UN environment programme

Navigating New Horizons

A global foresight report on planetary health and human wellbeing

International Science Council
The global voice for science

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This report was developed, produced and authored by a core team from UNEP's Office of the Chief Scientist in collaboration with colleagues from the International Science Council (ISC):

Andrea Hinwood, UNEP Chief Scientist
Dina Abdelhakim, Programme Officer
Jason Jabbour, Senior Coordinator (Lead Author)
Michael Asquith, Consultant
Sarah Cheroben, Senior Programme Management Assistant

Anne-Sophie Stevance, Head of Global Science Policy Unit, ISC
James Waddell, Science Officer, ISC
Peter Bridgewater, Senior Advisor, ISC

Editorial team: Amanda Lawrence-Brown, Michael Logan and Richard Crompton
Layout and design: Beverley McDonald

Glossary

Disruptions: Sudden or sharp shifts that can interrupt a trend, behaviour activity or process and can cause a potential disturbance or problem. Disruptions can be negative or positive (e.g. process improvements, innovation, solutions etc.).

Environment: The natural world including as a whole or in a particular geographical area, especially as affected by human activity and includes human settlements.

Exnovation: The concept of exnovation refers to the process of actively discarding outdated, inefficient or harmful technologies, practices and norms, and that goes hand-in-hand with actively unlearning ingrained beliefs, attitudes or behaviours that may have underestimated transformative potential to advance sustainability.

Foresight: A structured, multi-disciplinary approach to thinking systematically and exploring trends, emerging changes and to inform and enable present-day decisions and priority-setting. Foresight is not about forecasting or predicting the future, but rather it uses alternative futures and collective intelligence gathering processes intended to augment traditional forms of analysis and decision-making.

Horizon scanning: The foundation of a Strategic Foresight process and is the systematic outlook to detect early signs of potentially important developments by examining potential threats and opportunities. It involves a set of techniques and assumes ongoing monitoring of changes as they mature into trends. Horizon scanning can be used to support organizations and decision-makers in anticipating future developments, managing risks and pursuing opportunities to build resilience to future shocks and reduce uncertainty.

Human wellbeing: Can be understood as how people feel and how they function both on a personal and social level, and how they evaluate their lives as a whole.

Market leakage: An increase in greenhouse gas emissions when a project changes the supply and demand equilibrium, causing other market actors to shift their activities. For example, if a large forest-conservation project reduces the local timber supply so that demand is unmet, this may increase prices and pressures on forests elsewhere.

Megatrend: A widespread and long-term (or sustained) social, economic, environmental, political or technological pattern of change that is slow to form but has a major impact once in place—the trajectory of change (and sometimes the impact) can lead to irreversible transformations or disruption. While megatrends are global in nature, they can unfold differently from region to region, Megatrends have the nature of permanent trends that in a growing degree permeate all areas of human life.

Nature-based solutions (NbS): These are approaches to address societal challenges, such as climate change or biodiversity loss, through nature and its processes. They involve conservation, restoration or sustainable management of ecosystems to provide benefits for people and the environment.

Planetary health: Includes the relative condition and ability of our ecosystems, small and large, and the Earth's natural systems (e.g. geosphere, biosphere, cryosphere, hydrosphere and atmosphere) to support human societies.

Global Polycrisis: Occurs when two or more crises that may be independent or not, become causally entangled—i.e. the interactive effects among them escalate the severity of impacts of each—and thereby significantly degrade global planetary health and thus humanity's prospects for wellbeing in a relatively short period of time. These interacting, cascading series of events or sudden (non-linear) crises, across space and time, occur simultaneously and therefore produce harms greater than the sum of those the crises would produce in isolation, were their host systems not so deeply interconnected.

Signal of change: The initial symptoms (or early signs) of change—they can be any small but potentially important development, practice, idea, event or innovation that points to a future possibility, different to today's norm or that could potentially disrupt, positively or negatively, current trends. Signals of change can be thought of as seeds of a possible future development. In foresight, they are often hidden among disconnected pieces of information that may initially appear to be background noise but ultimately have disruptive potential through direct or indirect impacts on the global environment. Signals can also help illuminate an unexpected aspect of an ongoing change.

Social contract: A tacit agreement among members of a society—the state, citizens, as well as private and civil society sectors—that defines their mutual relationships, respective responsibilities, shared values and expectations of each other.

Solar radiation modification: Intentional human intervention in the Earth's climate system to reflect a portion of incoming sunlight back into space or to reduce the amount of solar radiation reaching the Earth's surface, with the aim of counteracting global warming or mitigating its effects.

Trends: A general pattern or direction of change that has been observed over time, which may continue or shift in the future. Trends can be strong or weak, increasing, decreasing or stable (mature) and are used in foresight to understand the trajectory of developments.

Triple planetary crisis: The intersecting challenges of pollution, biodiversity loss and climate change, collectively posing significant threats to the Earth's environment, ecosystems and human wellbeing.

Unlearning: The process of letting go of outdated or inaccurate information, beliefs or behaviours in order to make room for new learning and growth.

Zoonotic diseases: Illnesses caused by pathogens, such as viruses, bacteria or parasites, which can be transmitted between animals and humans.

Contents

Foreword

In the face of the triple planetary crisis of climate change, nature and biodiversity loss, and pollution and waste, we might easily throw up our hands and imagine the world of 2050—just 25 years from now—as a dangerous, damaged place where both human society and the environment it inhabits face new and heightened threats.

However, the point of this report is not to predict the future. The intention, by drawing on a wide diversity of disciplines and voices, is to foresee the future. What, might you ask, is the difference? Prediction is passive: it means locking in a vision of the future. Foresight is about imagining the future and then looking at how to change it.

Foresight enables a shift in perspective, opening-up valuable insights and revealing unconsidered or underestimated threats and opportunities to achieve planetary health and human wellbeing. It enables us to anticipate shocks and disruptions that the world should prepare for.

From an environmental perspective, this requires looking at and beyond the triple planetary crisis to include other significant drivers of change, including social and demographic shifts, media and information, technology and Artificial Intelligence, geopolitical tensions, governance, social and institutional trust, migration and conflict, among others. Taking this holistic view helps us to see and understand more.

This report offers insights into the evolving environmental and global context in which we are operating. This is reflected through a constellation of shifts, while also providing a range of emerging signals of change—each hinting at potential disruptions that could accelerate or redirect current trends and create new forces, good and bad. Ignoring such signals and potential disruptions limits future choices.

It is not always easy to identify these signals and disruptions. However, through collective and strategic intelligence, key areas for action can be identified to intercept these potential disruptions. These areas are applicable not only to United Nations (UN) agencies, such as the United Nations Environment Programme (UNEP), but to governments, decision-makers and stakeholders at all levels.

The disruptions presented in this report are not guaranteed to happen. But they could happen. We need to be ready. So, this report suggests how to monitor, navigate and prepare for them, not least by maintaining focus on meeting international goals, avoiding policy traps and missed opportunities.

UNEP's mission is to place the environment at the heart of the work of the UN and to support Member States, to look beyond the horizon into the future and reshape the present—so that we can support the actions, changes and course corrections needed to protect the planet as a basis for human peace, prosperity and equity.

Inger Andersen, Executive Director, UNEP

Preface

In societies and governments, there are many cognitive and political biases that force a focus on the short term—to the detriment of long-term prosperity. Lagging Sustainable Development Goals (SDGs), climate change, declining biodiversity and a raft of other issues show that our focus on the short and near term is doing the world no favours. The world faces multiple and cascading issues, which are affecting all countries and the developing world more acutely.

If our species is to flourish in face of many complex challenges that do not play out within neat electoral cycles or quarterly financial reports, we need to get better at focusing on and preparing for the future. COVID-19, conflict and disasters have demonstrated the need to be prepared for both the expected and unexpected.

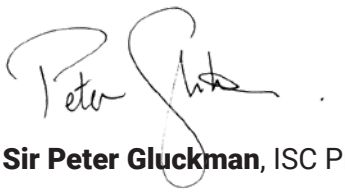
When the United Nations Environment Programme (UNEP) and the International Science Council (ISC) embarked on this discovery of the tools and application of foresight, it became clear that we are not very good at this, over any timescale. A year ago, a global recession was seen as a foregone conclusion. Yet, even with war, geopolitical volatility and upheaval, a recession has not been triggered. In part, this is because forecasting models and precedent often fail to consider the situational and idiosyncratic context. In other words, the resilience of society and our systems was underestimated.

This is where foresight comes in. Foresight describes the thought processes and analytical approaches that aid more forward-thinking, so that decisions can direct us towards desirable futures and prepare for unknowns. While we may not know exactly what or when, it is possible to use robust foresight processes to understand the risks and trends that societies must prepare for.

This joint UNEP-ISC foresight report describes some of the ways in which capacity for applying foresight can be built. It extends beyond UNEP's traditional sources of data and information—the strictly 'environmental'—to encompass all factors that could determine the future trajectory for planetary health and human wellbeing.

The primary intent is to build a focus on the future, so that member states, policymakers and societies can have the best possible information on how to be prepared for disruptions and take decisive action. The report also provides actionable insights to the UN system on which aspects should be given consideration for strategic planning and developing a clear sense of direction. It highlights the need to integrate policy making across domains to address many so-called wicked problems and help with the stewardship obligations all policy makers have as we confront the future.

Choices made now will dictate humanity's success in responding to the triple planetary crisis and achieving the SDGs. Foresight can help us to make these choices, build resilience by being more prepared, actively prevent negative disruptions and amplify positive disruptions. The future is coming. Foresight can help us decide what it will look like.



Sir Peter Gluckman, ISC President

Dr Andrea Hinwood, UNEP Chief Scientist

Executive Summary

As the leading global authority on the environment, the United Nations Environment Programme (UNEP) plays a critical role in keeping the environment under review and finding solutions that inspire, inform and enable nations and peoples to improve their quality of life without compromising that of future generations.

UNEP strives to empower the United Nations (UN) community, its Member States and individuals to identify issues requiring vigilance and to take anticipatory actions that can rebalance planetary health and human wellbeing. To do this, the organization needs to have a responsive, holistic approach to meet the demands of a rapidly changing world—a world of more fragility and greater uncertainty. UNEP has embraced foresight, a strategic capability and set of tools, to identify and explore possible disruptions on the horizon, to confront our ways of thinking about them and learn how applying such forward-thinking tools can prepare us for the challenges and opportunities ahead.

Foresight helps detect signs of approaching change, determine their potential developments and strengthen resilience against the unexpected—translating future uncertainty into present day choices. Put simply, careful and incisive foresight can help UNEP to achieve its aims of identifying and working on the right issues at the right time for the right audience.

This Navigating New Horizons report outlines a process focused on planetary health and human wellbeing—an intentional framing to expand the range of issues and informed views that typically shape UNEP's work. Why? To ensure we are looking in places not normally considered, but where the organization can act or provide advice for others with relevant portfolios.

This 18-month foresight process—which encompassed a two-part Delphi survey, the development of scenarios, sensemaking at global and regional levels and engaging with youth voices—has resulted in diverse data points and qualitative feedback to uncover what the future (near and far) could hold for planetary health and human wellbeing.

Through the process, it has become clear that the world is facing a different context than it faced even ten years ago. Some of the issues are the same, but the rapid rate of change combined with technological developments, more frequent and devastating disasters and an increasingly turbulent geopolitical landscape, has resulted in a new operating context, where any country can be thrown off course more easily and more often.

The world is already on the verge of what may be termed 'polycrisis'—where global crises are not just amplifying and accelerating but also appear to be synchronizing. The triple planetary crisis of climate change, nature and biodiversity loss, and pollution and waste is feeding into human crises such as conflict for territory and resources, displacement and deteriorating health.

The speed of change is staggering. Social norms, employment, leisure and our relationship with nature are all inexorably shifting. The rapid development of new technologies and artificial intelligence (AI) are influencing all facets of life. Overlapping and interrelated factors will influence the environment—these include competition for natural resources, new forms of conflict, mass forced displacement and migration, persistent widening inequalities, declining trust and weakened institutions, the prevalence of mis/disinformation and an increasing global multipolarity.

This new global context is giving rise to a series of critical shifts, emerging issues and potential threats that may or may not eventuate, but which the world needs to keep a watching brief on due to their potential to significantly disrupt different sectors and hence affect planetary health and human wellbeing. As witnessed over the past two years, even seemingly improbable or distant disruptions or circumstances—e.g. COVID-19, the Russian Federation's invasion of Ukraine, major conflicts and mass displacement in Gaza and Sudan, the global energy and cost-of-living crises—can quickly become a reality and affect the whole world. Thus, paying attention to signals of change, including weaker ones, with a view to anticipating disruption and minimising surprise is paramount.

The emerging issues and signals of change presented in the report are both new and old, with the convergence and interaction between seemingly distinct issues and the new global context making the signals important. The technology signals include the emergence and diffusion of innovations including speculative technologies with the report focusing on how AI will interact with and influence the decisions made about the environment, lives and lifestyles, for both positive and negative. Demand for critical minerals specifically, including for clean energy technologies, is set to increase rapidly and could have significant impacts on biodiversity and nature, food and water security and pollution. These pressures are extending to the deep sea, the outermost reaches to our planet's atmosphere and even outer space. This critical shift intersects with other technology signals of change including the rapid growth in space activity and orbital debris, and the potential deployment of Solar Radiation Modification (SRM) technologies, also known as solar geoengineering, which while perceived as unlikely must still be monitored.

Old issues such as weaponization of technologies and access to water, food, energy and critical infrastructure have been made potentially more problematic with the convergence of new technology and inability of legal systems to keep pace; notably AI and autonomous weapons systems, which increase the risk of environmental destruction and biological warfare. Growing antimicrobial resistance in the environment, emerging zoonotic diseases and ancient viruses arising from thawing permafrost are all signals requiring monitoring. Uninsurable risks and losses jeopardizing long-term prosperity, poverty alleviation and environmental protection; surging fossil fuel subsidies eroding the energy transition; and a looming mental health crisis amongst adolescents whose neural systems are increasingly primed for anxiety—each of these issues hint at deeper and potentially disruptive changes on the horizon. Ignoring these signals, as unlikely as they may be, comes with peril.

The good news is that just as the impact of multiple crises is compounded when they are linked, so are the solutions. This report has leveraged foresight to generate insights that can shift the momentum from the brink of polycrisis to polystability. Key to a better future is a focus on intergenerational equity and a new social contract reinforcing shared values that unite us rather than divides us. A new social contract would involve the global community pursuing transformative change across technological, economic and social factors and paradigms and collective goals. Such a contract—including the further refinement and integration of a liveability approach and supplemental index encompassing new economic and health measures—will better reflect, foster and support local, network-driven resilience.

Adopting agile and reflexive governance—with shorter-term time-bound targets to enable course correction combined with multi-layered monitoring at the UN level—would significantly enhance achievement of the Sustainable Development Goals (SDGs). Placing a new global emphasis on wellbeing metrics rather than pure economic growth will help the transformation needed. The future must be consultative, multilateral, cooperative and integrate the voices of traditionally marginalised groups, including women, youth, local communities and Indigenous Peoples.

Introduction

In 2023, the United Nations Environment Programme (UNEP) set out on a journey with the International Science Council (ISC) and regional partners to develop and implement a foresight trajectory. The ambition was threefold: to expand our collective capacity to anticipate the future, embed foresight and futures thinking in the culture of the organization, and, crucially, deliver a proactive reading on potential disruptions and untapped opportunities to enable better decisions, preparedness and anticipatory action. This Navigating New Horizons report aims to deliver on the latter goal: translating future uncertainty into present day choices that can get the world ready for what is coming. The insights and issues presented, and the conclusions drawn within this report, reflect a breadth of ideas, information and collective insights generated through a rigorous, participatory and multi-method foresight process.

The report presents the main findings of a Global Foresight exercise. It is about roadblocks, headwinds and accelerators in the form of issues that may or may not happen. The report identifies and assesses so-called 'signals of change'—early symptoms or indications of changes that could result in potential disruptions or important developments on the horizon for which the world may need to prepare. It also discusses eight critical shifts (or emerging phenomena) and some of the interconnections between them, and the signals and disruptions identified (Figure 1). These disruptions are potential events or circumstances that could affect planetary health, human wellbeing and the way societies function. Taken together, the findings are an opportunity for being more deliberate about what, where and when actions are taken and to critically examine whether current interventions are fit for purpose. Available science has been used to support conjecture on the characterisation of potential disruptions, but these are plausible estimates or 'what-if' questions. Generating the insights presented in this report has enabled reflection on the what ifs and to arrive at solutions that address many of the pressing issues being faced today.

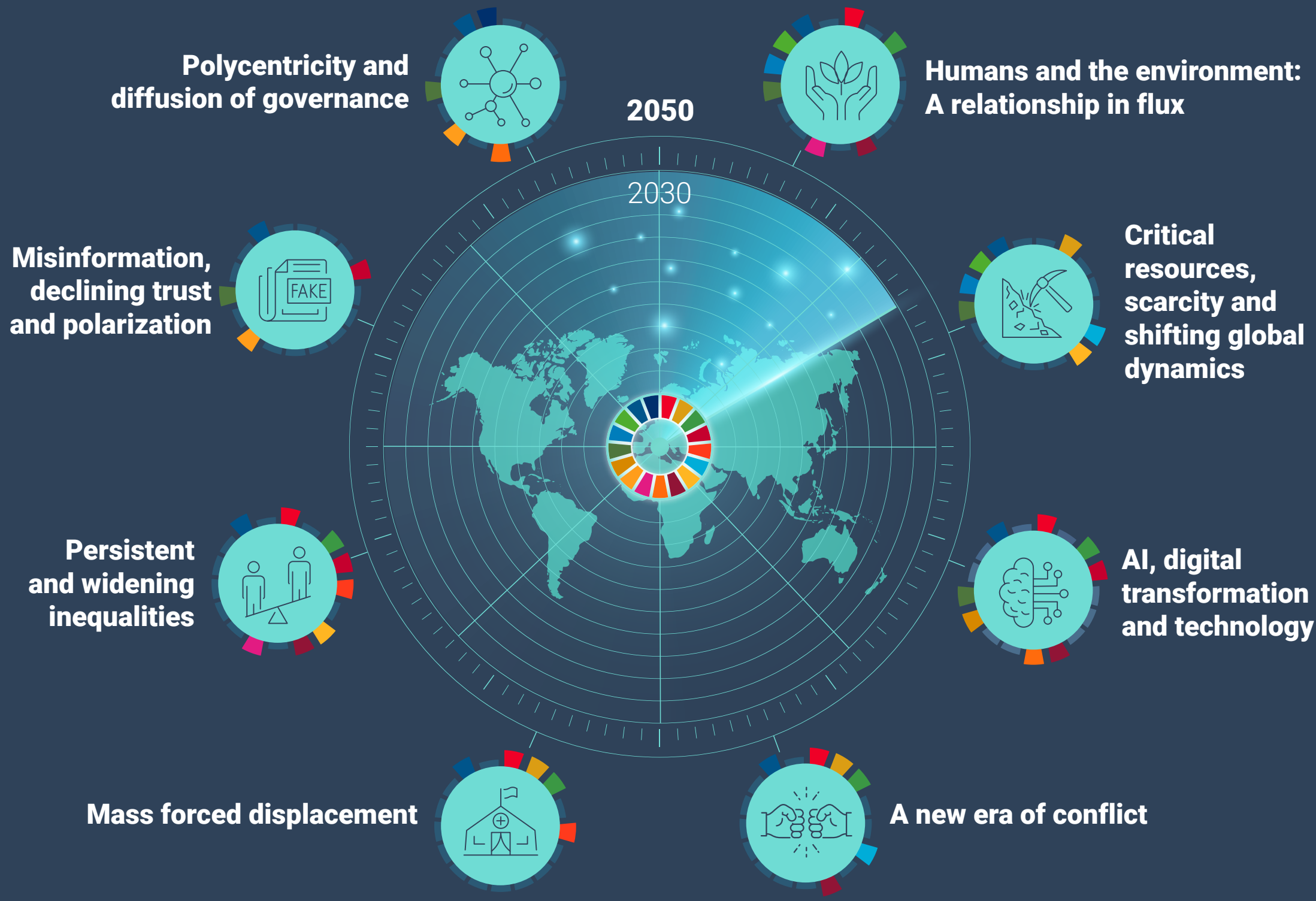
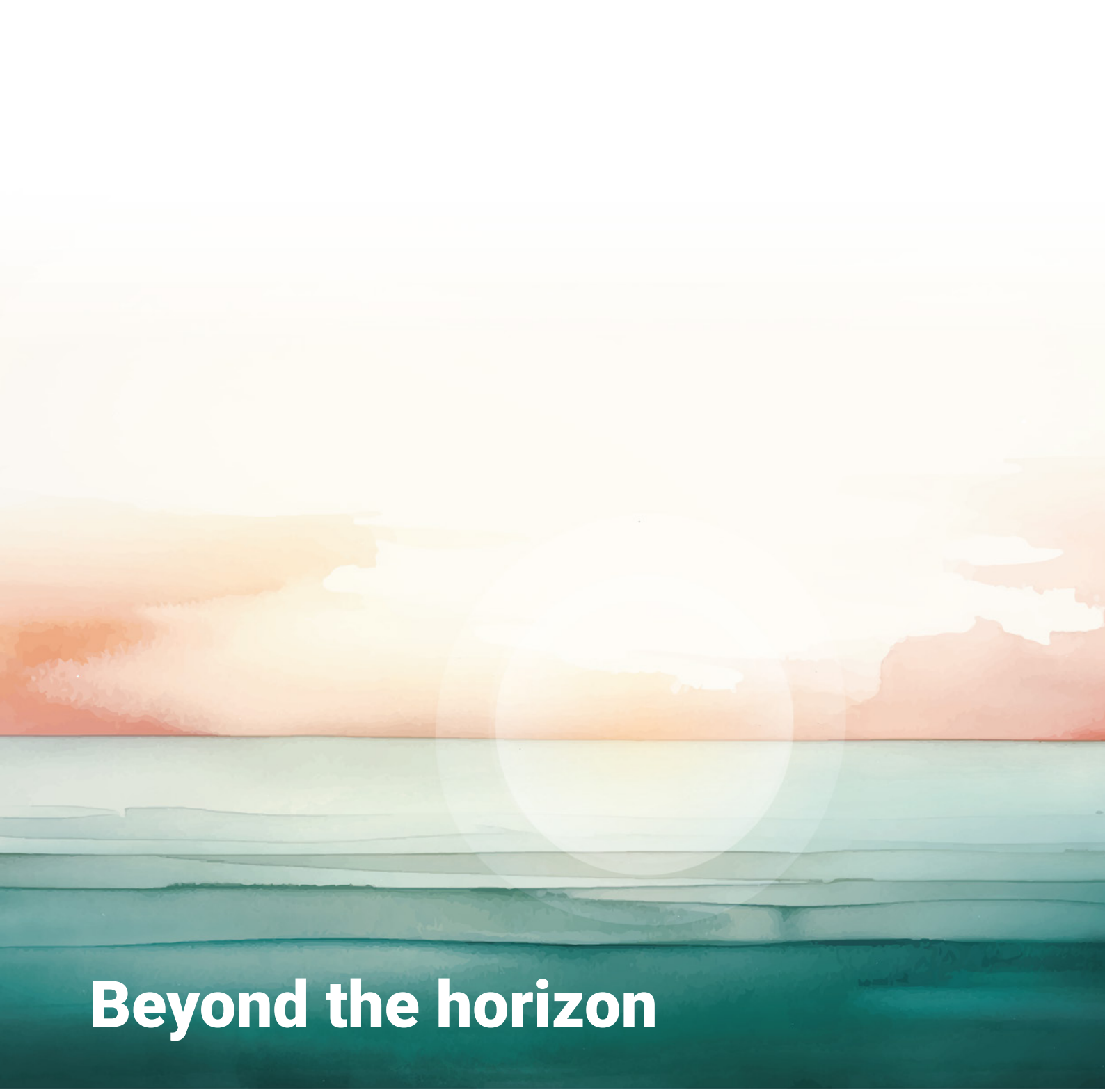


Figure 1: Eight critical global shifts or phenomena that emerged from the foresight process.



Beyond the horizon

Humans are ingenious. We have uncovered intricate scientific methods to measure climate change from times before accurate records even existed. Core samples from the poles or glaciers, season by season, provide millennia of climate data. The study of how 300-year-old sea sponges, which have been living off the coast of Puerto Rico since the start of the industrial age, may help reveal the hidden intricacies of how the Earth's temperature has been changing during their lifetime (McCulloch *et al.* 2024).

Indeed, innovations in science and technology have done much to illuminate both the ability to understand the past and our propensity to imagine and project it into the future (Jabbour 2021; Pereira *et al.* 2021). While the natural world has always been in constant flux, we humans find ourselves in a version of the world that appears to be changing faster than we can imagine or adapt to. The state of uncertainty and indeterminacy in which we exist requires the adoption of new approaches to how we imagine the future and prepare for it.

Empirical data, observation and theory are the foundations of scientific inquiry. The scientific method provides tools like predictive analytics, modelling and forecasting to gain insights by extrapolation; they facilitate the generation of testable and verifiable predictions about the future that facilitate preparation for what appear to be established trends or possible outcomes. However, the ability to find meaningful patterns and to see a future beyond what can be predicted based on historic data also requires better use of imagination and consideration of early symptoms or indications of change or signals that might be indicators of a new disruption beyond the horizon.

In some ways, foresight serves as a powerful radar, scanning beyond the horizon to reveal what could be approaching. Equipped with this advance knowledge, the ability to anticipate potential futures and stress-test assumptions and strategies against them, enhances the ability to foster resilience in the face of unforeseen circumstances. Their impacts can be perceived as positive or negative, depending on one's perspective.

