



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