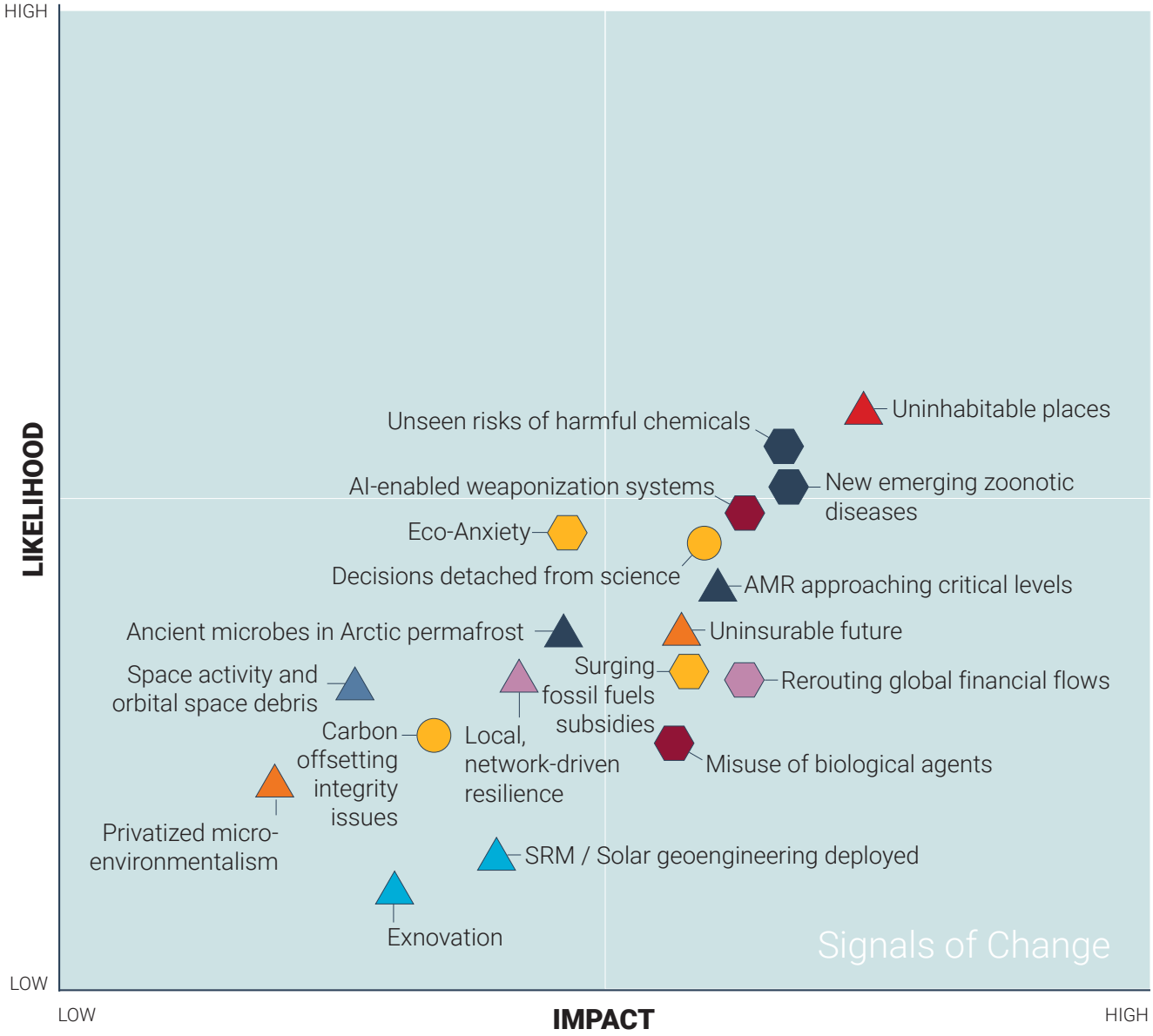
Building on well-established assessments of current and future trends, this report looks at emerging issues and signals that may be the precursor of wider changes. In doing so, it delves into the periphery of plausibility, embracing imagined futures and the inherent uncertainty they hold, to uncover what the future, near and far, could hold for planetary health and human wellbeing.

The report provides insights into critical shifts (or emerging phenomena), as well as potential disruptions that could hinder environmental management and impede the achievement of international goals, ultimately jeopardizing planetary health and human wellbeing. The report outlines a range of issues grounded in available science while considering existing trends and emerging issues that are on the horizon to see how they interact, and the potential for disruption and impact.

The timing of this report is intentional and critical. The Sustainable Development Goals (SDGs) are significantly off track, accelerating environmental degradation and a warming climate is evident globally, violent conflicts are spreading, and the multilateral system is undergoing profound changes to ensure it is better equipped to address contemporary and legacy challenges. But there are also signs of hope: the unprecedented expansion of renewables projected to overtake coal to become the largest source of global electricity generation by 2025 (International Energy Agency [IEA] 2024), a new Global Biodiversity Framework, the ozone layer on track for full recovery, and the adoption of the so-called 'high seas treaty' now protecting two-thirds of the ocean beyond national jurisdictions. On the eve of the Summit of the Future, all eyes are on the international community—amidst a backdrop a global tension. One question looms large: can we summon up a better future for the planet and people, with peace and prosperity for all?

The Summit of the Future provides an additional impetus to reevaluate and develop a more intentional and systematic approach across the United Nations (UN) system, as well as informing international responses to complex global disruptions and shocks by guiding anticipation, future-thinking, collective intelligence and solidarity. The Summit aims to facilitate inclusive, pragmatic and sustainable decision-making. It will consider the needs of the youth of today and the generations of tomorrow. Hopefully it will also help to broaden collective resolve for planetary health and wellbeing.

One thing is certain, the broader multilateral system needs to be more nimble, proactive and interconnected. Strategic Foresight, alongside data, digital, innovation and behavioural science, are the pillars of a rejuvenated 'United Nations 2.0'—which aims to create an organization that is empowered through embracing a forward-thinking culture and cutting-edge skills.



Critical Shifts:

- Humans and the environment: A relationship in flux
- Resources, scarcity and shifting dynamics of global security
- AI, digital transformation and technology – waves of change
- A new era of conflict
- Mass forced displacement
- Persistent and widening inequalities
- Misinformation, declining trust and polarization
- Polycentricity and diffusion of governance

Time Range:

2 - 3 years | 4 - 6 years | 7+ years

Figure 2: Eighteen signals of change and potential disruptions depicted along three dimensions: likelihood, impact and time horizon.

Notes: The average result for each dimension, generated from Delphi survey respondents, are displayed as follows: On the y-axis is likelihood (how likely the signal of change is to occur) and on the x-axis is intensity of impact (how much impact the signal of change could have). Respondents assessed likelihood on a 7-point scale ranging from exceptionally unlikely to virtually certain to occur and assessed impact on a 3-point scale ranging from low to high. The potential time horizon (when the signal of change and associated disruption could fully materialize) is represented by the shape of the icons and is divided into time segments of 2–3 years (circle), 4–6 years (hexagon) and 7+ years (triangle). The colour of each icon represents which of the eight critical shifts each signal of change falls under.

UNEP's Foresight Trajectory: A methodology snapshot

This report is the culmination of 18 months of data gathering and experiential learning aimed at equipping UNEP and the wider UN with a more anticipatory approach. At the core of the Foresight process is a global horizon scanning exercise to harvest and analyse a vast range of emerging issues, that could manifest significant future developments—in this case, affecting planetary health and human wellbeing. Identifying and assessing these 'signals of change' involved two rounds of survey questionnaires (using the Delphi approach), regional and youth sensemaking workshops, scenario-building and structured debates and discussions with an international Foresight Expert Panel.

This group of 22 distinguished members of the scientific community from developing and industrialized countries represented a wide spectrum of disciplines, expertise and knowledge (see Acknowledgements). The series of foresight workshops took place across each of the UNEP regions, specifically Africa, Asia Pacific, Europe, Latin America and the Caribbean (LAC), North America and West Asia (Annex 1).

The methods and techniques employed in foresight are subject to contextual and content issues—thus, approaches must be tailored and adaptive. The process and methodological approach employed here is distinct in two important ways. First, a strong emphasis is placed on the different understandings of emerging change in different regional contexts. In particular, the regional workshops highlighted diversity in worldviews, sociocultural contexts and subtle but important variations in the perception of risks and opportunities in different parts of the world. This is particularly important in the detection and interpretation of early or often termed 'weak' signals of change, which are often hidden among disconnected pieces of information that may initially appear to be background noise but ultimately have direct or indirect disruptive potential. Attention was paid to involving diverse perspectives and stakeholders (e.g. youth, experts, decision-makers, civil society actors) across a range of informed views and subject areas including those beyond UNEP's traditional domains of engagement.

The second difference in approach involved the concurrent construction and application of four contrasting scenarios of plausible futures to 2050. The scenarios take the form of qualitative narratives of 'alternative futures' or storylines that conceptualise what the future may hold under different conditions and assumptions given existing trends, drivers and pressures. They intend to capture the realm of possible developments that may be faced in different parts of the world when addressing the environment as the future unfolds, and informed the work undertaken during the regional workshops. This framing tool challenged any anticipatory assumptions that participants (individually and collectively) may have brought to the exercise, and helped explore alternative ways that issues might unfold under different contexts and conditions.

Figure 3 summarises the methodological approach to the foresight process and the detection, analysis and contextualization of issues presented in this report. The process involved six phases with interactive and iterative links to support interpretation and provide context. For a more detailed description of the steps and the rationale for the decisions taken, see **Methodology Working Document**.

The report draws on nearly 1,200 inputs submitted by 790 respondents to the first Delphi survey in May 2023. Data from this first survey and sense-making sessions were distilled into 29 'clusters' of emerging change that affect the environment and manifest in various forms, and 280 specific signals of change. As part of the initial clustering analysis, issues were concentrated under eight driving forces: direct environmental change; innovation and technological breakthroughs; laws, regulation and policy shifts; economic and financial systems; geopolitical developments; social and cultural dynamics; demographic and shifting behaviours, attitudes and habits; and resource scarcity.

The Foresight Expert Panel further distilled the 280 signals of change prioritised into 20 signals with high disruptive potential (indirect or direct) and low-to-medium probability of occurrence. Here, the process of identifying these signals was guided by a conceptual framework of key attributes and indicators for interpreting and evaluating signals (e.g. prevalence, novelty, probability of occurrence and perceived impact, adapted from van Veen and Ortt 2021; Nash *et al.* 2022; Mauno *et al.* 2023). The prevailing signals of change were embedded in the second round of the Delphi Survey (April 2024) for further evaluation by 512 respondents.

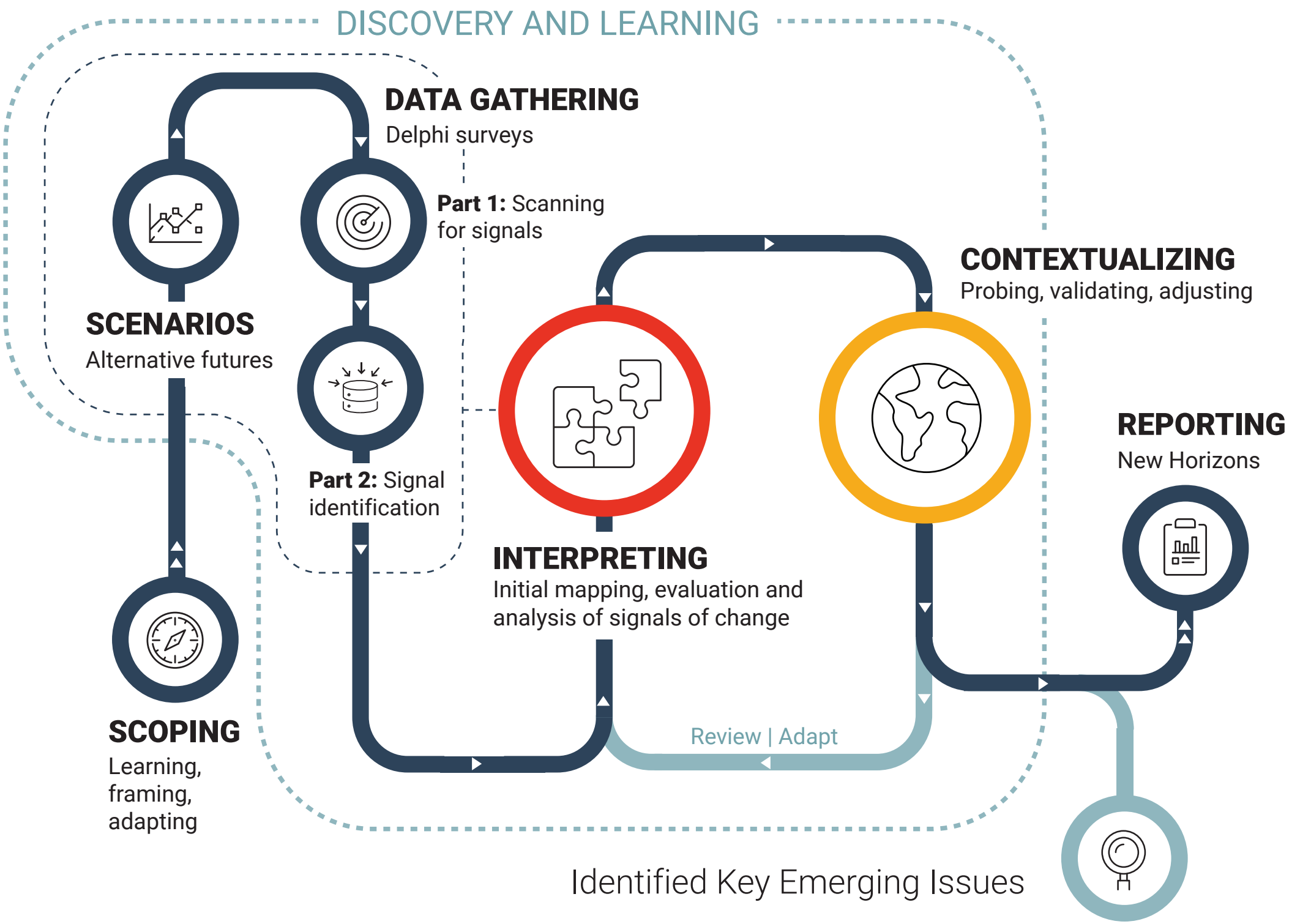


Figure 3: A conceptual summary of the foresight process and methodological steps, highlighting the iterative (and non-linear) nature of the process including the data-gathering and interpreting phases, and the continuous discovery and learning process.

Drawing on the information from the Delphi surveys and the collective insights from the regional, youth and Foresight Expert Panel workshops, the process identified eight critical shifts that define the world today and in the quarter century to come. In addition, and perhaps more importantly, the process identified 18 signals of change and potential disruptions that require monitoring as they could significantly influence planetary health and wellbeing.

Part 1

The New Global Context

In 2015, UN Member States adopted the SDGs—a call to action with a universal set of goals, targets and indicators, describing a desired future of peace and prosperity on a healthy planet.

Ten years later, progress has been disappointing. The world is not just lagging on eradicating poverty, hunger and inequality—more than halfway to the 2030 Agenda deadline—but the latest SDG Progress Report shows we are leaving more than half the world behind, with 85 per cent of the 169 SDG targets are off track and 37 per cent have experienced no progress or, worse, have regressed since 2015 (United Nations [UN] 2023). Perhaps most worrying of all, given the potential for irreversible damage to our planet, the environment-related targets are far off course, and in some cases, backsliding. Progress on four key environmental stewardship goals–SDG6 (clean water and sanitation); SDG13 (climate action); SDG14 (life below water) and SDG15 (life on land)–were assessed as having 42.85 per cent of their associated targets in stagnation or regression in the most recent comprehensive stocktake of global progress on the 169 targets for the SDGs (UN 2023; Figure 4). While SDG6 and SDG15 show some recent improvements at the indicator level (UNEP 2024), 60 per cent of the environmental related indicators assessed continue to show deterioration or inability to assert their status (UN 2023).

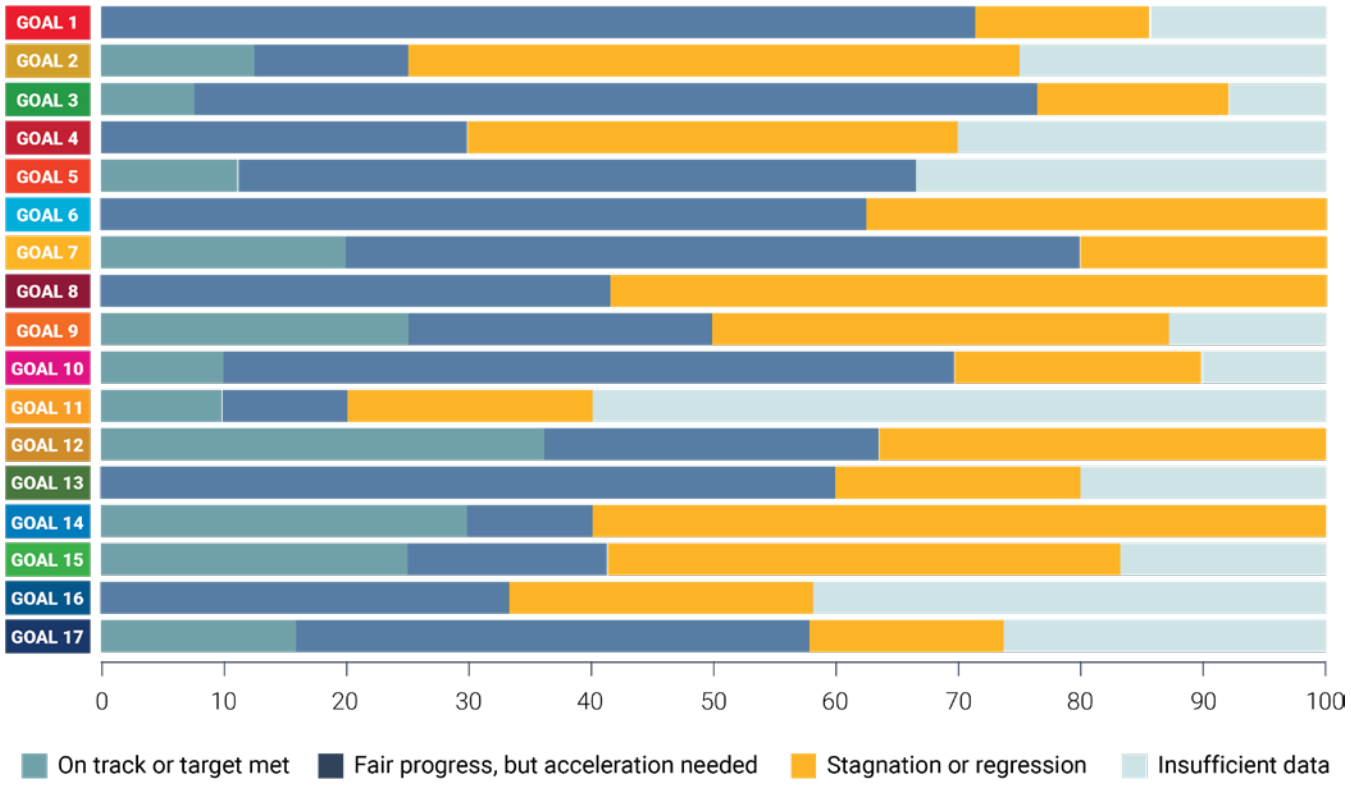


Figure 4: Progress assessment of targets for the 17 Goals revealing significant backsliding (stagnation or regression) for the key environmental stewardship goals: SDG6 (38 per cent), SDG13 (20 per cent); SDG14 (60 per cent) and SDG15 (42 per cent). Source: UN 2023.

The scale and frequency of global disruptions are increasing (Fatima 2023; Lawrence *et al.* 2024). Following on the heels of the COVID-19 pandemic, the story of the past two years has been one of conflict, disaster and despair. The impacts on the global food and energy markets display the growing

dysfunction and fragility of the financial system and increase doubts about its capacity to weather multiple storms. Acute, compounding shocks have become protracted stressors—testing countries and individuals in new ways and stretching adaptive capacity to the limit.

Seen in combination with rising geopolitical tensions and the extraordinary pace of technological change—most obviously in the field of artificial intelligence—there is a strong sense that humanity is already living in a fundamentally different global context. As the world enters this new era of instability and interdependence, crises are more likely to converge and erode development gains and environmental buffers, increasing vulnerability to future shocks (International Science Council [ISC] 2023). It is not just the scale of change which is unprecedented but also the speed. Technology and innovation have reshaped economies and transformed many societies. Every aspect of life is undergoing radical, disruptive changes at an accelerating speed. From technology to social norms to changing patterns of employment, leisure, diet and fashion—even the international geopolitical order which arose after World War 2 (WWII) and the Cold War—are all inexorably shifting.

The signals of change presented in this report provide further evidence of the pace and scale of global change today and associated risks and potential disruptions on the horizon. As outlined above, the foresight exercise culminated in two sets of insights across a broad range of thematic areas. First, a set of eight critical shifts or emerging phenomena that force us to rethink current work programmes and hence our expectations about the future. Second, 18 signals of change and potential disruptions further out on the horizon, offer glimpses that foreshadow some of the underestimated changes to come. Both sets of change point towards a proliferation of emerging and potentially significant risks and their cascading impacts.

The signals, critical shifts (e.g. emerging phenomena) and potential disruptions also seem to be causally connected. Environmental change, for example, is often both a driver and a consequence of innovation and technological breakthroughs, geopolitical conflicts or forced movements of populations. This complex web of causal connections makes it all the harder for governments and societies as they seek to map a path forwards. Faced with this complexity, how can they make sense of the multiplying challenges ahead? How can they navigate them?

Welcome to the polycrisis

In an interconnected world, a local crisis seldom remains local for long. Territorial conflicts overspill; migration spreads; resource pressures increase. We see it in the triple planetary crisis of pollution, biodiversity loss and climate change. Each of these three feeds into and aggravates the others. Pollution changes climate patterns. This damages ecosystems. Damaged ecosystems fail to filter water and absorb emissions. Thus, the cycle continues, worsens and widens, and where reversed improvements are observed.

Start to factor in how this impacts humanity—and the feedback loops which result against a backdrop of unprecedented convergences between ecological, political and economic strife—the concept polycrisis might come close to reflecting the new global context. A global polycrisis arises from “the causal entanglement of crises in multiple global systems in ways that significantly degrade humanity’s prospects” (Lawrence *et al.* 2024). These interacting events (or crises) occur simultaneously and cause more harm, and surprise, than the sum of those crises would produce in isolation. This is now a feature of the times. As such, the multiplying crises need to be understood as a whole and addressed as a whole.

Just as the impact of multiple crises is compounded when they are linked, so are the solutions.

The growing body of knowledge about complex systems and how they change offers some answers. According to research in systemic resilience and transformation, several factors can increase the frequency and intensity of sudden, non-linear shifts in systems. These include changes in conditions that reduce the resilience of systems—for example, if gradual global warming manifests in sudden shifts in ocean currents (Johnson and Lyman 2020; Peng *et al.* 2022; Ditlevsen and Ditlevsen 2023). They also include the emergence and diffusion of novel species or innovations—for example, advances in Artificial Intelligence (AI) could trigger rapid and disruptive changes in labour markets, rendering some professions obsolete and creating new concentrations of power and wealth (Duch-Brown *et al.* 2022; Szabó and Boncz 2023).

A third important factor is the existence of causal interactions between systems, which means that a crisis in one system influences the occurrence, frequency or intensity of crises in another. This situation is explored in a growing literature on 'global polycrisis', which captures the idea that the multiplying shocks that humanity faces today—wars, extreme weather, inflation, pandemics and hunger—represent interwoven aspects of a larger phenomenon.

Global polycrisis is, in large part, a consequence of globalization. In the era of globalized commerce, travel and hyperconnectivity, localized crises are transmitted within and between systems by the movement of energy, matter, information and biota. Meanwhile, the drive towards efficiency and loss of diversity in socio-economic and ecological systems means that systems are becoming less resilient to this spread of disruptions. Crucially, the interactions of crises in different systems produce "harms that are different from and usually greater than the sum of the harms that would be produced separately" (Lawrence *et al.* 2023).

The horizon scanning exercise brought to light evidence of rapid, surprising and often alarming shifts, as accelerating processes of environmental, technological and social change give rise to sudden disruptions. While the signals are clearly diverse in character, they are deeply intertwined and rooted in common stressors, particularly the steady degradation of ecological resilience. In addition to helping understand the scale and nature of global crises, systems thinking also offers ideas about how societies can respond—mitigating systemic risks and seizing opportunities for positive change towards sustainability.

This will mean restoring the resilience of complex systems so that they are less vulnerable to shocks, for example by investing in nature, creating buffers in global systems of finance and trade, improving social safety nets or finding ways to rebuild trust and social cohesion.

It will also mean guiding the evolution and uptake of innovations such as AI so that their extra-ordinary transformative potential contributes to human wellbeing and planetary health. In practice that is likely to necessitate a combination of anticipatory and adaptive governance, supported by foresight and monitoring.

Finally, it will mean recognizing that the causal entanglement of systems offers the possibility to move from polycrisis to multiple equilibria. It means that actions to increase resilience and mitigate risks in one system are likely to have positive implications elsewhere, for example by reducing harmful feedback loops and preventing the contagion of disruptions across multiple systems. But seizing these opportunities will require that governments and international organizations adopt a broad, whole-system perspective, which seeks to understand the interactions between crises and the architectures that link systems globally. When those connections are understood, it becomes possible to design interventions that reduce fragility and create a foundation for genuinely sustainable development.

Part 2

Shifts, signals and potential disruptions

Each of the eight critical shifts identified during the process are outlined below together with associated signals of change—they have a lower probability of occurrence and are possibly unintended but have significant potential to disrupt if they eventuated. The signals of change are not necessarily positive or negative, but simply early symptoms or indicators of a future development with potential to grow in scale and distribution.

A synopsis has also been provided of the most acute potential disruptions on the horizon for each signal of change, which could significantly influence planetary health and wellbeing. They need to be kept on the radar to observe their direction, character and strength before they develop into stronger trends. Monitoring signals on the horizon provides information to mute signals that have the potential to disrupt negatively, but also amplify those that will accelerate positive change.

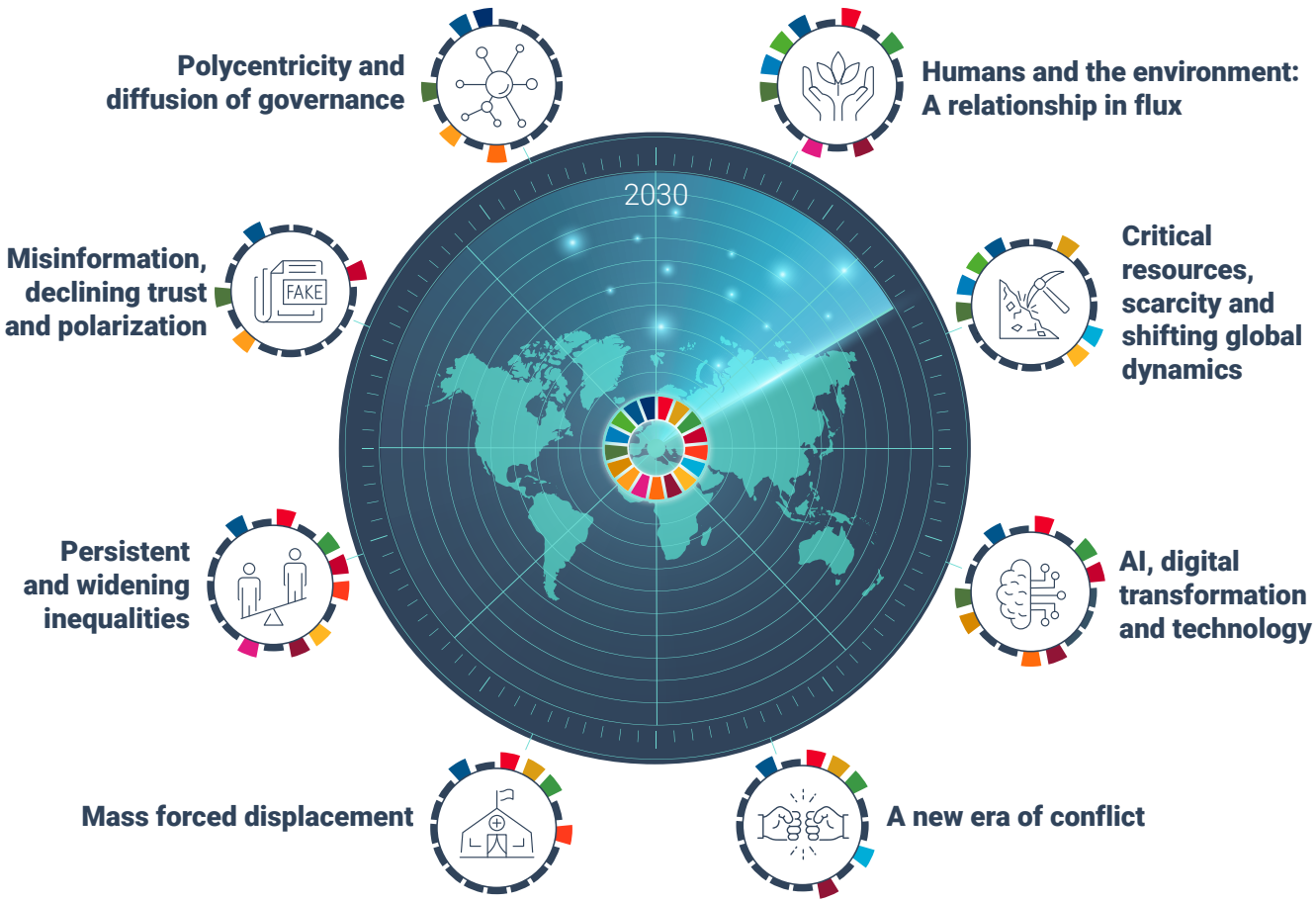


Figure 5: Eight critical global shifts or phenomena that emerged from the foresight process. These shift together with the 18 signals of change (Figure 2) provide insights about unconsidered and/or underestimated threats and opportunities on the horizon.

2.1 The relationship between humans and the environment is in flux

The human condition and the health of our planet are inextricably linked. Our collective resilience, wellbeing and ability to navigate crises is fully connected to the food we eat, the water we drink, the air we breathe and, crucially, our relationship with the Earth.

And yet human influence has left no corner of our planet untouched. Less than 25 per cent of the land area remains free from significant human impact, and this area is projected to shrink to less than 10 per cent by 2050 (Teea *et al.* 2021; Kortetmäki *et al.* 2024). It is estimated that up to three-quarters of freshwater areas and over half of marine areas are exploited for food production. The biomass of wild mammals has fallen by 82 per cent since prehistory with projections that by 2050 humans will have eliminated 38–46 per cent of all biodiversity measured as mean species abundance (Kortetmäk *et al.* 2021). Without swift and substantial intervention, nearly a million of the Earth's estimated eight million species may be driven to extinction (Intergovernmental Science-Policy Platform on Biodiversity and Ecosystem Services [IPBES] 2019).

The latest figures from the Intergovernmental Panel on Climate Change (IPCC) and the UNEP Emissions Gap Report (2023) paint a bleak picture of the accelerating climate crisis. Record-breaking climate events surge in number, velocity and scale, wreaking havoc across the globe with escalating frequency. Despite the Paris climate pledges, the current trajectory puts the world on track for a catastrophic temperature increase beyond between 2.1°C and 3.9°C by 2100 (Liu *et al.* 2021; IPCC 2022; Kemp *et al.* 2022). And that is without considering worst-case climate responses. This trajectory promises a bleak reality: coral reefs bleaching, extreme weather events intensifying, species dwindling and human suffering escalating worldwide. At this rate, by 2050, nearly one-quarter of the global population of adults aged 69 years and older, will be exposed to chronic and acute dangerous heat extremes, putting up to an additional 246 million older people at risk—largely in Africa and Asia (Falchetta *et al.* 2024)—with far reaching impacts on people's physical and mental health, health care systems, air quality, water quality and water-related diseases, infrastructure and service disruptions, labour productivity and wellbeing. These climate impacts will also have disproportionate effects on women (Ngcamu 2023; Desai and Zhang 2021).

Approximately two-thirds of current greenhouse gas emissions stem from the combustion of fossil fuels and industrial processes. Methane, nitrous oxide and fluorinated gases are also increasing and contribute about a quarter of emissions. Collectively, the G20 nations are currently responsible for approximately 76 per cent of global emissions—with the largest historical cumulative emissions coming from China, the United States of America and the European Union, while least developed countries contributed 4 per cent (UNEP 2023a).

The past decade showed, as few others have, the speed and scale at which change can happen. The frequency of extreme weather events has increased dramatically in the last half century. Between 1970 and 2021, according to the World Meteorological Organization (WMO), storms, heat and flooding caused US$4.3 trillion in economic losses and killed more than two million people (WMO 2024).

To date, research has mainly focused on understanding the effects of drivers on ecosystem functioning, not on the effects of changed ecosystems on the drivers – the feedback loop. It is evident that the rate of these changes—particularly since mid-1940s—and the drivers acting on them are accelerating (Figure 6). It is the speed of change and scale, changing the trajectory of planetary health and human wellbeing.

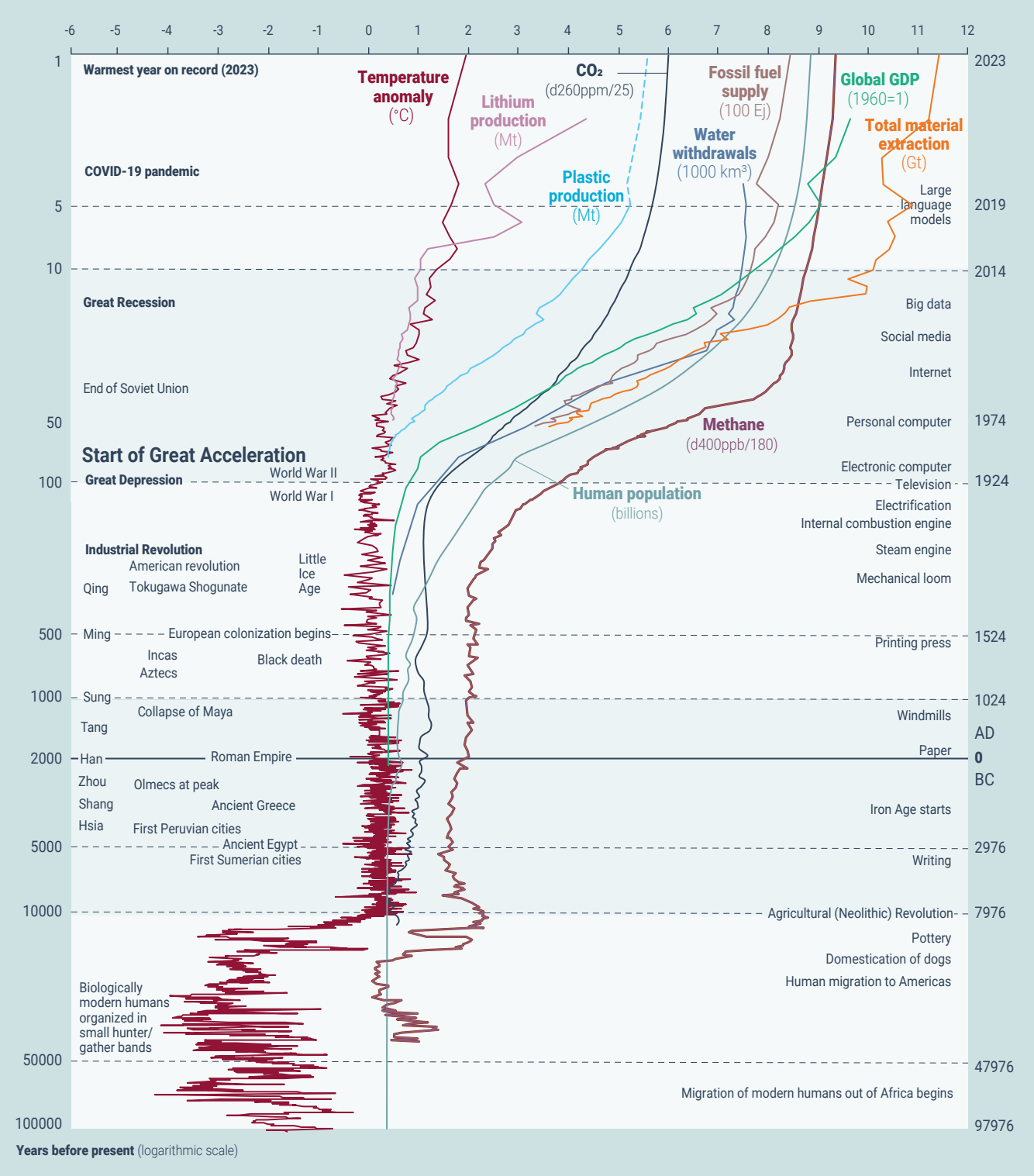


Figure 6: The Great Acceleration after the Second World War. Source: Adapted from Costanza *et al.* 2007; Global Material Flows Database (UNEP 2023a); Global Resources Outlook; World Energy Balances Highlights 2023; Minerals UK; Geyer *et al.* (2017); OECD (2022).

No year has yet confounded climate scientists' predictive capabilities more than 2023, with huge heat anomalies testing new extremes (Schmidt 2024). We have entered uncharted territory. Unchecked consumption of natural resources has propelled us into a triple planetary crisis, jeopardising the wellbeing of both human and non-human inhabitants alike.

Positive feedback loops are exacerbating already desperate situations. For example, severe flash flooding in the Horn of Africa continues to ravage several countries in 2024—Kenya, Somalia, Sudan, United Republic of Tanzania and Uganda—nearly 49 million people are experiencing acute food insecurity and over 2 million people are displaced (ReliefWeb 2024). Record levels of flooding also continue to severely affect the state of Rio Grande do Sul in Brazil, where hundreds were injured and over 600,000 people displaced from their homes. With flood water still rising (at the time of print). Many people now have no access to drinking water or electricity, and internal migration is expected to explode in the coming months (Price 2024). In just one-year, successive disasters have cost Brazil over US$20.4 billion from public funds (Fontes 2024). This year, in South and Southeast Asia, record-breaking temperatures (well above 45°C for several days) has had devasting impacts causing widespread crop damage and reduced yields, forcing thousands of schools to close and putting millions in distress and particularly people living in refugee camps and informal housing (Dong *et al.* 2024; ReliefWeb and United Nations Office for the Coordination of Humanitarian Affairs [OCHA] 2024; World Weather Attribution [WWA] 2024).

The world is edging ever closer to environmental change that may be irreversible. Thawing permafrost, glacier loss, mass deforestation, prevalence of microplastics in fauna, corals irreversibly bleached (triggering their death) and now the looming breakdown of the vast system of ocean currents, the Atlantic meridional overturning circulation (AMOC), is a key component in the regulation of the global climate. New warning signs suggest that the risk of the AMOC breakdown could be much closer than the modelling has projected and could occur as early as 2057 (Ditlevsen *et al.* 2023; Cini *et al.* 2024; van Westen *et al.* 2024). At that speed, and the scale of reverberating impacts that would ensue, adaptation would be near impossible (Ben-Yami *et al.* 2023).

Looking ahead, there are signals that continuing environmental degradation and systemic shifts are pushing natural ecosystems and humans to limits, becoming something fundamentally new in how society and the environment behave towards one another which could be positive or negative.

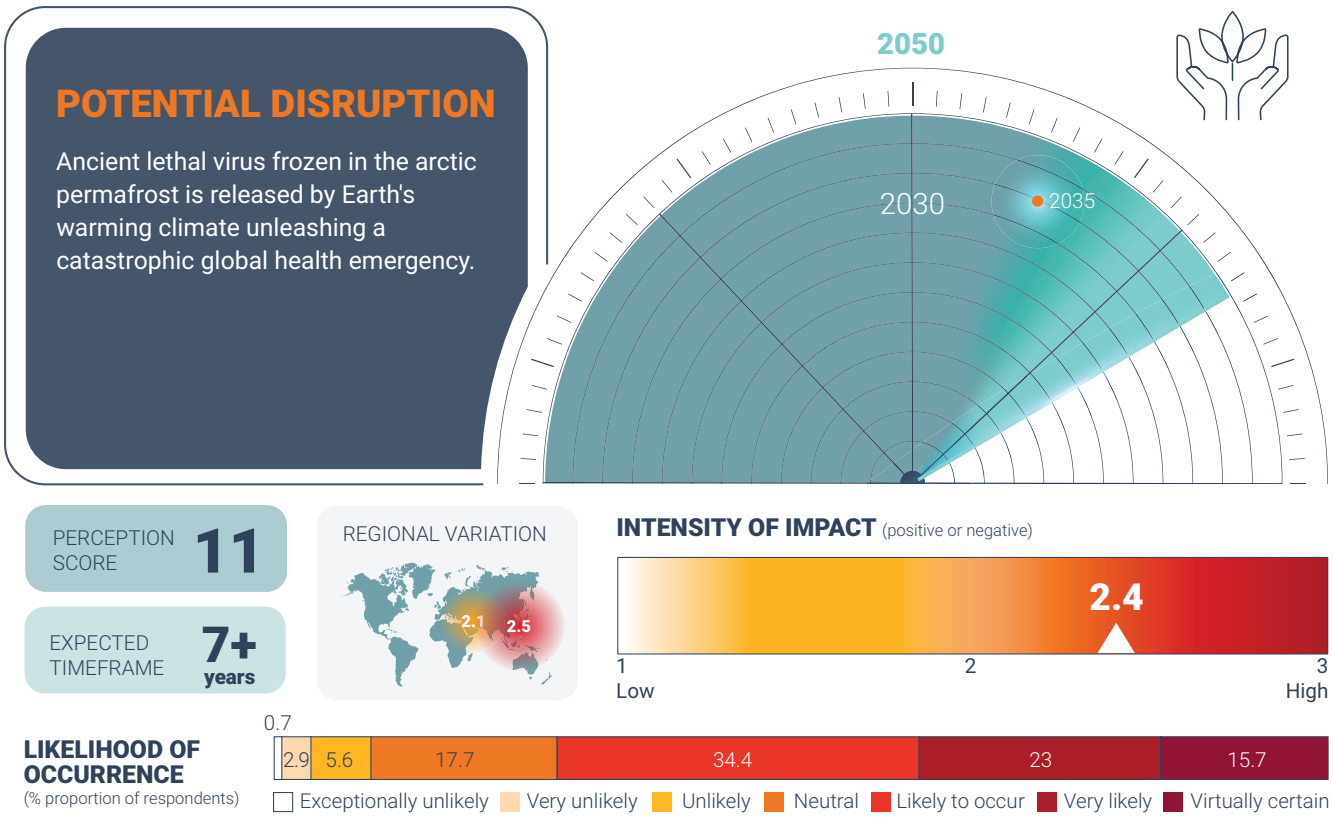
Signals of change

Each of the signal of change images summarize the information gathered during the learning phase for each identified signal of change in the foresight process. They provide a concise description of the potential disruption and their percieved likelihood of occurrence and severity (responses from the Delphi Survey) along with the following:

Likelihood of Occurance: The proportion of respondents who assessed the probability that the signal of change will materialize.
Intensity of Impact: An average score representing the percieved severity of impact if/when the signal of change materializes (postive or negative).
Perception Score: Determined by ranking each signal of change based on its combined likelihood and impact score.
Expected timeframe: An indication of the time horizon during which survey respondents believe the signal of change will be most disruptive or transformative.
Regional Impact: The map highlights the regions with the highest perception of severity of impact (red) and lowest perception of severity (green).

Signal of change **1**

Ancient microbes hidden in thawing Arctic permafrost



In recent decades, the Arctic has been warming much faster—four times in fact—than in the rest of the globe; this is a phenomenon known as Arctic amplification (Rantanen *et al.* 2022). This unprecedented warming has led to the thawing of vast permafrost areas, which scientists forewarn hold hidden dangers including massive quantities of methane, a potent greenhouse gas (Miner *et al.* 2022; Birchall *et al.* 2023). Permafrost degradation could also facilitate the transport of toxic waste (Revich *et al.* 2022) and radioactive material (Miner *et al.* 2021) into the environment, endangering ecosystem function and human health.

More recently, researchers have exposed a new unseen danger: reservoirs of ancient, mostly uncharacterized, microorganisms and viruses that could be viable if not lethal (Wu *et al.* 2022; Alempic *et al.* 2023).

Environment Alert

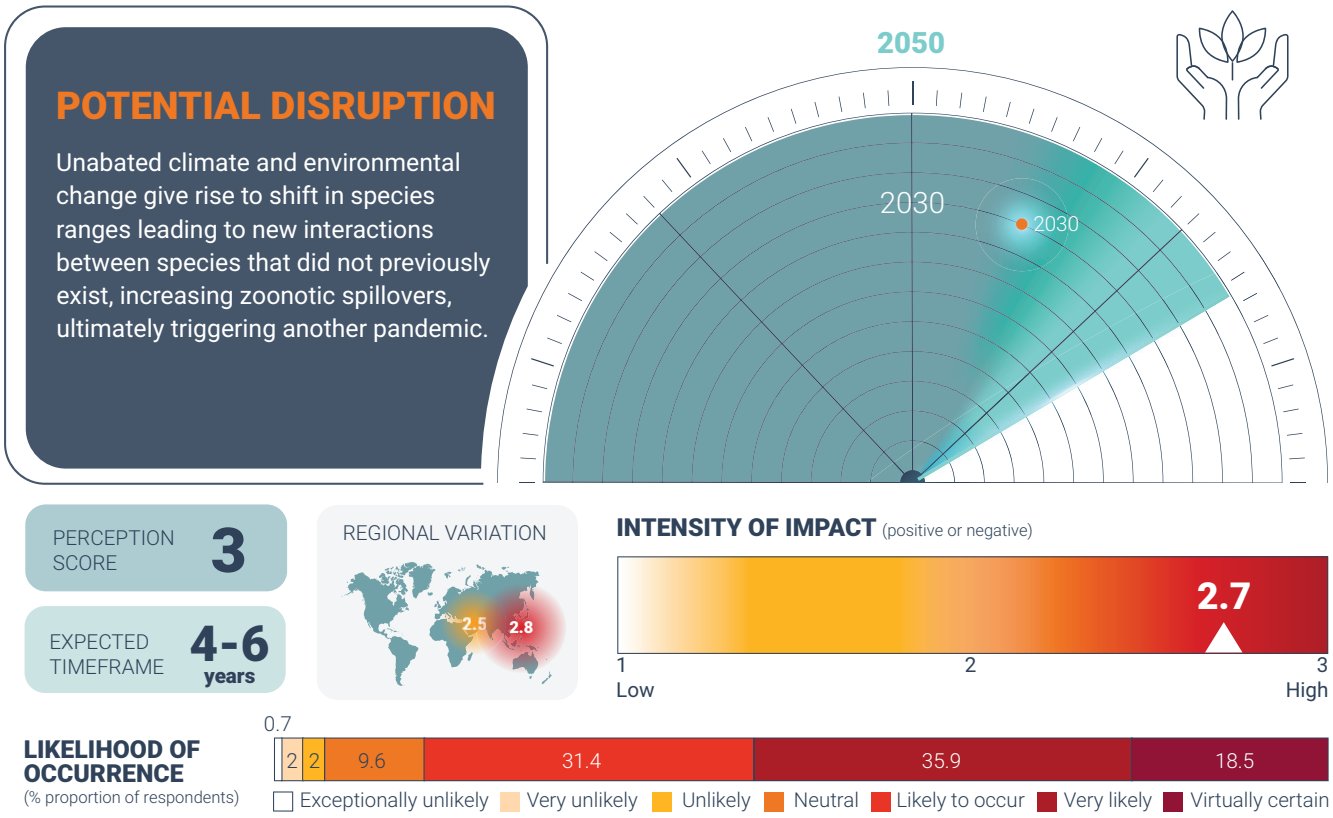
Permafrost thaw is a critical issue with severe impacts for people and the environment. Beyond the well-known environmental consequences, potentially large number of microbes released from thawing permafrost, including pathogens, pose new risks to all modern ecosystems.

As the thawing and disappearance of permafrost accelerates, it raises concerns about the potential introduction of ancient microorganisms into the environment, with large uncertainties regarding their implications for modern ecosystems and human health (Strona *et al.* 2023). Novel antibiotic-resistant bacteria, viruses, fungi and parasites could be released posing significant challenges to human and animal immunity (Chiappelli and Penhaskashi 2022). The recirculation of long-frozen microorganisms, including viruses and bacteria, when exposed to conducive conditions such as liquid water and contact with live animals, pose contamination risks (Charlier *et al.* 2020).

Researchers have estimated that up to four sextillion (4,000,000,000,000,000,000,000) micro-organisms could be released from thawing cryosphere each year as result of climate change (Yarzábal *et al.* 2021). This phenomenon has already led to the revival of ancient mega-viruses and the emergence of an outbreak of anthrax in western Siberia from rapid thawing of Bacillus anthracis spores in permafrost killing thousands of reindeer and affecting dozens of people (Charlier *et al.* 2020; Stella *et al.* 2020). Of course, the consequences of permafrost thawing extend beyond infectious diseases impacting various aspects of life and prosperity on Earth.

Signal of change **2**

New emerging zoonotic disease



Zoonotic diseases are infectious diseases caused by pathogens that transfer to humans from non-human hosts. These diseases may pose significant systematic global public health risks due to their potential to spread rapidly and unpredictably. Changes in land use, deforestation and habitat destruction, urbanization, wildlife trafficking and unsustainable agricultural practices are already considered as activities increasing the risk of the emergence and spread of zoonotic disease (Plowright *et al.* 2021; Rush *et al.* 2021; Esposito *et al.* 2023; Plowright *et al.* 2024). Recent studies indicate that if the increase in spillover events continues, estimated at between 5 and 8 per cent annually, the most common types of such pathogens are likely to result in 12 times the number of deaths in 2050 compared with 2020 (Meadows *et al.* 2023).

Recent outbreaks, such as SARS, influenza A/H1N1, H5N1, MERS, Nipah virus disease, Ebola and COVID-19, have resulted in substantial human and economic losses (Debnath *et al.* 2021). These have also underscored the potential of previously unknown or neglected pathogens to cause epidemics (Dobson *et al.* 2020), the World Health Organization (WHO) reported 891 human cases of avian

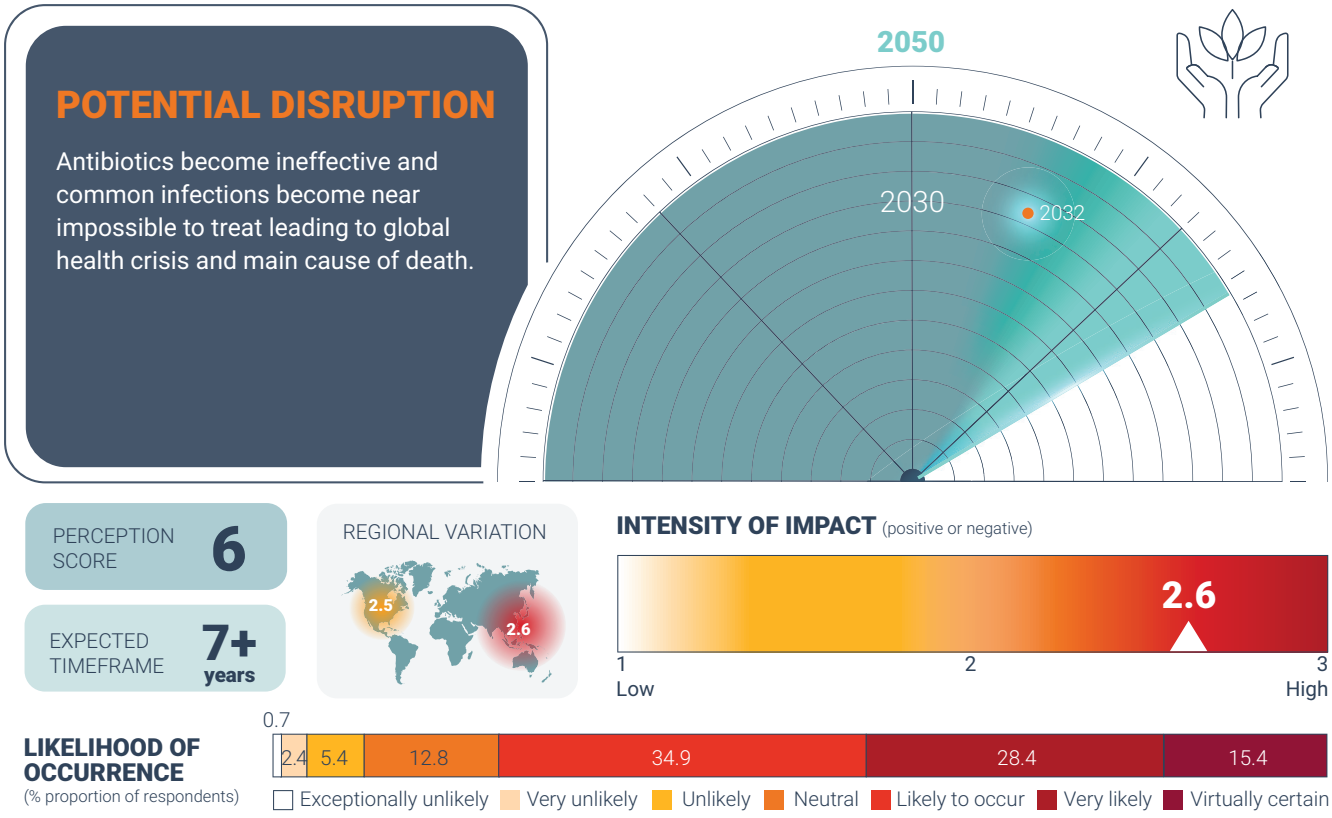
Environment Alert

Ecological factors play an extremely important role in zoonotic disease emergence and are critical for safeguarding planetary health. Land-use changes, deforestation and certain agricultural practices disrupt ecosystems and increase human-wildlife interactions, creating conditions for zoonotic spillover.

influenza (H5N1) from 24 countries resulting from contact with live or dead birds or contaminated environments (WHO 2024). This in combination with the potential of previously unknown or neglected pathogens to cause epidemics (Dobson *et al.* 2020), with an estimated 1.7 million undiscovered viruses in the global virome, the aggregate of all viruses across the entire biosphere (Lawrence *et al.* 2023) amplifies concern about the issue.

Signal of change **3**

Antimicrobial resistance approaching critical levels



Antimicrobial resistance (AMR) refers to the ability of microorganisms such as bacteria, viruses, fungi and parasites to resist the effects of antimicrobial drugs, making infections caused by these microorganisms more difficult to treat (UNEP 2023b). This resistance occurs when microorganisms evolve and adapt so the drugs designed to kill them become ineffective (Aijaz *et al.* 2023), and thus rendering the medications ineffective. AMR poses a significant challenge to public health. Murray *et al.* (2022) estimates that 1.27 million deaths globally were attributed directly to drug-resistant infections. It is estimated that by 2050 the number of deaths resulting from AMR may reach 10 million (UNEP 2023b).

AMR proliferation stems from increased antimicrobial use and misuse, alongside other microbial stressors like pollution, fostering resistance in both human and environmental settings potentially passing other causes of mortality (Tang 2023; Cella *et al.* 2023; UNEP 2023b; Ahmed *et al.* 2024).

Environment Alert

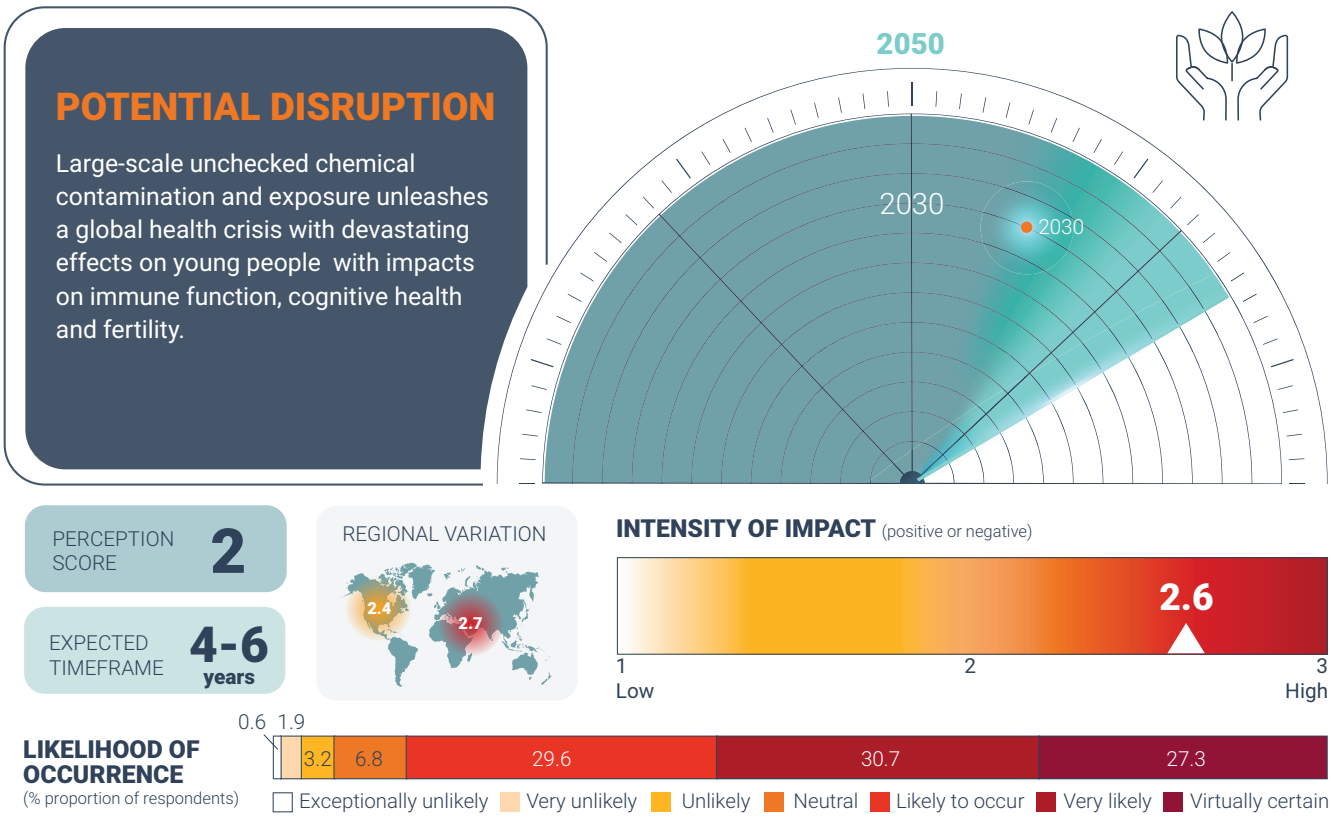
The widespread use and misuse of antibiotics and other microbial stressors, such as pollution, create a breeding ground for AMR—favourable conditions for microorganisms to develop resistance both in humans and the environment—with significant implications for human wellbeing and ecosystems.

Recognised by WHO as one of the top ten global health threats, AMR is already jeopardising human and animal health, the environment, food security, economic development and societal equity (Weldon 2024). Low- and middle-income countries are disproportionately affected by AMR, exacerbating poverty and inequality (Ahmed *et al.* 2024). Women, children, migrants, refugees, people employed in certain sectors (e.g. agriculture or healthcare) and those living in poverty may be particularly vulnerable and/or more exposed to drug-resistant infections (WHO 2021; UNEP 2023b).

AMR undermines modern medicine by complicating infection treatment and rendering medical procedures riskier, thus threatening healthcare gains (UNEP 2023b). Economically, AMR imposes substantial costs, with projected healthcare expenditures of up to US$1 trillion by 2050 and potential Gross Domestic Product (GDP) losses of up to US$3.4 trillion annually by 2030 pushing more people into poverty (World Bank 2017; Roope *et al.* 2019). The ramifications of AMR extend beyond human health, impacting agriculture, economies and the environment (Varaldo *et al.* 2020; UNEP 2023b).

Signal of change **4**

Unforeseen impacts of harmful chemicals and materials



There are thousands of chemicals in use globally with the number of new chemicals increasing every year (United States Government Accountability Office [GAO] 2019; UNEP 2019)—there are currently 350,000 chemical and substances listed for production and use (Wang *et al.* 2020; Muir *et al.* 2023). Demand for chemicals is expected to increase associated with decarbonization and digital transformation (Lopez *et al.* 2023; Kloo *et al.* 2024) and may increase the number of chemicals and substances in use and hence finding their way to the environment.

Current findings suggest that the "identities of many chemicals remain publicly unknown because they are claimed as confidential (over 50,000) or ambiguously described (up to 70,000)" (Wang *et al.* 2020). In addition, of those that are known from high producing countries only an estimated five per cent are measured in the environment (Muir *et al.* 2023). Chemicals registered as being toxic, or persistent, by a few countries are numbered in the thousands (Karlsson 2023; Muir *et al.* 2023; Li *et al.* 2024), yet the vast majority have not been measured in the environment or in humans.

The Stockholm Convention on Persistent Organic Pollutants is an international treaty to regulate the release of toxic organic chemicals. Twenty-six chemicals have been banned globally, and nine compounds are under review (Karlson 2023).

While it is noted many of the chemicals registered for use may not make their way to the environment, many do. The volume of pollution and waste arising from processes that make and use these chemicals projected increase as are the number of products with a variety of harmful chemical additives (UNEP 2023c).

Many of these chemicals, including microplastics, find their way into the environment and the human body via agriculture, industry, transport and domestic products. Some are associated with adverse health effects, but the number and nature of multiple exposures is not well understood, and the hidden health and ecological costs likely underestimated. The implications for the young are already of concern given placental and early childhood exposure and for those who are vulnerable and have pre-existing illness (Muir *et al.* 2023). The implications of an increase in chemicals being synthesized, the lack of environmental and human monitoring and the complex mixtures to which ecosystems and humans are exposed (Carpenter *et al.* 2002) make the task of characterizing impacts both challenging and crucial. There are many efforts and work ongoing to address these challenges (Escher *et al.* 2020; Naidu *et al.* 2021).

Environment Alert

The ever-increasing number of chemicals in use, coupled with limited knowledge about their presence in the environment, the combined impact of mixtures and potential long-term impacts is a serious concern. Many of these chemicals, including persistent and toxic substances, are finding their way into the environment through various pathways, harming ecosystems and human health.

2.2 Critical resources: scarcity and competition reshaping dynamics of global security

Recent trends have seen increased competition over resources and the global commons (Dou *et al.* 2023; UNEP 2024). Some are familiar such as oil and gas while others are newer like rare earth minerals. And some are worryingly fundamental: food, water and land. In some cases, demand has outpaced supply, and in others access to vital resources has become increasingly controlled by few and conditioned by instability and volatility. These shifts are reshaping the dynamics of global security. As countries discover more sources for materials—including through new techniques and environments such as deep-seabed mining—heightened competition and potential confrontation are likely to increase.

The global transition to clean energy is expected to create an enormous increase in demand for critical minerals, particularly those used in manufacturing batteries and electricity networks, key inputs in emerging technologies and markets (UNEP 2024). The International Energy Agency (2024) estimates that achieving the Paris Agreement, improving air quality and providing access to modern energy globally would increase demand for rare earth metals more than seven-fold and more than 10-fold increase in lithium demand (Figure 7). Even under existing policies, which fall far short of achieving global climate and sustainability targets, the projected increases in demand for minerals are substantial.

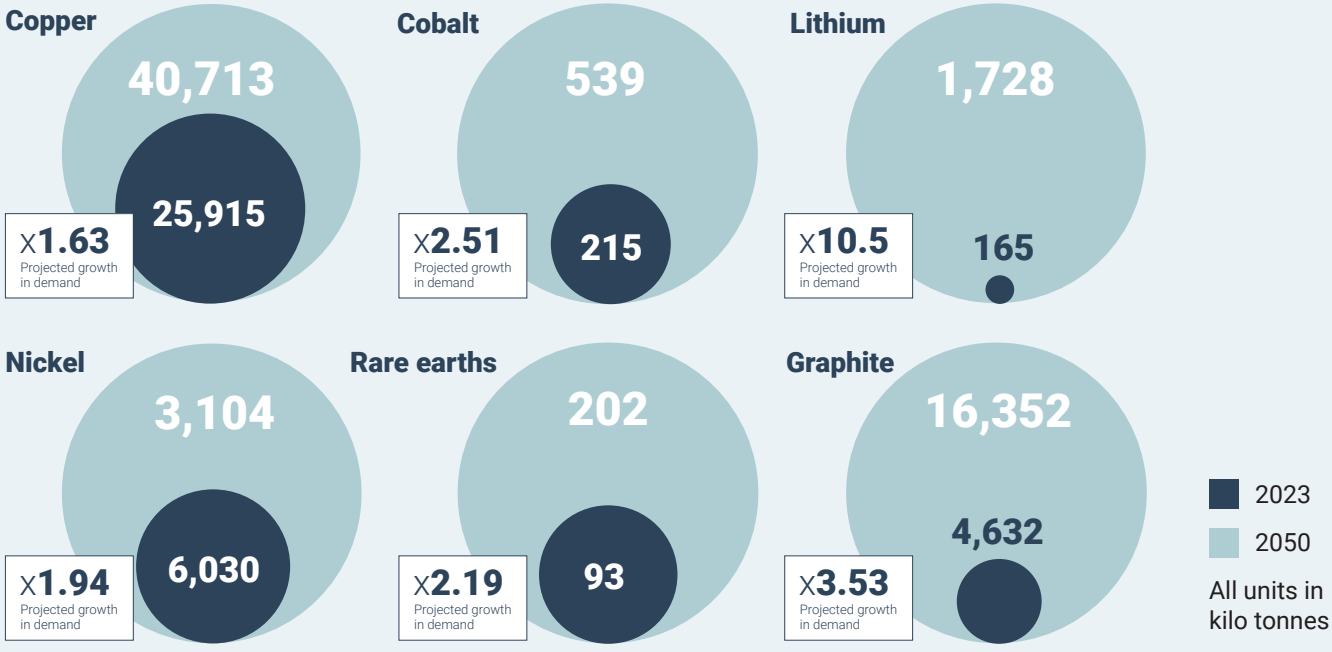


Figure 7: Projected growth in demand for critical minerals in 2050 to achieve net zero emissions. Source: IEA 2024.

As demand for minerals intensifies, so do the pressures on terrestrial reserves. In some locations, extraction now focuses on poorer quality ores, increasing energy needs and generation of wastes (Hund *et al.* 2023). The concentration of reserves in certain regions and countries (Figure 8) increases the risks of disruption to supply chains arising from shocks such as mining conflicts, trade restrictions or geopolitical tensions. Climate risks are also growing, for example in mining areas where there is pressure on water resources (Balaram *et al.* 2023).

Many low- and middle-income countries are blessed with an abundance of natural resources. While this has the potential to fuel development and prosperity, concerns remain over resources either due to scarcity or the desire for control (Muigua 2020; Dinga *et al.* 2024). Countries like the Democratic Republic of the Congo, Zimbabwe, Zambia, Djibouti and Angola have vast mineral wealth which is being exploited (Shiquan *et al.* 2022; International Monetary Fund [IMF] 2024), often with little to no consent and participation of local communities or structures to hold stakeholders accountable for environmental and social impacts and exploitation (Dinga *et al.* 2024; Kuttu *et al.* 2024). Recent economic growth in parts of Sub-Saharan Africa highlights the potential for resources to be a catalyst for positive change. By prioritizing sustainable and transparent practices, just transition, fostering community engagement and ensuring equitable distribution of benefits—in-line with the recommendations of the UN's Panel on Critical Energy Transition Minerals—Africa for example can harness its natural resources for the long-term wellbeing of its people and the environment.

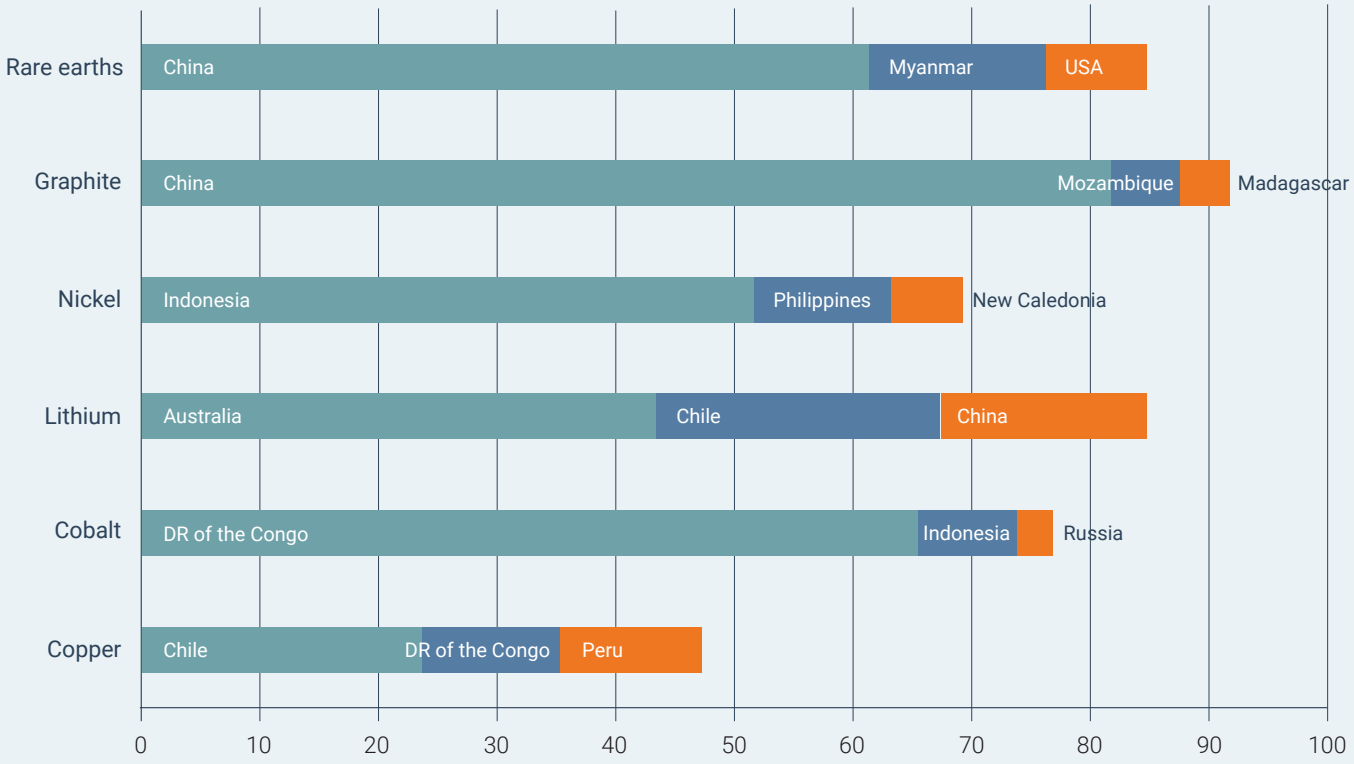


Figure 8: Percentage of global supply of critical minerals deriving from the three largest producers, 2023 for select critical minerals and metals. Source: IEA 2024.

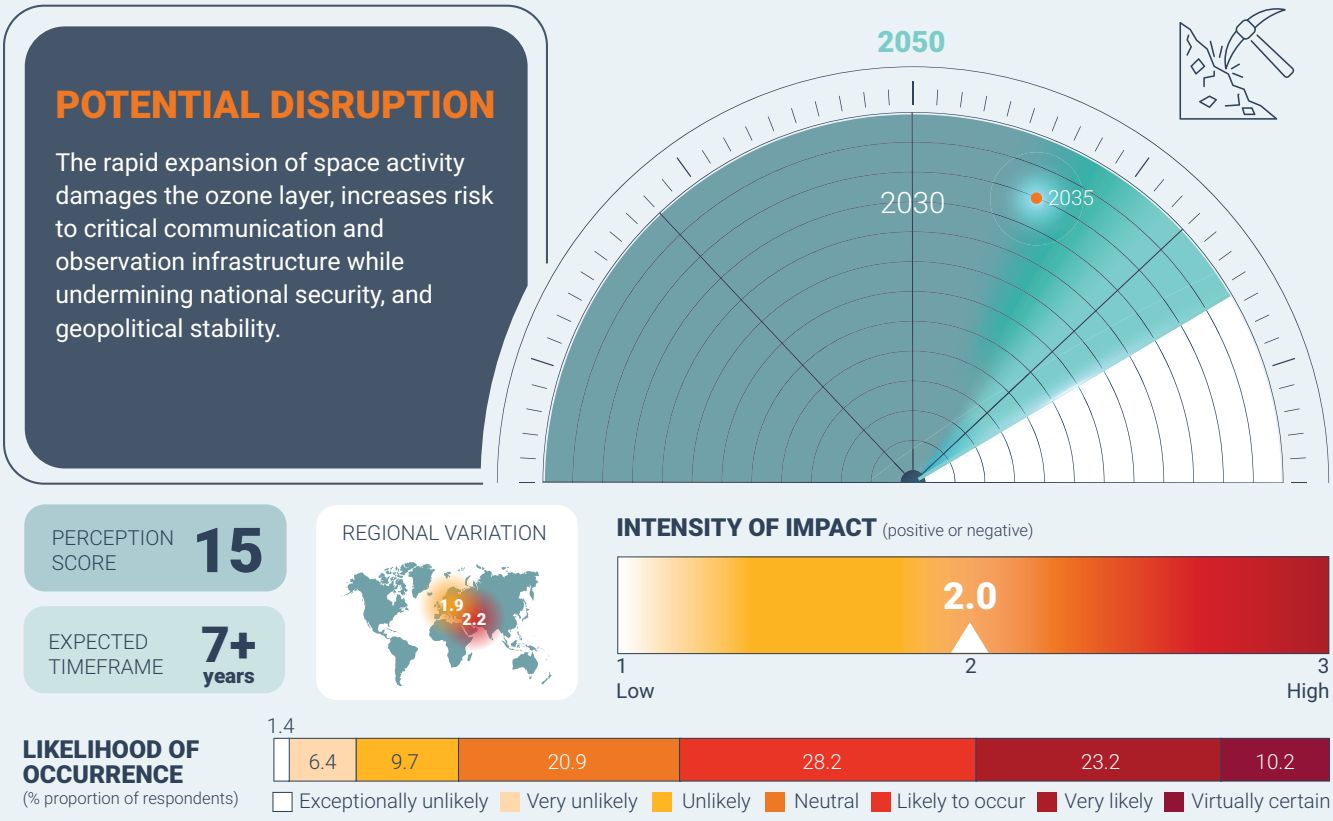
Collectively, such concerns about security of access mean that many countries are keen to diversify supply (Ponomarenko *et al.* 2021). The large quantity of untapped critical minerals and metals on the deep-sea floor is therefore receiving increasing attention both within and beyond national jurisdictions (Balaram 2023; Cadena *et al.* 2024). There is substantial concern and debate about the necessity and desirability of deep-sea mining, including about the quality of ores on the seabed, the technical feasibility and timeframe for extracting minerals and the associated environmental impacts and risks and benefit sharing in areas beyond national jurisdiction.

Meanwhile, the most essential resources—water and food—are also becoming the most threatened. Climate change exacerbates water scarcity and variability, leading to more frequent and severe droughts, floods and water stress. Approximately 2.4 billion people live in water-stressed countries (UN 2023). Climate-related impacts can further strain water resources and increase the likelihood of conflicts, particularly in regions already vulnerable to water insecurity.

Food and water are inextricably interrelated with 72 per cent of freshwater withdrawals supporting agriculture (UN Water 2023). Pollution, over-extraction and unsustainable water management practices contribute to environmental degradation and diminish the availability of clean water. Disputes over pollution control, water quality and ecosystem preservation can arise between stakeholders with competing interests (Food and Agriculture Organization of the United Nations [FAO] 2023). While the prevalence of severe food insecurity globally has declined slightly—from 11.7 per cent in 2021 to 11.3 per cent in 2022—nearly 900 million people are still severely food-insecure (FAO 2023) and as many as 783 million are facing chronic hunger and teetering on the brink of famine, with a greater number of women than men affected in every region of the world (World Food Programme [WFP] 2023). The declining availability of clean water also has a greater effect on women and young girls who are usually most involved in the process of water gathering and have greater water needs for sanitation.

Signal of change **5**

Rapid expansion of space activity and orbital space debris



As humanity goes above and beyond our planetary home, the increase in commercial spacecraft, growth of space debris and re-entry emissions caused by the return of infrastructure to Earth may have unintended consequences for the stratosphere and other environmental issues. Recent studies on space activity suggests that the launch of objects into space, payloads and rocket bodies and

associated payloads, have increased demand for critical resources, contribute to climate change through emissions of greenhouse gases, affect stratospheric radiative forcing and increase pollution (Calabuig *et al.* 2024; Donou-Adonsou *et al.* 2024). As commercial space exploration intensifies, the prospect of mineral and metals extraction (and processes) on the lunar surface is becoming more of a reality (Shaw *et al.* 2022).

Rocket launches and re-entry emit combustion emissions including carbon dioxide, water vapour and nitrogen oxides—black carbon (BC) from carbon-based solid and hypergolic fuels and kerosene, and alumina particles (Al_2O_3) and gaseous chlorine from solid fuels (Ryan *et al.* 2022); a number of these combustion emissions are ozone depleting (Maggi *et al.* 2023).

Recent studies suggest that emissions from rockets released in the upper atmosphere have nearly 500-times greater warming potential than surface and aircraft emissions sources (Ryan *et al.* 2022). The US National Oceanic and Atmospheric Administration (2024) reports that "the atmosphere more than seven miles above the surface is peppered with particles containing a variety of metals from satellites and spent rocket boosters vaporised by the intense heat of re-entry." These metals have the potential to cause stratospheric ozone depletion (National Oceanic and Atmospheric Administration [NOAA] 2024). Re-entering debris can affect the atmosphere not just by the deposition of re-entry substances but also by the shock waves of their re-entry causing chemical reactions in the atmosphere itself (Park *et al.* 2021). The impacts are being modelled but have yet to be determined.

Environment Alert

While the burgeoning space industry unlocks opportunities for exploration and resource extraction, it also introduces novel environmental concerns. Rocket emissions and debris pose a risk to the stratosphere, potentially undermining decades of ozone layer protection efforts. The increasing volume of space debris raises concerns about light pollution and climate disruption.

The collision of satellites in space can generate hundreds of thousands of pieces of debris (Clormann and Klimburg-Witjes 2021). The environmental impacts of space debris include light pollution and re-entry depositing alumina into the upper atmosphere, with changes to solar radiation that could affect the Earth's climate (Maloney *et al.* 2022). Space debris could be considered the new microplastics problem in a different dimension.

With the global space industry is projected to grow to US$3.7 trillion by 2040 (Tyler 2023), monitoring is needed to ensure that the solid progress made on protecting the ozone layer through the Montreal Protocol is not undone; given the potential impacts of re-entry emissions on the stratosphere but also other atmospheric layers (Ferreira *et al.* 2024). Other environmental impacts such as light pollution and impacts on infrastructure require monitoring as the benefits of communications and earth observations could be undermined.

2.3 AI, digital transformation and technology – a wave of change

The astonishing rate of change in technology, notably digital and artificial intelligence, could reshape our world in the coming years in ways that are unimaginable. As the pace of technological advancements and digital transformation accelerate, so will the impacts both positive and negative. These innovations hold tremendous promise to accelerate improvements across various systems, from energy to mobility to food and beyond.

Yet the trajectories for certain technological advances not least the digital transformation and AI's impending influence on society, is far from given. No revolution comes without risks. It is widely believed that this digital revolution will profoundly impact planetary health, environmental sustainability, prosperity and human agency by enabling global decarbonization, revolutionizing connectivity and inclusivity, and fundamentally altering the way society interacts, learns, communicates and perceives reality. From that perspective, AI and digital transformation is both a technological revolution and a cultural one.

Since the start of industrialisation, successive and accelerating waves of technological innovation have transformed societies and economies globally, radically altering ways of living and working (Figure 9). Scientific and technological breakthroughs have created opportunities and boosted living standards in many regions, and further technological advances will be essential if humanity is to achieve sustainability in coming decades.

Innovation cycles also produce creative destruction: radically uncertain and difficult trade-offs. The technological advances of the past century are inextricably linked with today's ecological and climate crises.

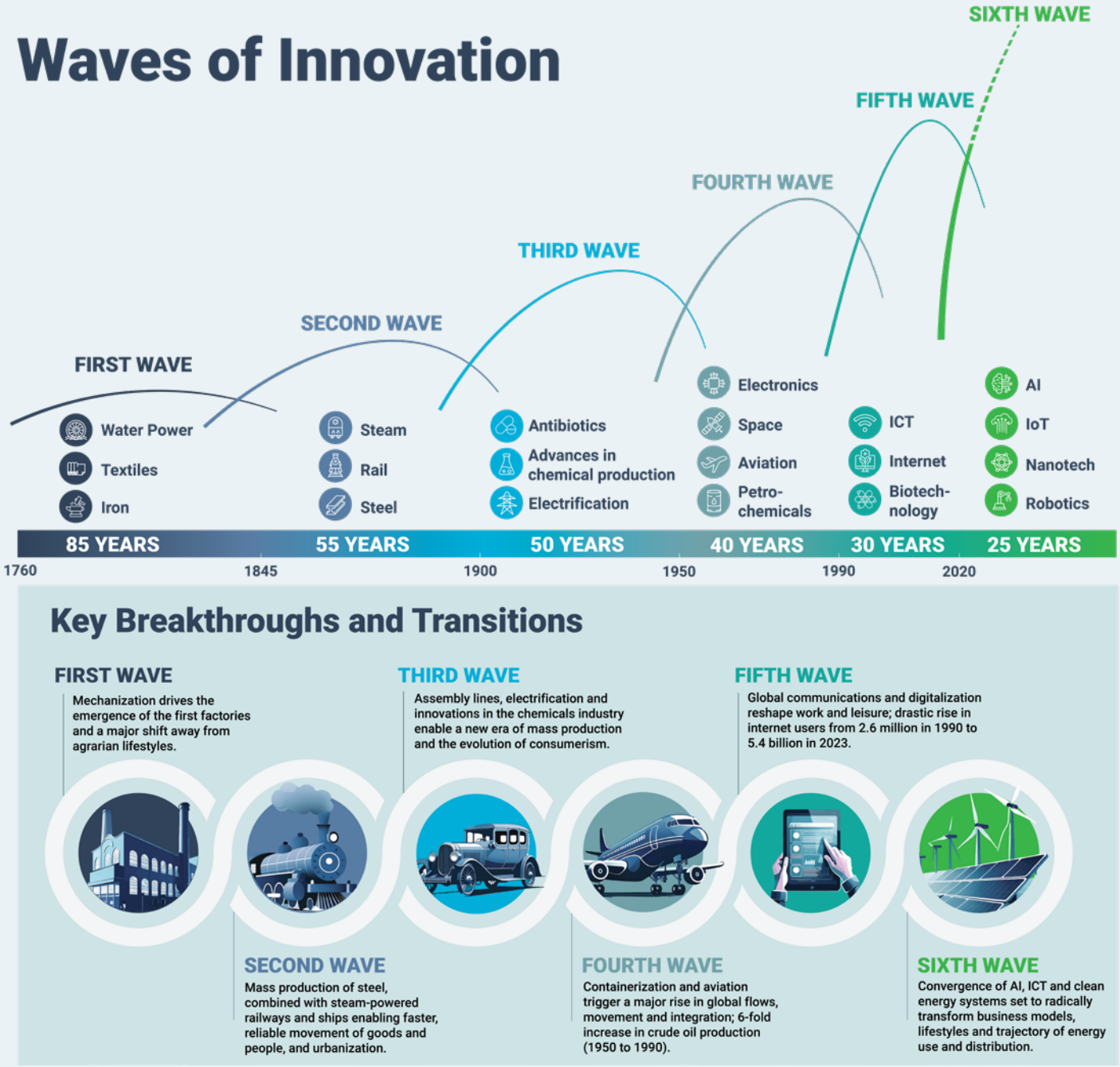


Figure 9: Waves of Innovation since the industrial revolution. Source: Adapted from Hilbert (2020). Digital technology and social change: the digital transformation of society from a historical perspective.

As societies globally strive to implement sustainability transitions, governance of innovation has become crucially important. Yet achieving effective governance looks increasingly difficult. Public institutions struggle to keep up with the pace of innovation driven by exponential growth in computational power and rapid diffusion of technologies in global markets (Schmidt 2023). Businesses have powerful commercial incentives to deploy new ideas as rapidly as possible. And the scale and pace of global environment and climate crises makes it easier to justify experimentation with large-scale 'quick fixes' that create unknown risks (Petrescu *et al.* 2023; Søgaard Jørgensen *et al.* 2024).

Three main drivers underpin current trends in the digital landscape: the proliferation of mobile phones and smart devices; expanded internet access and Internet of Things; and the exponential growth and rapid ubiquitous adoption of AI and the explosion of computational power and performance.

Mobile and other devices have become part of our lives, ensuring constant connectivity. Mobile phone usage has become ubiquitous, with over 8.89 billion subscriptions—and approximately 5.6 billion individuals worldwide possessing at least one subscription according to GSMA (2024) near-real time data (Figure 10). In many regions, mobile phones symbolise progress and inclusion, providing access to technological platforms and social media, thereby fostering global connectivity and economic participation.

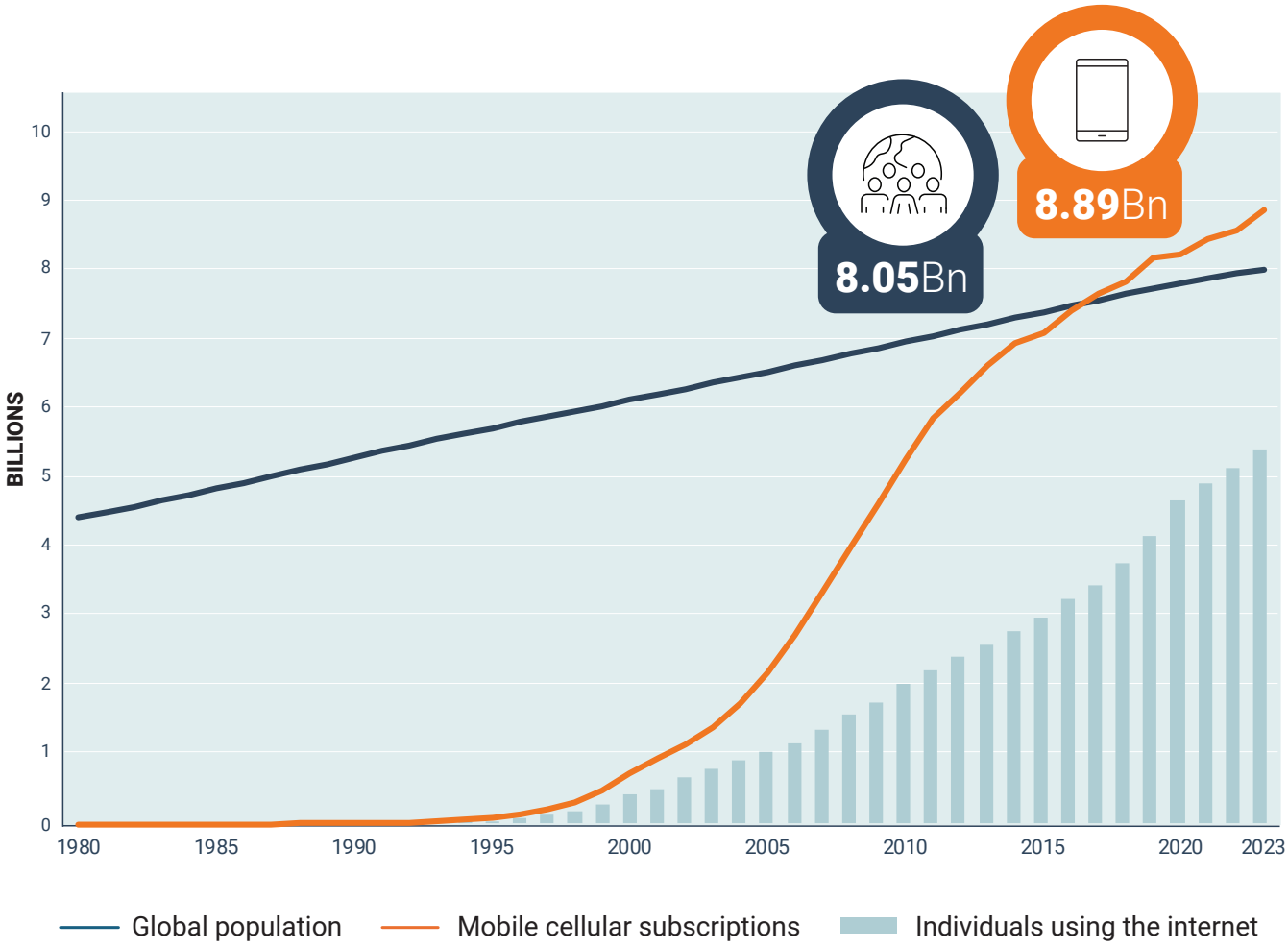


Figure 10: Estimated number of mobile-cellular phone subscription has eclipsed the number of people in the world population. Source: Adapted from ITU DataHub 2024.

Internet usage continues to surge, with 67.4 per cent of the global population using the internet at the start of 2023 (International Telecommunication Union [ITU] 2023). The proliferation of internet usage—predominantly through mobile devices—facilitates advancements across various sectors, including education, political engagement, healthcare and digital services, promoting societal integration and progress.

Meanwhile AI, a driving force behind the digital revolution, is increasingly integrated into decision-making processes across sectors such as health, education and governance. This rapid growth has prompted over 60 nations to develop national strategies for AI, recognising its potential to reshape individual autonomy, economic development and social welfare (Vats *et al.* 2022). However, the proliferation of AI could also propagate existing inequalities, especially for women, minorities and people from low-income backgrounds. This is largely due to the potential biases in the training data, which often do not adequately represent women and communities from the Global South (Hall and Ellis 2023; Roche *et al.* 2023; Young *et al.* 2023).

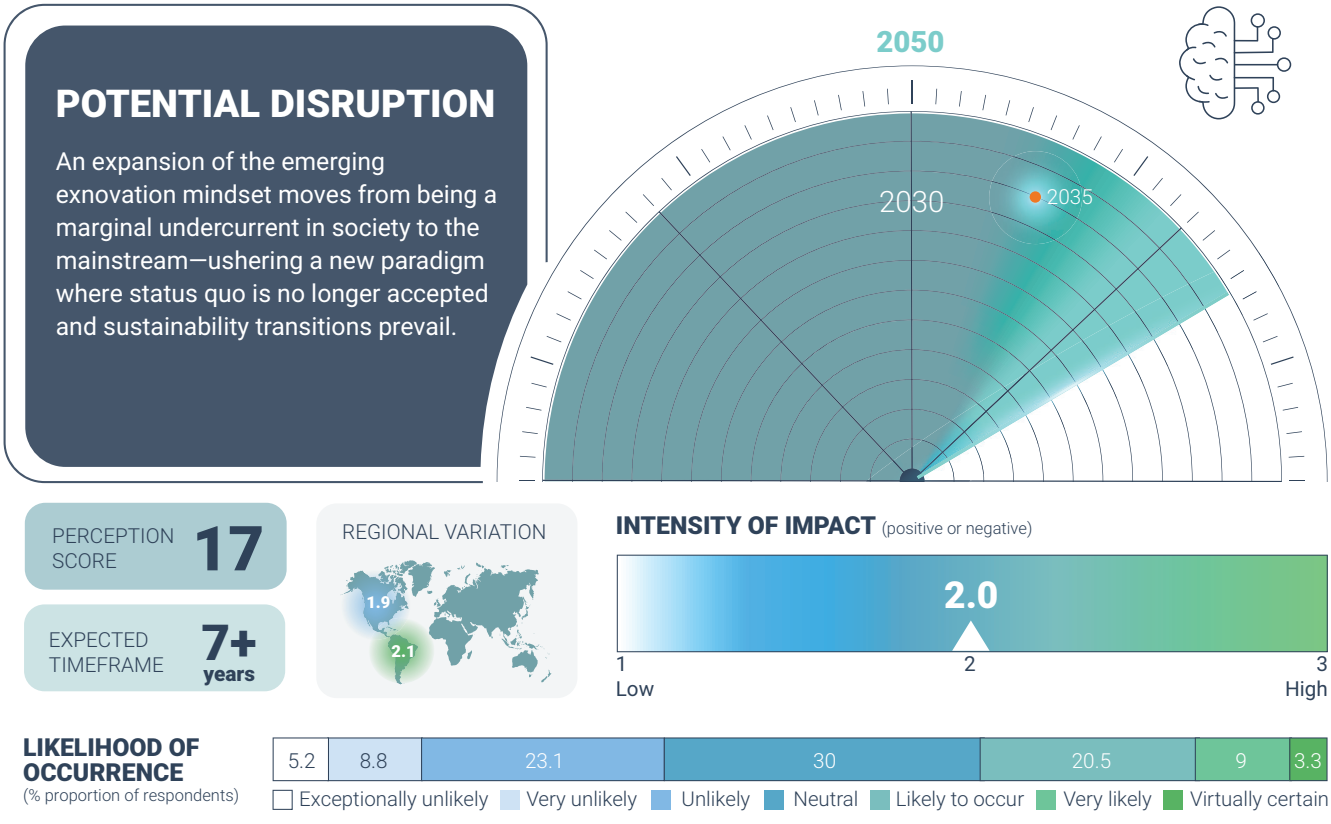
While digitalization and AI offer opportunities for economic growth and social progress, their implications for the environment are complex and multifaceted. The potential implications for increased demand for both critical minerals and rare earth elements, as well as water resources to meet new data centre demands, needs careful consideration.

Practices such as e-waste recycling, energy-efficient data centres, renewable energy adoption and responsible resource management are essential to mitigate environmental harms.

Of course, the nature and dynamics of technological transformation—not least the distribution of both its benefits and harms—vary considerably from one region to the next. In Africa, for example, digital technology and AI advances play a crucial role in its development trajectory, including its potential to accelerate the transition towards energy security and efficiency. Yet, the development and implementation of ethical frameworks and governance of AI remain heavily concentrated within the Global North. Balancing this potential double-edged sword and ensuring that AI and other technologies remain tools to drive progress and innovation rather than instruments that perpetuate existing inequalities, require Africa's valuable contributions and perspectives in shaping AI's future and stringent policies to govern its usage (Nwokolo *et al.* 2023; Okolo *et al.* 2023).

Signal of change **6**

Emerging mindset of continuous learning and 'exnovation'



Transforming the underlying systems driving environmental pressures—energy, food, mobility and finance—depends on the emergence and diffusion of technological and social innovations that offer new ways for societies to meet their needs. But it also requires a concurrent process of 'exnovation'—the practice of actively discarding outdated, inefficient, or harmful technologies, practices and norms (Hölscher and Frantzeskaki 2020; Schlaile *et al.* 2024).

Exnovation often generates substantial resistance across society. For example, transitioning to new sources of energy or food inevitably leaves stranded assets and impacts profits and livelihoods across value chains, potentially disrupting entire regional economies. Established modes of producing and consuming are also embedded in cultural norms and sense of individual and collective identity. Most people have very strong emotional connections to their existing ways of living.

For this reason, the concept of exnovation is frequently taboo; politicians are often keen to celebrate innovation but seldom want to focus on its destructive counterpart even though it is an essential aspect of transformative change.

Recent years have provided ample evidence of resistance to exnovation, whether in the form of protests, against efforts to transform farming or the successes for populist agendas that seek to discredit climate science and deny the need for systemic change. Yet there are also signals of an emerging public discussion that accepts and even embraces exnovation (Pel *et al.* 2022). This is apparent, for example, in the rapid growth of the sharing economy—projected to grow 34-fold in a single decade to US$335 billion by 2025 (Sharma 2023). This may point to a weakening association of ownership and social status; the scale and impact of the global divestment movement; the increasing popularity of so-called 'exnovative lifestyles' that promote decluttering or deceleration (e.g. the slow food movement); and the growing discourse on 'sufficiency' and 'degrowth' and their practical uptake in the context of community initiatives such as ecovillages and transition towns (Pel *et al.* 2022). Central to these shifts is a mindset of continuous learning, which goes hand in hand with active unlearning of engrained beliefs, attitudes and behaviours.

Environment Alert

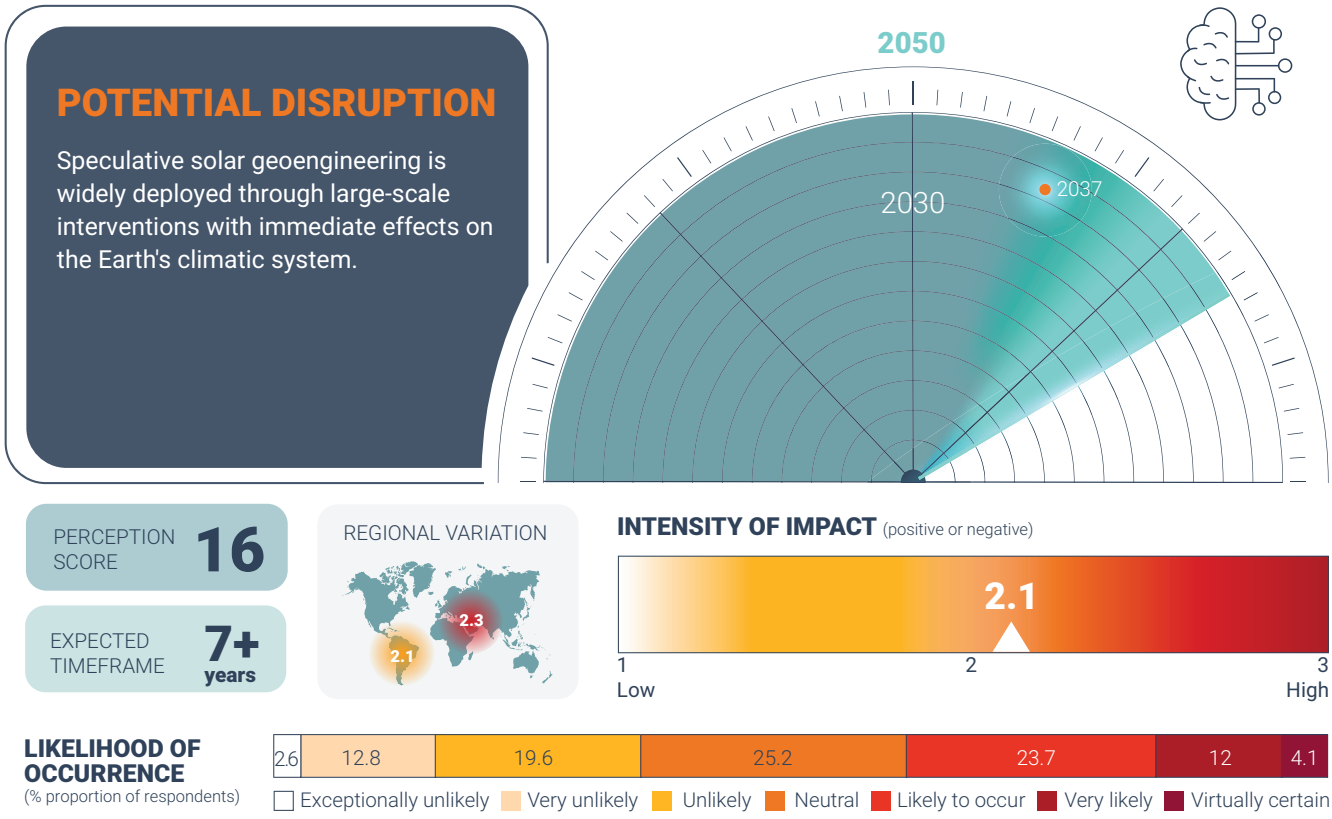
Achieving a sustainable future necessitates a two-pronged approach: embracing innovation while actively discarding practices that harm the environment, or exnovation. This emerging mindset can serve as a catalyst for the 'just transition'—opening discourse on sufficiency and paving the way for widespread adoption.

The long-term implications of these signals are unclear but there is already evidence that the exnovation mindset is moving into the mainstream of public discourse. In the political domain, governments increasingly introduce deliberate measures to phase out harmful products and technologies, including fossil fuel power and vehicles. The prominence of the 'just transition' in government policies also signals a recognition of the need for exnovation and a tool to facilitate the process. Some governments are actively advocating for new ways of living and seeking to mobilize their populations. India's Lifestyle for Environment campaign is one prominent example. And at the intergovernmental level, there are even signs of engagement with concepts such as sufficiency, for example in the International Resource Panel's Global Resource Outlook 2024 (IRP 2024).

Collectively these shifts could have a big impact. Although transforming cultural paradigms, mindsets and worldviews is often very difficult, it potentially offers the most powerful leverage point for effecting change in societal systems (O'Brien 2016).

Signal of change **7**

Deployment of Solar Radiation Modification



The concept of Solar Radiation Modification (SRM), also known as solar geoengineering or climate altering technologies, proposes to cool the planet by reflecting sunlight back into space, thereby reducing global mean temperatures. The idea is not new with research on the possibility of measures to cool the planet arising from the volcanic eruption of Mt. Pinatubo (Bluth *et al.* 1991; UNEP 2023d). Despite this, geoengineering and SRM occupies a particular space, where even 10 years ago such untested schemes, while potentially feasible, seemed little more than the fancy of science fiction writers and fringe scientists. Today, with climate impacts rising and becoming more severe and frequent, concerns over the apparent inability to drastically cut emissions and scale up carbon dioxide removal are driving scientific research, investments and development, as well as political and public interest, on the topic of SRM. Looming large over the discussions and debate around SRM is the moral hazard concern—that normalizing the discourse and even research into these technologies will detract from mitigation efforts (Cherry *et al.* 2022; Stephens *et al.* 2023).

The understanding of the environmental, biophysical and socioeconomic impacts of SRM is extremely limited. If SRM technology was deployed the cooling effects would start to diminish as soon as SRM deployment was halted leading to what is known as a termination shock—a rapid and substantial rise in global temperatures following a sudden and sustained cessation—with potentially devastating impacts on ecosystems (Trios *et al.* 2018; UNEP 2023d). Other impacts and unintended environmental consequences include a delay in the closing of the ozone hole, warming of polar regions and cooling of the tropics. These technologies are seen as potentially influencing geopolitics, introducing security risks and aiding developed countries at the expense of developing ones, which are already deeply impacted by changes to the environment and climate. The technologies do not solve the underlying causes of climate change.

Recognizing that SRM technologies remain speculative and highly contentious, scientific scrutiny and more inclusive public discourse on the implications (including ethical issues) of SRM is critical at this stage. Choosing to ignore SRM altogether at this stage, could carry its own risks—leaving society and decision-makers ill-prepared and potentially misguided (Wiener *et al.* 2023).

Environment Alert

If deployed, SRM poses substantial environmental and social risks and impacts including unintended consequences like termination shock, changes in stratospheric ozone and regional climate variation including potential extreme events, acid rain and altered precipitation patterns.

In February 2024, international negotiations at the Sixth United Nations Environment Assembly (UNEA-6) on a draft resolution to initiate a thorough independent scientific review on the potential risks of SRM was unsuccessful, as several countries strengthened their resolve in taking strong and proactive positions on what clearly remains a highly complex, under-studied group of technologies and a growing source of interstate tensions (Biermann and Gupta 2024; Morrissey 2024).

Detractors and proponents of SRM alike are emphasising the need for a governance architecture. The European Union, United Sates of America and China are currently funding research to better understand the science, and at present do not openly support the 'full-scale' deployment of SRM technologies. However, pressure for a 'quick fix' to climate-related problems and insecurity is likely to increase as temperatures continue to rise.

2.4 A new era of conflict

Armed conflict and violence are on the rise. Between 2021–23 there was a dramatic increase in casualties, mainly caused by four conflicts: the civil war in the Tigray region in Ethiopia, the civil war in Sudan, the Russian Federation's invasion of Ukraine, and the conflict in Gaza. Fifty-nine state-based conflicts across 34 countries were registered, higher than any time since 1946 (Rustad 2024).

The nature of conflict has also transformed substantially (Davies *et al.* 2023; Alderdice 2024). Regional tensions, a breakdown in the rule of law, absent or co-opted state institutions, illicit economic gain and the scarcity of resources exacerbated by climate change have all become dominant drivers of conflict

(UN 2024a). Increasingly, conflicts are propagated and sustained by the engagement of non-state actors, political militias, domestic criminal groups and terrorist organizations, which in some cases are supported overtly or covertly by state actors. Civilians are in the firing line, and the neglect of forcibly displaced people has become the new normal (Abu-Hanna *et al.* 2023; International Committee of the Red Cross [ICRC] 2024; Semerdjian 2024).

As this report was being written, the Democratic Republic of the Congo, Sudan, Yemen, Ukraine and Gaza are facing humanitarian and environmental catastrophes. These hotspots, which represent the deadliest of armed conflicts since the 1994 Rwandan genocide (Institute for Economics and Peace [IEP] 2024), are characterized by severe disruptions to societal functioning, extensive human, material and environmental losses, and impacts surpassing the affected society's coping capacity. Critical infrastructure, including water systems and waste management facilities, were compromised, exacerbating environmental hazards. Climate change adds to the stresses caused by conflict, and is characterised by UN Emergency Relief Coordinator Martin Griffiths as "a rapidly increasing driver of humanitarian need". Humanitarian diplomacy, Griffiths argues, has been "obliged to take a front seat in the absence of much political diplomacy because of the divisions, the geopolitics that we face today… the use of negotiation and dialogue to end conflict is a trait, a norm, a commitment which is now no longer an essential component in international diplomacy" (Griffiths 2024).

Armed conflicts consistently result in environmental degradation and destruction. This leads to enduring repercussions that heighten the vulnerability of affected populations and can also exacerbate pre-existing patterns of discrimination, especially for women and children, which exposes them to heightened risks of violence (UNEP 2022; OHCHR 2024; UNEP 2024). Although certain international laws aim to safeguard the natural environment and mitigate damage (ICRC 2019), armed conflicts remain a significant driver of environmental harm, triggering food and water insecurity, loss of livelihoods and biodiversity depletion.

In Gaza, heavy restrictions on access to basic goods and the collapse of local agrifood systems have exacerbated a dire humanitarian situation (FAO and WFP 2024). Wastewater and solid waste management infrastructure collapsed as a result of conflict, leaving sewage and waste to spread, infiltrate groundwater and present human exposure and disease risks. The contamination of land and water, and damage to agricultural land, presents significant challenges in remediation and recovery (UNEP 2024; World Bank and UN 2024a).

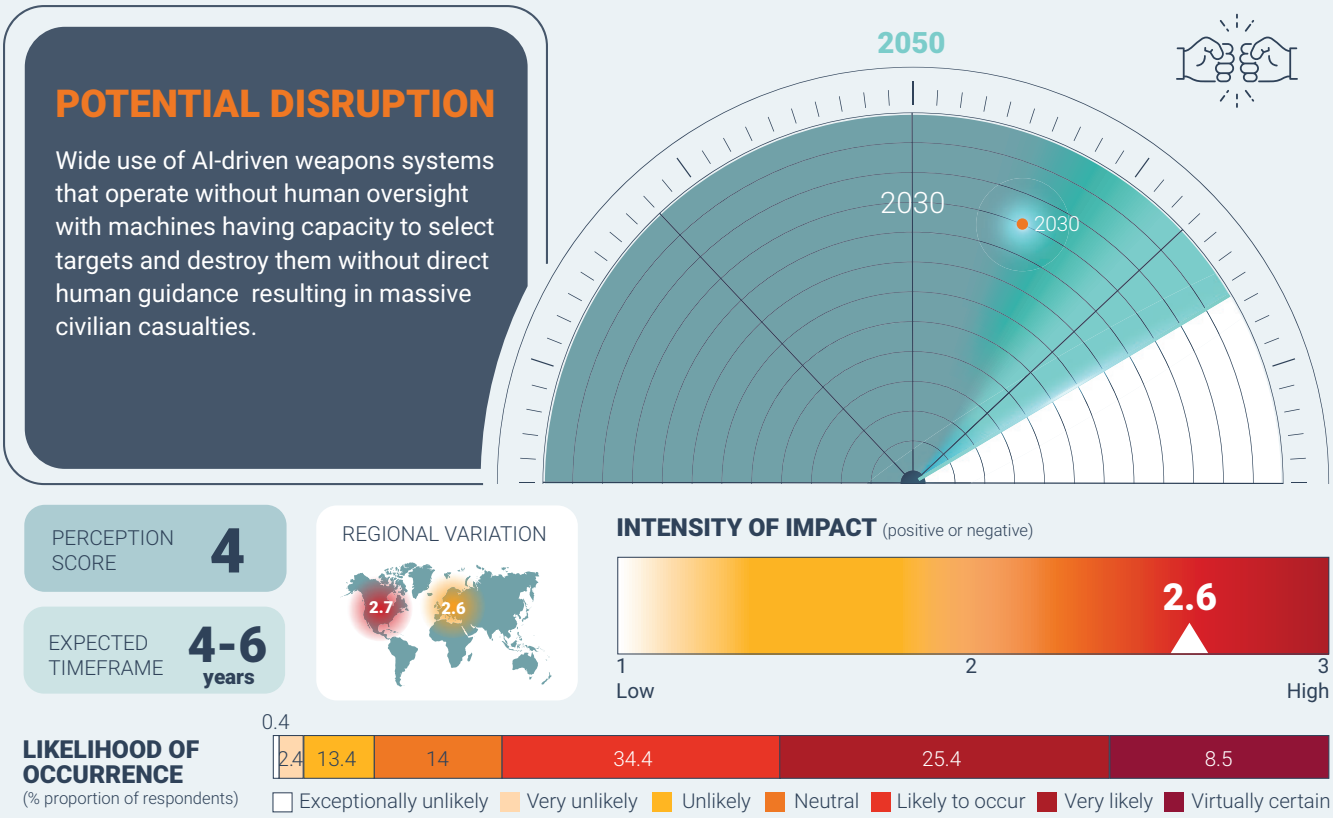
Technological advances are contributing to the changing nature of conflict. The proliferation of internet access and smartphones has drastically altered the landscape. The use of big data, satellite imagery, AI and other emerging technologies facilitates environmental monitoring and accountability in conflict zones. But some technological advances—namely AI and machine learning—are also reshaping the dynamics of warfare in concerning ways, for example, by making attacks (cyber or physical) more finely targeted, harder to attribute and easier for small groups to carry out (UN 2024a). Additionally, the deployment of autonomous aerial and ground-based vehicles, coupled with satellite technology, redefines the boundaries and nature of warfare. While initially perceived as tools to minimise damage, drone technology has become increasingly prevalent in conventional warfare and accessible to non-state actors (UN 2024a).

Natural conditions, compounded by climate volatility and extremes, pose escalating risks, exacerbated and manipulated by a new spectrum of conflict and the weaponization of access to water, food, energy and critical infrastructure (Daoudy *et al.* 2022; Kenna and Alexander 2022; Scissa 2024). Since 2011, during conflicts in Gaza, Libya, the Syrian Arab Republic and Yemen an estimated 180 instances of deliberate targeting of water infrastructure has occurred (World Bank 2021b).

The weaponisation of access to natural resources—such as water, energy and food—is a pressing concern, especially in the face of climate change. Water scarcity has reached crisis levels globally, and projections indicate that by 2025 two-thirds of the global population will experience water stress with 1.8 billion people experiencing complete water scarcity (Padder and Bashir 2023). There is increasing evidence of weaponisation of supply chains for key commodities (Parasecoli and Varga 2023; Bednarski *et al.* 2024; Glencross 2024). This is having ripple effects on regional and global systems—as we have seen with Ukraine and the Middle East—with financial markets, security dynamics and geopolitical stability (Farrell and Newman 2022).

Signal of change **8**

Autonomous and artificial intelligence weapons systems



The rapid progress in applied AI solutions for a range of commercial and military applications, availability of open-source AI solutions (Ams 2023; Hunter *et al.* 2023; Rashid *et al.* 2023; Garcia 2024) and the ongoing conflicts in Ukraine and the Middle East, which are active testing grounds for drones and other advanced AI applications (Greene 2022), are all signals of a dangerous global shift in the arena of AI weaponization and robotic warfare (Horowitz 2016; Roumate 2024).

This opens up the potential for swift, unchecked developments, which could be used to covertly create new types of weaponry systems and conceal abuses of technology in modern warfare and thereby compromise global security (Johnson 2020; Raska 2024; Roumate 2024; Simmons-Edler *et al.* 2024). Concerns have been raised about a lack of human oversight regarding AI systems used in military activities and the large language models (LLMs) that support them. The 2024 study by Rivera *et al.* (2024) found that LLMs could recommend pro-escalation tactics without clear logic or rationale.

This was noted as similar to the arms races and calls for nuclear weapons use. A specific example of these concerns and lack of oversight is the Israeli 'Lavender' AI system used for civilian classification and military targeting in operations in Gaza (Abraham 2024; Raska 2024; Simmons-Edler *et al.* 2024).

AI-enabled systems radically accelerate the speed and scale of warfare in terms of inflicting harm on both civilians and the environment, particularly as conflict is becoming increasingly concentrated in urban areas (Hägerdal 2023; Hook and Marcantonio 2023). Here, heavy bombardment of populated areas can contaminate soil and groundwater in the long term; both through the munitions themselves and as collapsed buildings release hazardous materials including asbestos, industrial chemicals and fuel into the surrounding air, soil and groundwater (UNEP 2022).

Environment Alert

AI weaponization and robotic warfare raises ethical security and environmental concerns. Conflicts involving AI-enabled warfare can result in unintended large-scale damage or destruction to critical resources, such as water supplies, agricultural land and natural reserves, exacerbating the environmental toll of warfare. Open-source AI and ongoing conflicts act as testing grounds for autonomous weapons, potentially leading to unforeseen environmental consequences. Such technologies may recommend tactics with unclear environmental ramifications.

Concurrently, emerging commercial humanoid robots, like those recently developed by Berkeley Labs (Council 2023) and Tesla (Alvarez 2023), along with the expansion of autonomous vehicles and drones (Shladover 2016; Rashid *et al.* 2023;) and the deployment of non-humanoid battlefield robots (Horowitz *et al.* 2020; Askew 2023) may signal the advent of a new era of warfare dominated by AI and robotics.

Developments in artificial neural networks capable of simulating, and sometimes surpassing, human thought (Mnih *et al.* 2015; Bojic *et al.* 2023; Du 2023; Hagendorff *et al.* 2023), coupled with the speed at which these technologies can perform tasks, introduce potential threats in the creation and manipulation of viruses and other substances (Sawaya 2023) posing added risks in warfare and conflicts. As machine-learning technology continues to advance, bringing us closer to superintelligent systems (Bostrom 2016; OpenAI 2024), the regulation of these technologies becomes critical to mitigate potential misuse.

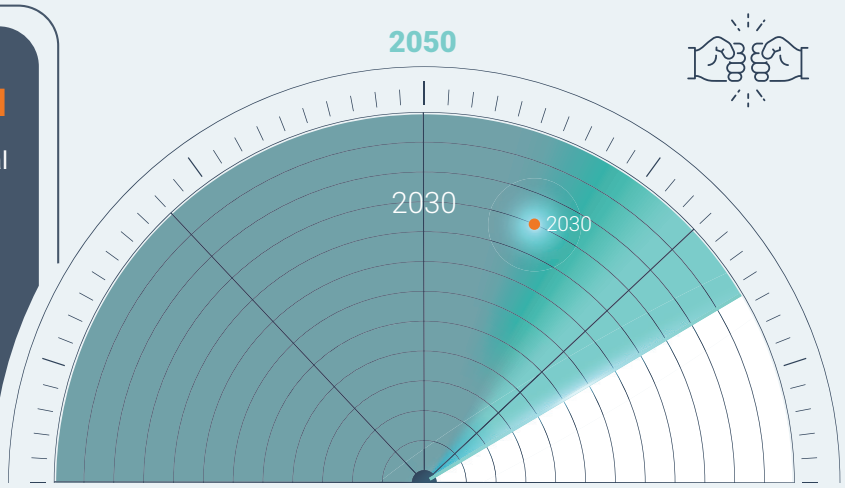
These signals point to a host of legal and moral questions and entered uncharted territory for advanced warfare that could have unfathomable consequences for civilization. As the UN Secretary General mentioned in a recent address: "We cannot sleepwalk into a dystopian future where the power of AI is controlled by a few people – or worse, by the opaque algorithms beyond human understanding [and control]. We need rules. Safety. Universal guardrails. And how we act now will define our era" (Guterres 2024).

Signal of change **9**

New technologies amplify risks of biological agents misuse

POTENTIAL DISRUPTION

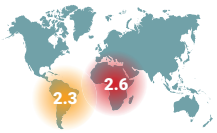
The convergence of AI, biotechnological advancements and their dual-use nature, combined with a lack of regulatory oversight (and inadequate frameworks) gives rise to the creation and use of biowarfare and bioterrorism threatening global security.



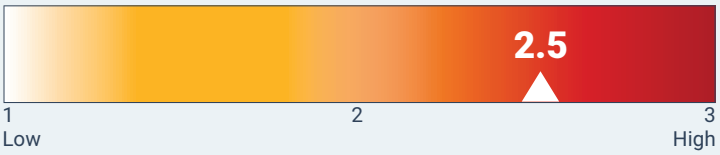
PERCEPTION SCORE **12**

EXPECTED TIMEFRAME **4-6 years**

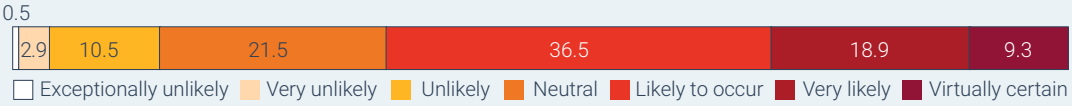
REGIONAL VARIATION



INTENSITY OF IMPACT (positive or negative)



LIKELIHOOD OF OCCURRENCE
(% proportion of respondents)



Exceptionally unlikely | Very unlikely | Unlikely | Neutral | Likely to occur | Very likely | Virtually certain

The use of biological agents, such as pathogens or their associated toxins, is not new in the context of warfare and terrorism. However, despite their use in war being prohibited under the Geneva Protocol (1925) and the Biological Weapons Convention (1972), their potential for harm is being amplified by the convergence of emerging bio- and other technologies, the pace of developments and the inability of existing legal and safety frameworks to keep pace with such change. International fora are discussing regulation of synthetic biology with ad hoc expert groups established to ensure appropriate horizon-scanning of these issues as well as discussion on benefit sharing of genetic resources (Convention on Biological Diversity 2022, Cartagena Protocol, Nagoya Protocol). These do not include risk assessment of biological agents for use in wider warfare.

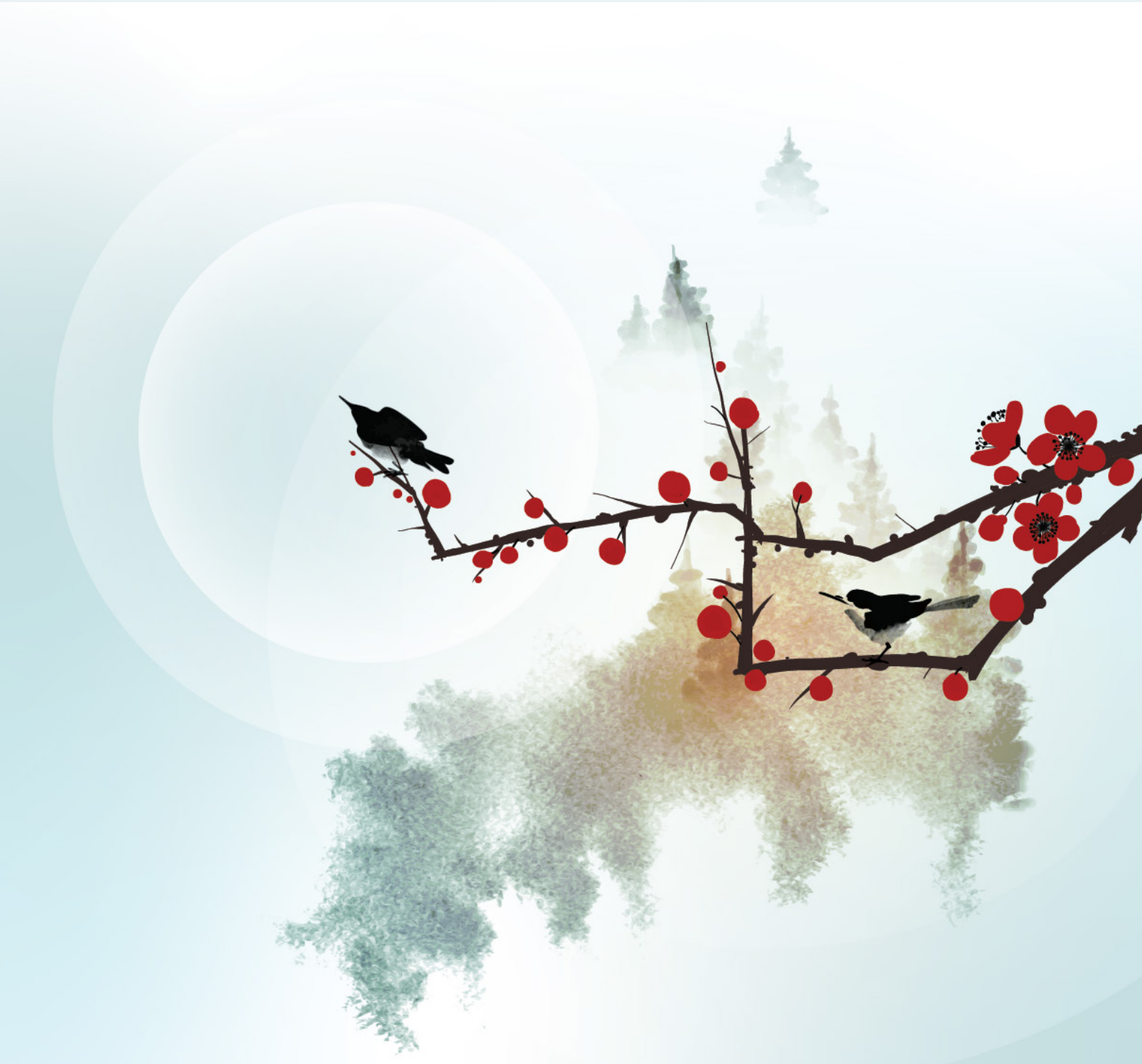
Preceding these international frameworks, concerns about genetic engineering have persisted since the 1970s (Paris 2023), with technical, social and organizational challenges impeding progress (Trump *et al.* 2021). However, the traditional framework for biological warfare, centred on known pathogens, like anthrax and plague, is undergoing a profound shift due to synthetic biology (Sandberg and Nelson 2020; Trump *et al.* 2021).

The combination of genomic technologies driving synthetic biology with AI and machine learning could lead to the development of novel biological weapons targeting specific demographics (Lentzos 2020). Additionally, the prospect of employing nano-aerial vehicles controlled by AI to disseminate bioagents poses a novel challenge (Kambouris *et al.* 2023). A biological attack on livestock or crops could yield significant economic repercussions (Roberge 2015). The recent COVID-19 pandemic has demonstrated the potential consequences on society and economies from biological threats, and how easily biological agents can spread across societies. In addition to widespread direct impacts, future

biological conflicts may employ small-scale, targeted assaults to instil psychological impact, capitalising on advancements in synthetic biology (Gisselsson 2022). Even if not purposefully deployed, research into such substances bears a risk associated with accidental or malicious release (WHO 2022).

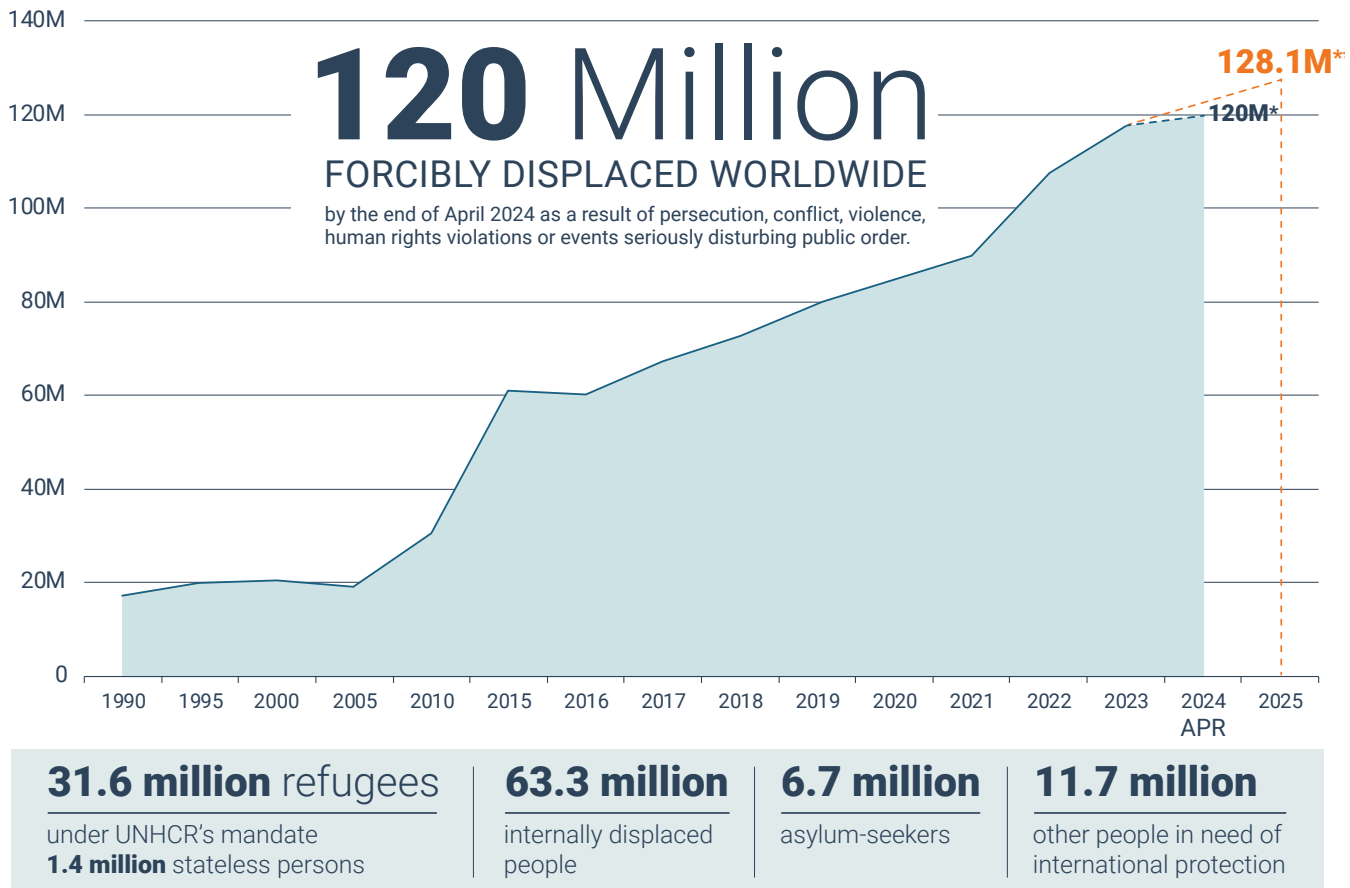
Environment Alert

The potential development of novel, targeted bioweapons capable of disrupting ecosystems, harming agriculture and causing widespread ecological damage necessitates urgent action. Existing frameworks must adapt to keep pace with rapid scientific progress, ensuring that these powerful tools are used for good, not to unleash environmental destruction.



2.5 Mass forced displacement

When home becomes uninhabitable—whether due to conflict, climate change or other external pressures—people are faced with little choice other than to move. This can be over borders and across continents. Human mobility and migration have long been a driver of development and innovation. But in a world characterized by multiple crises—economic, conflicts and disasters—the magnitude and character of these crises have changed over time and are amongst the most important phenomena this century (Dao *et al.* 2021; United Nations Refugee Agency [UNHCR] 2024). Global transformations in geopolitical and technological domains have played a key role in the changing nature of human movement and its impacts (McAuliffe and Triandafyllidou 2021). The effects of climate and environmental changes are increasingly forcing people from their homes. Water scarcity is linked with a 10 per cent rise in global migration (World Bank 2021a), and forcibly displaced persons and their host communities face numerous water-related risks (World Bank 2021b).



* Based on operational data. ** Projected annual increase of 8.1M extrapolating existing 2024 operational data.

Figure 11: Forced displacement. Source: Adapted from IOM 2024 Global Trends report, UNHCR 2024.

Today, one in every 69 people, or 1.5 per cent of the entire world's population, is now forcibly displaced—nearly a doubling of the people that were displaced a decade ago (UNHCR 2024) with women and girls affected the most. In the latest report of International Organization for Migration (IOM) forced displacement is now reported as the highest on record in the modern age (IOM 2024). Places such as the Democratic Republic of the Congo, Ukraine, Sudan, Syrian Arab Republic, Myanmar, Ethiopia and the Middle East have shown that most the world's forcibly displaced people are internally displaced, moving from their homes and communities but generally within national borders (Figure 11). Notably, according to new data from IOM, 10.7 million people are now displaced by conflicts in Sudan, nine million of which are internally displaced (IOM 2024). In Gaza, over 1.9 million people (85 per cent of the population) became internally displaced in less than 150 days, with their homes, amenities and support networks completely unreachable, even if they had only moved a few miles (Buheji and Hasan 2024; Norwegian Refugee Council [NRC] 2024; Sahara 2024; UNEP 2024).

While the number of internally displaced persons remains a relatively small proportion of the global population (71.4 million), in two decades the numbers have risen by 340 per cent (Internal Displacement Monitoring Centre [IDMC] 2023). This not only poses significant humanitarian challenges but also contributes to and is worsened by environmental and climate impacts, further exacerbating the complexities of forced migration. The persistence of the trend of extreme temperatures and climate-related events disasters has triggered an unprecedented surge in large-scale, prolonged and repeated displacements worldwide in last two years in many parts of the world in Pakistan, the Philippines, Somalia, China, India, Bangladesh, Brazil, Colombia and Kenya (IDMC 2023; WMO 2024).

Projections from IOM suggest that between 25 million and 1 billion people could become environmental migrants by 2050 (IOM 2024). According to the IPCC "approximately 3.3 to 3.6 billion people live in contexts that are highly vulnerable to climate change". Climate-induced human migration and displacement affect certain regions and their populations more than others, with some countries in Africa, Central America, the Pacific Islands and South Asia more at risk than other regions.

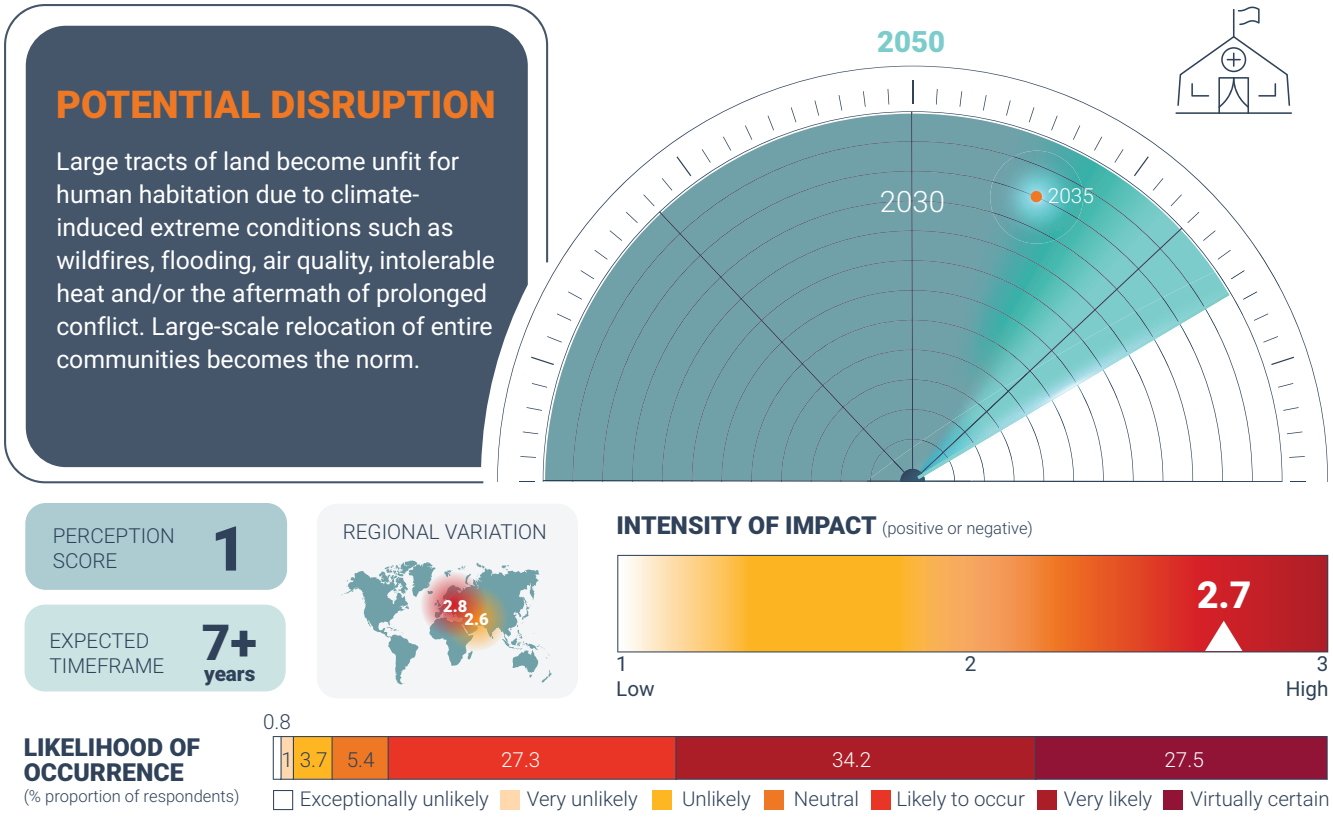
Climate-migration relationships are complex and context-specific. It is difficult to pin down precisely the extent to which human mobility and displacement is solely caused by climate hazards because this humanitarian crisis, as found in the Honduras case for example, is often intertwined with political instability, economic structure/changes, agricultural disruptions, food scarcity, physical insecurity due to crime and violence and so on (Pappas *et al.* 2021; Reichman 2022). Forced displacement has grown at an accelerating speed worldwide in the last decade or so not least due to global warming and geopolitical tensions. In 2018 it was estimated that some 22.5 million people have left their homes since 2008 due to climate change (IDMC 2018; UNHCR 2019). According to the World Bank's Groundswell report (2021) 216 million people worldwide could be forcibly displaced within their countries by 2050 due to climate change.

Migration can be a solution to the problem for affected areas, but it often creates new socio-economic problems and even political tensions in destination countries/locales (Sergievskaya 2021). Climate-induced migration is also associated with ethical and social justice considerations with human rights on the one hand and how to share the burden fairly amongst nation states on the other. Many nation states are under-resourced in accommodating climate-induced and humanitarian migrants more broadly. The effectiveness of relocation programmes remains to be improved, as are international regulation frameworks in managing this challenge.

The environmental considerations and implications are many from the provision of land, infrastructure, services, resources to dealing with unintended environmental impacts such as wastes and pollution from rapid forced migration placing impacts on nature and other natural resources.

Signal of change **10**

Uninhabitable Spaces



Climate change and other factors combine to influence habitability, which is defined as a characteristic of environments that support human safety, resilient livelihoods, people's capacity to adapt to risk and sustainable intergenerational development (Horton *et al.* 2021; Wrathall *et al.* 2023). Habitability has five pillars: land, freshwater, food, settlement and infrastructure, and economic and subsistence activities (Spencer *et al.* 2024).

In many locations, and specifically in small island nations, habitability is expected to decrease. This is anticipated due to rising temperatures, rising sea levels and degradation of buffering ecosystems, which in turn exacerbate human exposure to ocean hazards (Mycoo *et al.* 2022). The IPCC Sixth Assessment Report noted the threats of climate change on low-lying areas and vulnerability of communities. They report that those relying on coral reef systems for livelihoods may exceed adaptation limits well before 2100 even for a low greenhouse gas emission pathway. Those low-lying and coastal areas are at particular risk and hence the ability of these areas to support human life and livelihoods. The future habitability of atoll islands is a major concern (Duvat *et al.* 2021). Extreme heat also threatens habitation of communities in urban areas in the tropics and arid and semi-arid regions of the world (Cissé *et al.* 2022).

In a recent modelling study, scientists projected that over the coming 50 years, up to three billion people could be living well outside climate conditions (and particularly temperature) that have served humanity over the past 6,000 years, and worse, that by 2070, absent climate mitigation or migration, certain regions—Northern South America, central Africa, India and northern Australia—could simply become too hot to allow human life (Xu *et al.* 2020). While the temperate regions of the world are unlikely to become uninhabitable due to temperatures alone, extreme conditions such as flooding,

wildfires, intolerable low air quality, could eventually render some densely populated urban areas as well as rural communities—like those exposed to wildfires in the wildland-urban interface—as prohibitively dangerous locales, where seasonal displacement (temporary uninhabitability) becomes the norm (Palinkas 2020; Yadav *et al.* 2023). A recent study showed the number of extreme fires has risen more than 10-fold in the past 20 years in temperate conifer forests, and nearly seven-fold in the boreal forests of northern Europe and Canada as result of climate change (Cunningham *et al.* 2024). As places become uninhabitable, migration is anticipated and the need for social services will increase. Semi-arid areas, the tropics and some low-lying deltas and islands require prioritization for climate justice. Solutions need to be generated and investments made to address habitability risks focussing on areas to implement adaptation (Horton *et al.* 2021).

Environment Alert

Climate change will affect human habitability. Rising temperatures, extreme weather events and rising sea levels threaten the future availability of habitable environments. Low-lying island nations and coastal communities are particularly vulnerable, facing potential displacement due to ecosystem degradation and rising sea levels.

2.6 Persistent and widening inequalities

Over recent decades, the global community has witnessed remarkable progress in reducing extreme poverty (UN 2023). That progress has stalled. The COVID-19 pandemic brought considerable setbacks, particularly in the poorest countries (World Bank 2024a). Immense inequalities of income and wealth intensify within and between countries worldwide (World Inequality Database [WID] 2024). While the top 10 per cent account for more than three quarters of total global wealth, the bottom 50 per cent of the world population own just 2 per cent or almost nothing. The ultra-wealthy are gaining the most and much faster than the rest. Between 1995 and 2021, the top 1 per cent captured 38 per cent of the global increase in total wealth, while the bottom 50 per cent again accounted for just 2 per cent (Chancel *et al.* 2022).

This growing concentration of wealth not only confers huge economic and political power on a tiny elite, but it is also contributing to social stratification and undermining public institutions and social solidarity (Obeng-Odoom 2020; Gautney 2023; Remington 2023; Xu 2023).

Within nations, income inequality is rising due to unequal access to education, limited employment opportunities and inadequate social services, as well as regressive tax policies. Globalization contributes to economic growth in many parts of the world, but it has also led to increased competition and job displacement in specific sectors. Widening inequality also perpetuates unequal access to essential services, including ecosystem services: clear air and water, fertile soil, stable climate and vibrant biodiversity. Marginalized communities—including ethnic minorities, women, children and persons with disabilities—are disproportionately affected by inadequate access to these services, reinforcing the cycles of poverty and exclusion (Mackenbach 2017; MacDonald *et al.* 2020; Petrikova 2020).

Consequently, inequalities of wealth and income lead to ecological inequities. On one hand, the wealthiest people contribute massively to climate change and environmental degradation. One recent study finds that the wealthiest 1 per cent of the global population and the poorest 66 per cent each account for 16 per cent of greenhouse gas emissions (Khalfan *et al.* 2023). On the other hand, the poorest people face the most significant exposure to pollution and disasters resulting from the mismanagement of nature (Ajide and Ibrahim 2022; Kopp and Nabernegg 2022). For example, poorer people live in areas with worse air and noise pollution or industrial intensity because housing is cheaper there (Hajat *et al.* 2015; Rentschler and Leonova 2023). In practice, environmental harms of this kind often intersect with other forms of injustice, such as those linked to race, disability or gender. The result is multiplying the inequities visited on society's weakest and most vulnerable people.

Signal of change **11**

Privatized micro-environmentalism

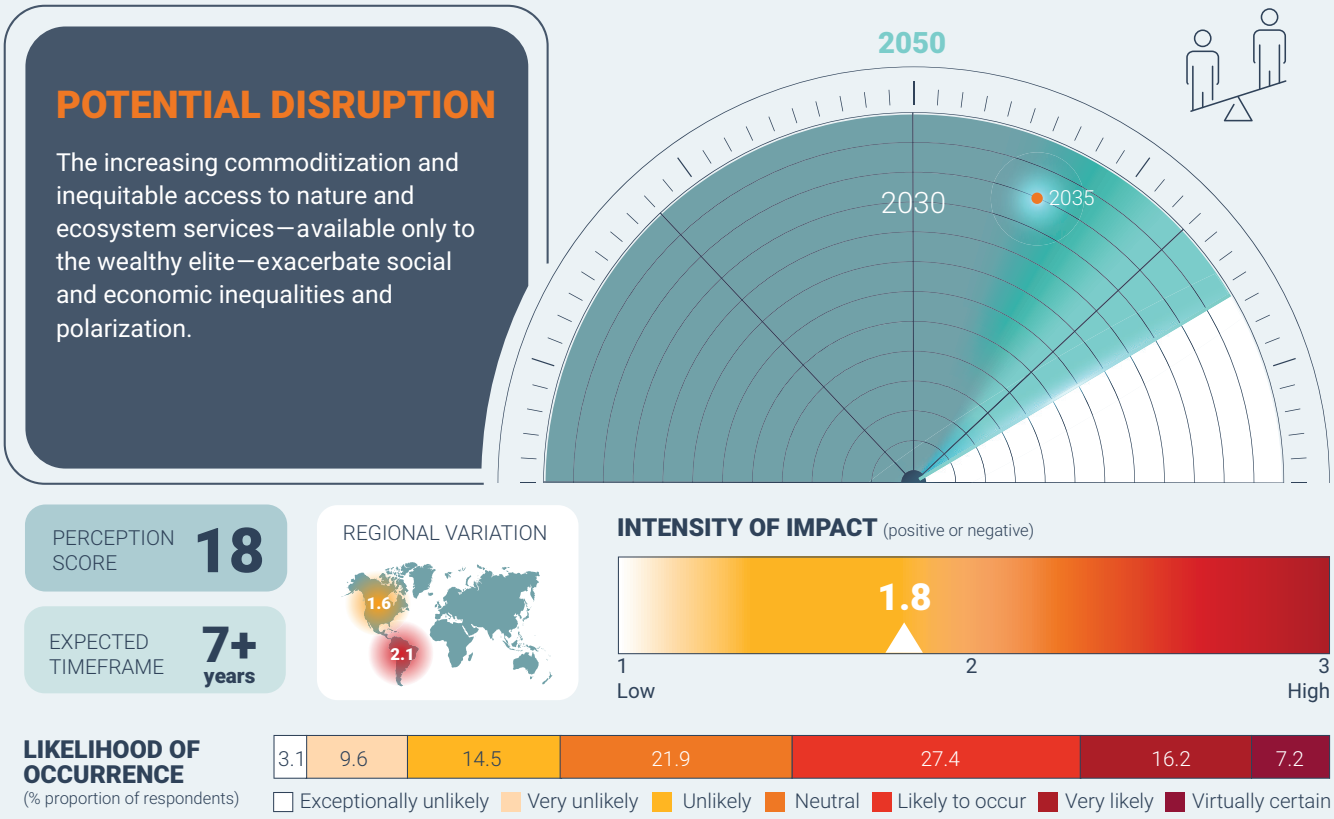


Figure 7.11

'Privatised micro-environmentalism' refers to the creation of private-access, enclosed and sometimes artificial habitats that offer stable ecosystem services to highly paying members. Independent of broader planetary decline, these 'private bubbles' greatly limit equal access to nature-based quality of life and bypass shared responsibility for conservation efforts, therefore disrupting notions of environmental stewardship (Bollig *et al.* 2023; Preston 2024).

Environment Alert

Privatized micro-environmentalism undermines environmental justice and collective responsibility. By commodifying clean air and nature access, it exacerbates existing inequalities. Furthermore, these enclaves risk draining resources and distracting from vital efforts to conserve and restore natural ecosystems for everyone, not just the privileged few.

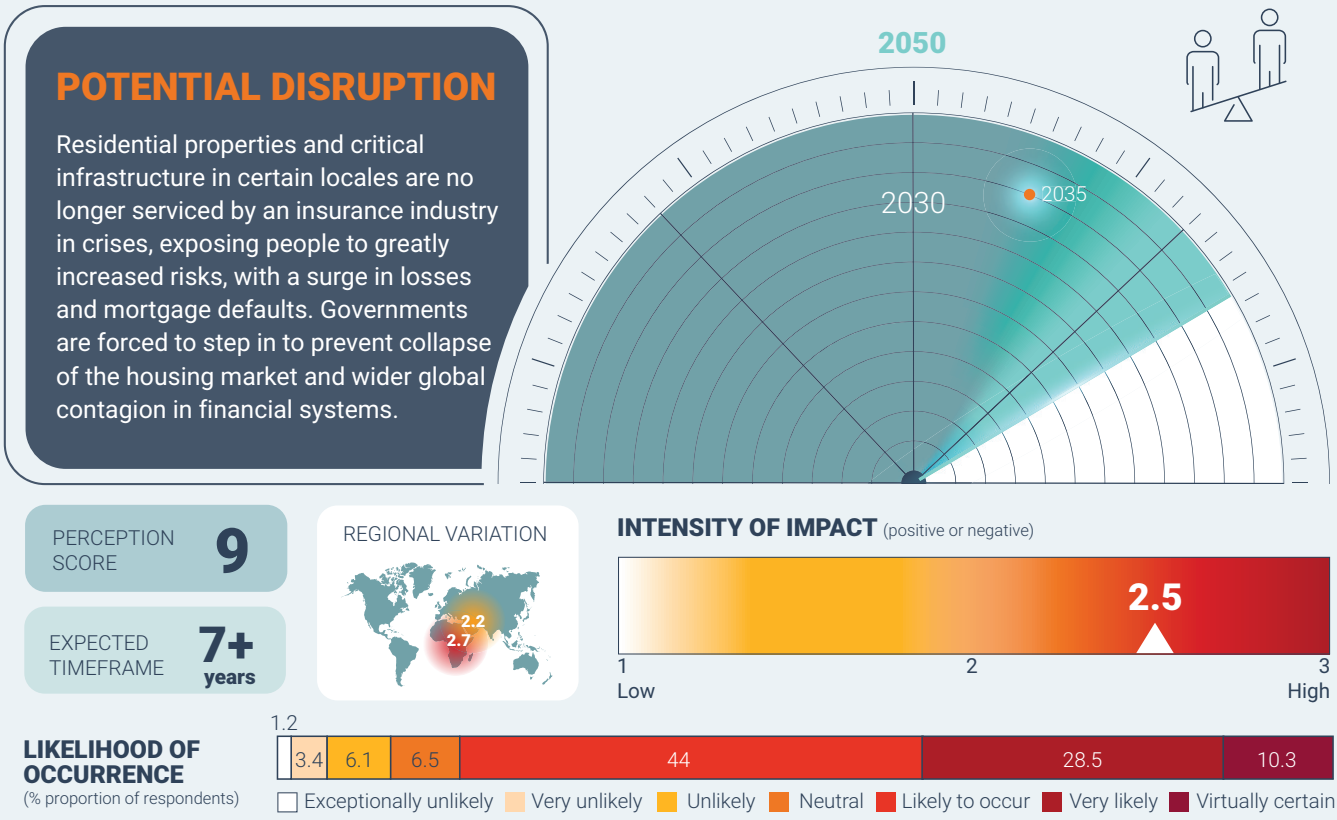
A fundamental principle of environmental justice dictates that clean air, water and a healthy ecosystem are basic human rights, and not privileges reserved for the wealthy. For the first time in its history, the UN has recognised that everyone, everywhere has the right to live in a clean, healthy and sustainable environment (Office of the High Commissioner for Human Rights [OHCHR] 2022). However, as wealth continues to become more concentrated, privatised micro-environmentalism may risk the erosion of equal access to a healthy environment. By creating exclusive enclaves, this concept while supporting biodiversity goals has the potential to exacerbate existing social and economic inequalities; a world where breathable air and a connection to nature are commodified by the ultra-

rich, denied to those with less wealth and contributes to the overall effects of the polycrisis. Generally viewed as positive, there are numerous examples of private game or conservation reserves, in both developing and developed countries, where typically there are fauna or ecosystems of interest (Kamal *et al.* 2014). Not much is known about the success of social and environmental outcomes in privately protected areas (PPAs) globally.

Privatised micro-environmentalism may foster a sense of detachment from the broader environmental crisis, which is already being driven by those in higher wealth brackets. Creating and maintaining enclosed ecosystems could require significant resources and energy, potentially leading to increased resource depletion and pollution. The focus on enclosed, controlled environments may also distract from efforts to conserve and restore existing natural ecosystems.

Signal of change **12**

Uninsurable future



The increasing severity and frequency of disasters is destroying assets and livelihoods, eroding the resilience of socio-ecological systems and undermining the ability of governments and communities to cope. A resulting increase in uninsured risk and losses and a lack of opportunities to transfer financial risk create additional burdens on the public sector. This risks further jeopardizing the state's capacity to promote long-term prosperity, poverty alleviation and environmental protection.

Governments are under growing pressure to provide disaster relief to key sectors, including agriculture, municipal infrastructure and real estate. As the planet's warming and its extreme weather events intensify, agricultural insurance and particularly small farmers, has become unavailable or prohibitively unaffordable as drought and floods increasingly threaten their crops (Mensah *et al.* 2023; Cooley 2024). In certain regions, government intervention and state assistance has become essential.

Yet shifting the risk to the state brings its own problems. For most crops, insurance is already heavily subsidized and the burden on state budgets is set to grow rapidly as climate change impacts intensify (Diffenbaugh *et al.* 2021).

In the area of real estate, private insurers are likewise withdrawing from regions exposed to substantial climate risks. Some subnational governments such as Florida and California, which historically have served as 'insurer of last resort' for homeowners, are at growing risk of insolvency (Farmer 2023; Taylor and Knuth 2024). In 2022, the Office of Management and Budget for the United States reported its assessment of the nation's financial risk exposure, finding that climate change could reduce GDP by 3–10 per cent, translating into revenue loss of 7 per cent by 2100, while facing an additional US$25–128 billion in additional disaster relief expenditures annually (Office of Management and Budget for the United States [OMB] 2022). Meanwhile the developing world continues to face increasingly limited access to disaster relief and recovery capital.

Environment Alert

Extreme climate events strain government budgets due to prioritizing disaster relief, and crucial environmental programs may face cuts. This potential lack of investment weakens capacity to protect ecosystems, jeopardizing biodiversity and hindering our fight against climate change itself.

Innovations in the financial and public sectors can help manage climate risks and sustain access to insurance. For example, insurers can offer reduced premiums or additional coverage benefits to policyholders that invest in adaptation strategies, early warning systems or resilient infrastructure—recognizing that mitigating risks beforehand is often much more cost-effective than repairing damage after a disaster (Feofilovs *et al.* 2024). Parametric insurance and reinsurance policies can help speed up responses and improve coverage. Unlike traditional insurance, parametric policies focus on the magnitude of a specific type of event (e.g. a tropical cyclone reaching a certain wind speed), enabling a simple, straightforward payout process (World Economic Forum [WEF] 2024). Governments can likewise support the development of supportive regulations, tax incentives, and risk-sharing frameworks, including effective collaborations between insurers and the public sector (Feofilovs *et al.* 2024).

2.7 Misinformation, declining trust and polarization

Reliable knowledge and scientific evidence has long been recognized as an essential foundation for effective public policy and good governance. In recent years, a combination of intertwined political, technological and social changes has weakened trust in science and undermined democratic institutions.

Scepticism and mistrust about climate change science has become an important political dividing line in many countries (Buzogány and Mohamad-Klotzbach 2021). Climate and energy transition policies have become a focus of populist rhetoric and agenda-setting. Populists have been successful in mobilizing substantial constituencies by linking climate change denial to a wider attack on (urban) elites and the political establishment, grounded in anxieties about the pace and cost of social and economic change, and the loss of national sovereignty. Misinformation and disinformation, increasingly powered by AI, is identified as the most severe global risk over the next two years in the latest Global Risk Report of the World Economic Forum (2024) undermining social cohesion, trust in institutions and fuelling political divides.

Populist actions to discredit scientific research and institutions have been enabled, in part, by rapid changes in information and communication technologies and dynamics in news media. The news media industry has gone through profound changes in the past decade that have impacted the way news is both produced and consumed. Across the world, people increasingly source news from social media, which attract and retain users by providing personalized and often emotionalized content on controversial topics. By creating silos of like-minded people and enabling an overrepresentation of radical viewpoints, social media can fuel polarization foment conspiratorial ideas and a create fragmentation of public discourse (Stark and Stegmann 2020; Xing *et al.* 2024).

Online social networks also enable rapid and widespread dissemination of deliberate disinformation and empower highly influential and disruptive political or cultural voices. Recent crises, including the ongoing wars in Ukraine and Gaza, and the shifts to a more digital, mobile, and platform-based media environment have accelerated since the COVID-19 pandemic (Ilan 2024). For example, the United Nations Educational, Scientific and Cultural Organization (UNESCO) (2022) notes that in September 2020, at the peak of the COVID-19 pandemic, "over 1 million posts were circulating on Twitter with inaccurate, unreliable, or misleading information related to the pandemic. …These false claims were often amplified by unscrupulous or misguided public figures". In this acceleration of manipulation, advances in AI-enabled machine learning and deep learning are actively being leveraged to deceive people by generating and delivering targeted fake content (Aïmeur *et al.* 2023).

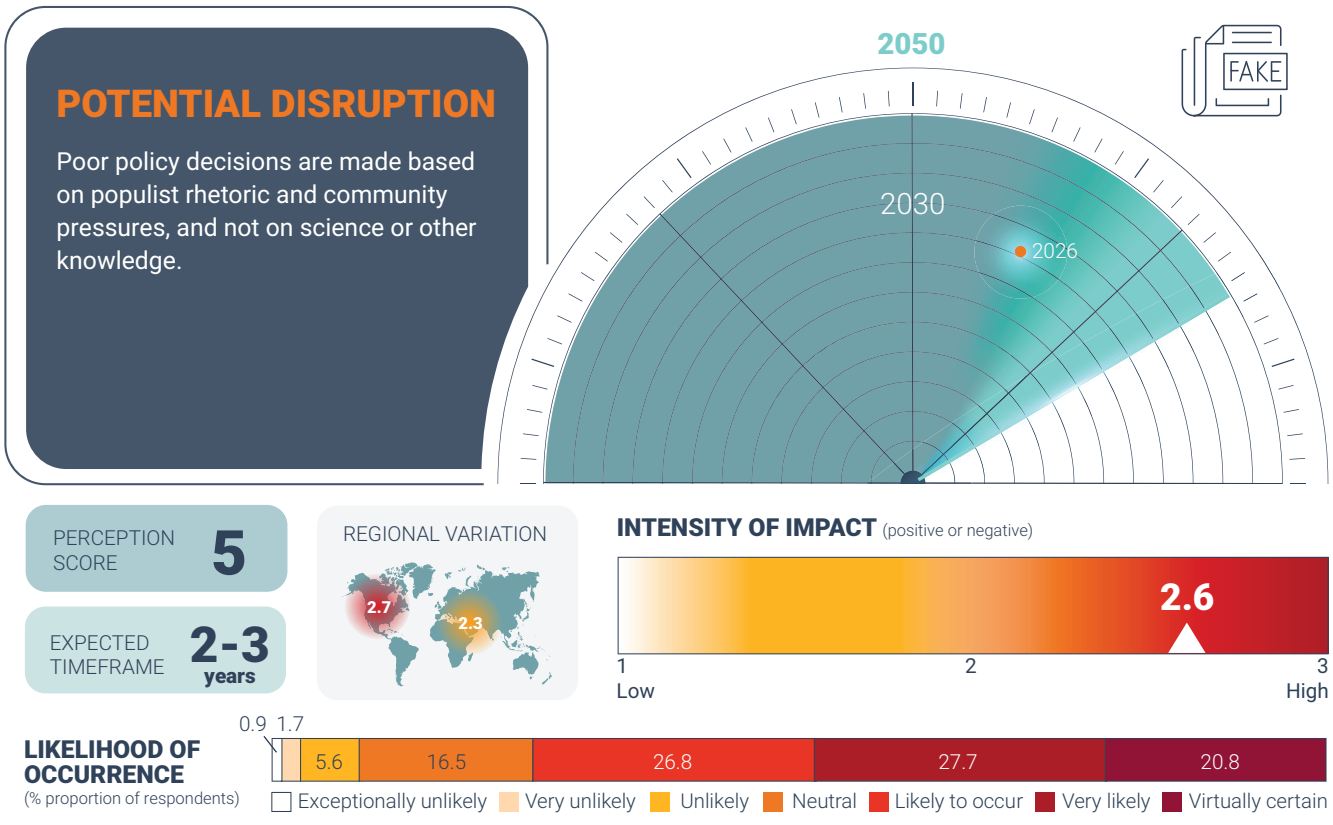
The growth of 'fake news' has the dual effect of misleading people and undermining trust in all news content, including from traditional news sources and government bodies. The disinformation potential of AI and 'deepfakes' further amplifies these risks—where foreign and domestic actors alike will exploit disinformation to further widen societal and political polarization (WEF 2024). A sharp decline in public confidence in large news media empires, including distrust with ownership and funding flows, and polarization of news audiences have had profound effects on civic life including peoples' relationship to science. Meanwhile, the continuing volatility in advertising revenues for mainstream news media and the shift towards digital social media is further undermining the ability to provide accurate news—an essential component of democratic governance (UNESCO 2022). In a context of eroding trust in science and public institutions, it becomes much harder to design and deliver effective policies to tackle societal challenges, including the climate crisis.

Dwindling trust in external entities, including other nations, reverberates on a global scale, exacerbating social, economic, environmental, and climate crises. As faith in established institutions wanes, individuals and communities gravitate towards spokespersons whose rhetoric resonates with distrust, often aligning with populist or 'anti-establishment' leaders (Ceron *et al.* 2021; Blake *et al.* 2024).

The decline in trust in science manifests differently in various contexts. In some regions, it stems from perceived failures to fulfil commitments, such as in climate mitigation or efforts to preserve and restore nature as well as pandemic response efforts. Other factors contributing to this decline include worsening economic instability, rising inequality, corruption and the proliferation of misinformation via social media platforms that has eroded trust in traditional media sources.

Signal of change **13**

Decisions increasingly detached from scientific evidence



Despite the growing knowledge and understanding of global challenges, effective actions remain insufficient. For over fifty years, the causes and impacts of climate change have been well-established, yet the targets of the 2015 Paris Agreement seem unattainable. Similarly, none of the global biodiversity targets have been fully met, despite clear evidence of increasing biodiversity loss (Global Biodiversity Outlook 5; IPBES 2019). The science is unequivocal: the cumulative impact of humanity's ecological footprint is becoming increasingly unsustainable. The COVID-19 pandemic exemplified issues around delayed governmental actions, influenced by public opposition, lack of trust and widespread misinformation (Lancet 2022).

Trust in science is influenced by various individual and social factors, including scientific literacy, social consensus and confidence in public institutions (Wellcome Global Monitor 2018; ISC 2023). During crises, trust in scientific evidence is often complicated by political agendas and historical tensions between stakeholder groups (Lewandowsky *et al.* 2022; ISC 2024), especially in the early stages of a crisis. The rise of AI-generated information will likely exacerbate these uncertainties. A recent study found that the individual propensity for confidence in public policy, and trusting evidence-based decisions, are conditioned by a societies' (or country's) level of agreement on how trustworthy science and scientists are (Sturgis *et al.* 2021).

Effective decision-making in the face of multiple, sometimes conflicting, values and priorities requires stronger, localized and equity-centred evidence-to-policy mechanisms (Evidence Commission 2022). The credibility, legitimacy and relevance of information are crucial for knowledge to support action (Cash and Belloy 2020). Emphasizing the social construction of knowledge and integrating diverse sources of information are vital for building trust and engagement (Pielke 2012; Pielke 2019). This involves equitable engagement, capacity building in evidence synthesis and better contextualization and communication of science (Pinto *et al.* 2021; ISC 2022; Lieu *et al.* 2023; Rasooly *et al.* 2023; ISC 2024).

Environment Alert

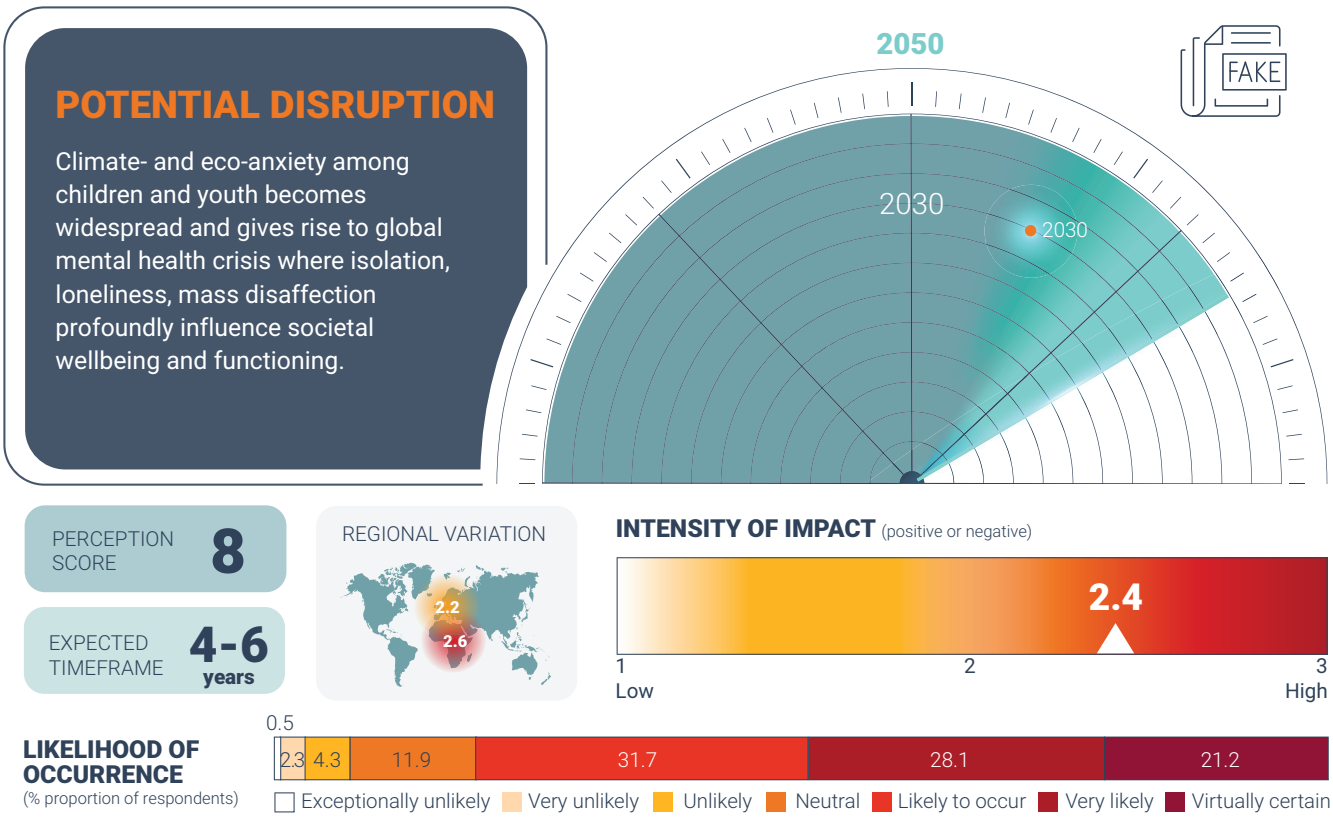
The capacity to effectively address environmental issues is adversely affected when the gap between scientific knowledge and effective action widens. Despite clear evidence of environmental threats, political agendas, misinformation and social inequalities often stand in the way of meaningful solutions.

Several factors contribute to the gap between accumulating knowledge and meaningful action, including political and cognitive biases and a tendency to prioritize short-term issues over long-term risks (ISC 2024). Current development paradigms often undervalue nature, overlook social and environmental externalities and favour short-term cost-benefit analyses over long-term wellbeing measures (ISC 2023). This leads to policymakers pursuing potentially detrimental objectives, leading to potential unintended effects including social impacts, such as direct impacts to income and wellbeing among certain trade or labour groups (Haywood *et al.* 2021). Consequently, this may lead to resistance to resulting policy proposal, as illustrated by community resistance to policy proposals, such as farmer protests in Europe against net-zero policies.

Political resistance may also arise due to inadequate consideration of social and cultural contexts, as seen with opposition to carbon levies in some Western countries (Umit and Schaffer 2020). Unintended environmental impacts can also occur due to high uncertainty in complex ecosystems (Scoones and Stirling 2020). The urgency of the climate crisis can result in poorly informed policies, particularly affecting the Global South, which often faces the consequences of international policies made without sufficient consultation with affected communities.

Signal of change **14**

Eco-Anxiety: An emerging crisis hidden in plain sight



The physical threats of environmental degradation and climate change are well established. In addition, direct and indirect exposure to climate-related disasters—such as floods, storms, wildfires, heatwaves and droughts that can lead to displacement and food shortages—can lead to psychological harms including depression, anxiety and post-traumatic stress (IPCC 2020; Haseley and Lament 2024). Recent research also provides evidence of disorders that are unconnected to specific climate events (Wu *et al.* 2020; Passmore *et al.* 2023; Haseley and Lament 2024).

'Eco-anxiety', 'climate grief' and 'climate anxiety' are terms used for the negative emotional responses related to the threat of environmental and climate crises. Unsurprisingly, climate researchers and communicators are vulnerable to such anxieties (Gilford *et al.* 2019). However, eco-anxiety affects people globally, and recent research suggests young people are especially affected. A 2021 survey asked young people in 10 countries including Brazil, India, Nigeria and the Philippines about their climate concerns and belief in government responses (Hickman *et al.* 2021). Their survey showed 59 per cent of respondents were very or extremely worried about climate change. More than half reported each of the following emotions: sad, anxious, angry, powerless, helpless and guilty. Correlations between climate anxiety and distress and perceived inadequate government response as well as feelings of betrayal were positive (Hickman *et al.* 2021). Further study emphasizes how children in particular face feelings of confusion, betrayal and abandonment because of inaction and their own lack of agency in the face of existential threats (Hickman 2024). Sustained exposure to chronic emotional stressors caused by climate crises can have long-lasting impacts, increasing mental health problems over time (Wu *et al.* 2020). And the internet and social media are further augmenting the challenge, for example by creating echo chambers, spreading misinformation (Zollo 2019) and generating emotional contagion (Goldenberg and Gross 2020).

Environment Alert

Increasing anxiety and stress around climate change and social unrest present an indirect threat to the environment. They can lead to decreased pro-environmental behaviours and a weakened sense of collective responsibility therefore finding solutions to address the mental health impacts of such existential threats is crucial.

Of course sometimes emotions like anxiety and anger are natural and even healthy emotional responses to impending crises that could motivate engagement, understanding and action—individually and collectively. Indeed, the surge of youth engagement in climate action during recent years illustrates the potential for positive responses. Yet there is also ample evidence that it can lead to counter-productive or destructive reactions like denial and avoidance (Léger-Goodes 2022; WEF 2022).

Reflecting on the accumulating evidence, Haseley and Lament (2024) suggest that climate anxiety in young people is "a crisis in plain sight" and that there are growing indications of "an emotional catastrophe being visited on the next generations". The potential implications of this for society are substantial. According to the World Health Organization, some 15 per cent of the global adult population experiences mental health problems to various degrees and some 12 billion working days are lost every year to depression and anxiety at a cost of US$1 trillion per year in lost productivity globally (WHO 2022).

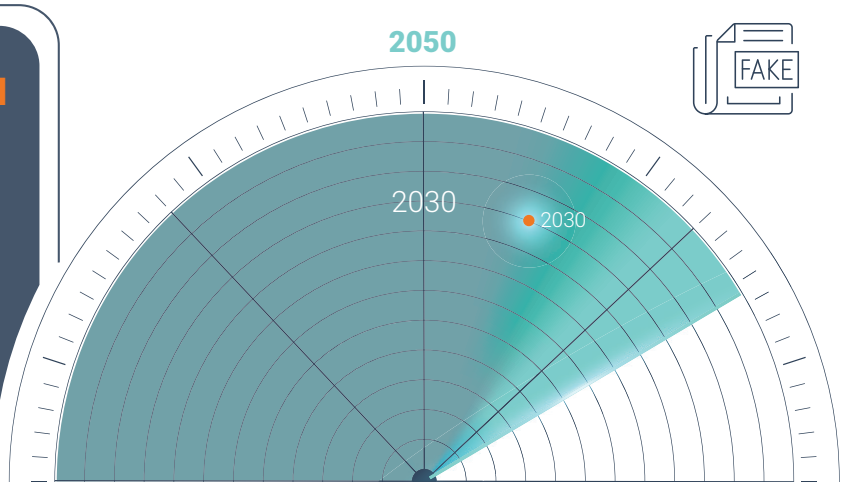
To mitigate these risks, it is essential that children and young people are given a sense of agency, empowerment and hope. This will depend in part on the information young people are provided and how it is framed. Here the development of solutions and action-oriented knowledge is key. Ultimately, everyone has a role to play—families, teachers, care and health professionals, civil society and international organizations (Léger-Goodes 2022; WEF 2022).

Signal of change **15**

Surging fossil fuel subsidies

POTENTIAL DISRUPTION

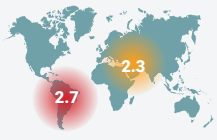
Surging subsidies continue unabated, reorienting global capital flows and investments away from clean-energy technologies further entrenching inequalities and triggering a massive regression on climate mitigation policies and backlash against the energy transition.



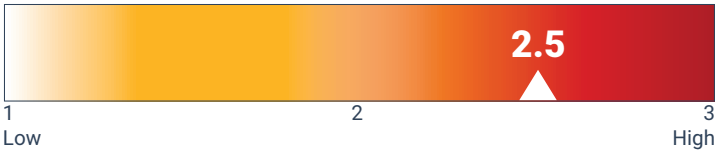
PERCEPTION SCORE **10**

EXPECTED TIMEFRAME **4-6 years**

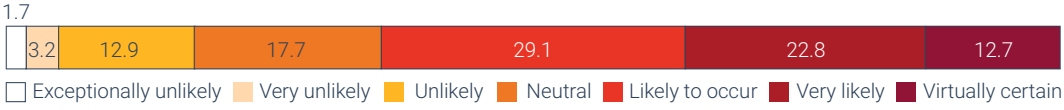
REGIONAL VARIATION



INTENSITY OF IMPACT (positive or negative)



LIKELIHOOD OF OCCURRENCE
(% proportion of respondents)



Fossil-fuel subsidies hit a record US$7 trillion in 2023, up by US$2 trillion in just two years, as governments responded to the global spike in energy prices. This trajectory, even if short term, may critically undermine the cost-competitiveness of renewable (clean) energy and further accelerate the reliance on fossil fuels and create a major stumbling block for the energy transition.

The Organisation for Economic Co-operation and Development (OECD) defines subsidies as government actions that provide advantages to consumers or producers, supplementing their income or reducing their costs (Central Statistics Office [CSO] 2019). Fossil fuel subsidies are often motivated by one or more objectives: energy independence, encouraging industry or safeguarding household purchasing power among impoverished and vulnerable groups. The recent surge in subsidies may be attributed to increased consumption by various countries, reflecting rising prices of fuel, transportation and industrial activities (Henseler and Maisonnave 2018). This surge could also signify heighten fossil fuel usage as the necessity to develop alternative sources persists. Eliminating all fossil fuel subsidies would particularly impact sectors such as mining, transportation and electricity production.

Environment Alert

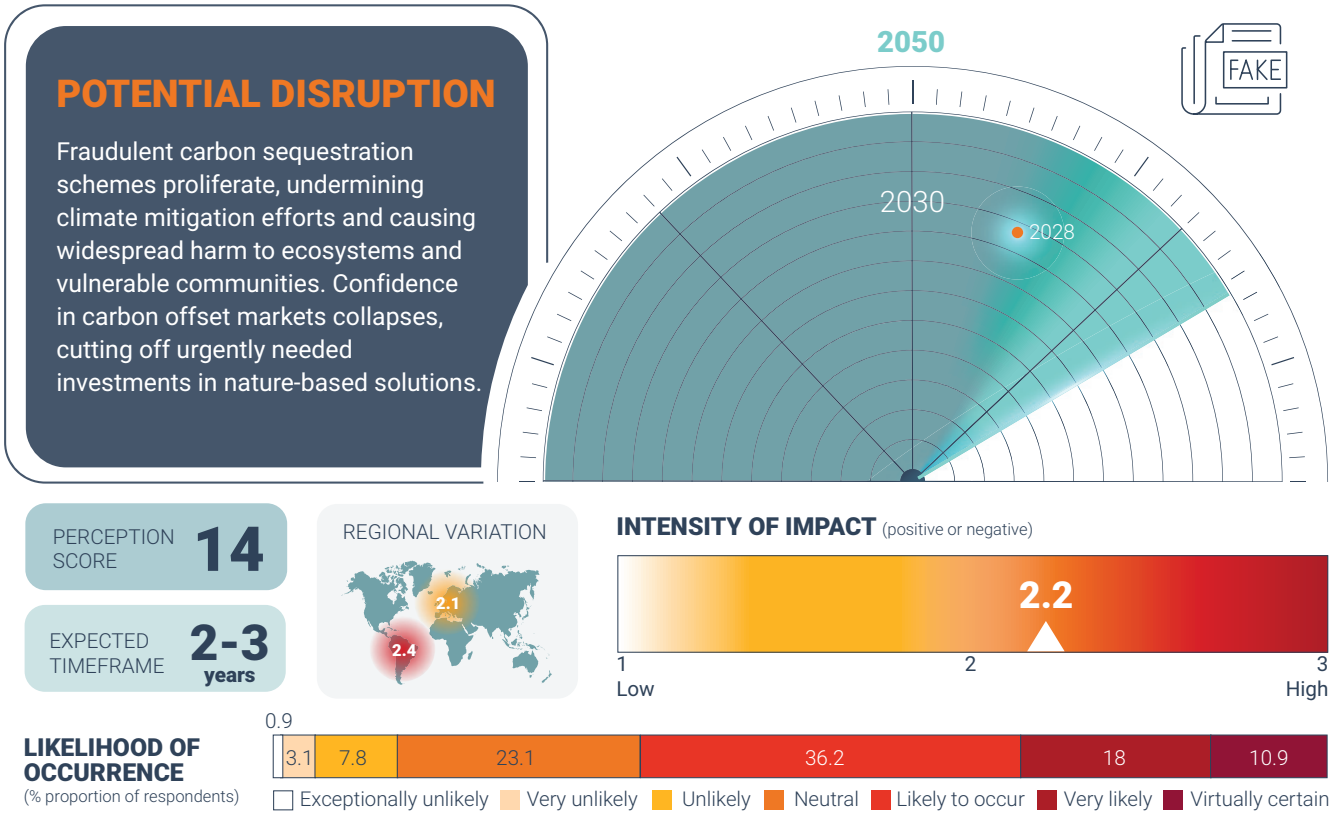
The surge in fossil fuel subsidies will influence the trajectory of addressing climate change. While intended to address short-term economic concerns they inadvertently undercut the cost-competitiveness of clean energy and incentivize continued reliance on environmentally destructive fossil fuels.

However, reforming the subsidy system presents several challenges. For instance, while reforming fuel subsidies can enhance a country's macroeconomic performance and alleviate fiscal pressures, the resultant price changes can lead to adverse direct and indirect impacts on the welfare of vulnerable groups and consequently exacerbate poverty (Cooke *et al.* 2016). Subsidy reductions entail higher prices for energy products directly consumed by households and potentially increased prices for non-energy products due to elevated energy input costs.

Given these impacts on household budgets and the popularity of subsidies, many governments find it challenging to decrease or eliminate them. Sectors benefiting significantly from fossil fuel subsidies may resist their removal, further complicating reform efforts. The environmental costs of continued fossil fuel use are considerable and the longer the sector takes to reduce and phase out such practices, the more CO_2 is being emitted.

Signal of change **16**

Escalating risks of corruption in carbon offsetting



Carbon offsetting is a widely used tool in the fight against climate change. It offers individuals, companies or governments a way to negate (or compensate for) their fossil fuel emissions by funding an equivalent emissions reduction or removals practice elsewhere. In other words, investing in activities that either sequester carbon dioxide (CO_2), for example by planting trees or restoring forests and wetlands, or prevent it from being emitted in the first place, for example through energy efficiency improvements or by avoiding the destruction of mangroves. Strictly speaking, the practice of offsetting is considered the last step in the mitigation hierarchy (Bergès *et al.* 2021)—i.e. only once every effort has been made to reduce/avoid emissions, the 'residual' emissions that cannot be eliminated are those that could potentially be offset.

Carbon offset schemes often include tradable certificates or 'rights' linked to offset activities or projects, where the trading of certificates occurs in both voluntary and compliance carbon markets. In principle, well designed and implemented carbon offsetting initiatives can help to mitigate climate change while also providing valuable co-benefits, such as reducing health impacts from air pollution, and increasing biodiversity and other services for example through restoring ecosystems. In practice, however, problems associated with some carbon offsetting include a range of issues and questionable practices, both historical and emerging, that are undermining the effectiveness (including long-term climate benefits) of carbon offsetting and the credibility of such schemes. Issues range from weak verification processes that allow fictitious or fraudulent projects to be certified (Battocletti *et al.* 2023; Espenan 2023) to misrepresentation of an activity's sequestration potential or the duplicative sale of individual credits to multiple buyers (Gill-Wiehl *et al.* 2024).

There is mounting evidence and concern that large-scale offset initiatives, even those believed to be of 'high-integrity', have been overstating their ability to contribute to limiting atmospheric greenhouse gas emissions. Recent investigations reveal that most offset schemes vastly underestimate the magnitude

of market leakage effects (Filewod and McCarney 2023). In 2023, one study reportedly found that more than 90 per cent of projects by a global certifier were likely 'phantom credits' (Ross 2024). The results of this specific study continue to be securitized. However, a growing body of empirical evidence that demonstrate irregularities and issues of integrity (e.g. Roopsind *et al.* 2019; West *et al.* 2020; Calel *et al.* 2021; Guizar-Coutiño *et al.* 2022; West *et al.* 2023) and a subsequent erosion of trust and confidence in the voluntary carbon offset market (King 2024; Pande 2024).

In some instances, projects are actively harmful. Afforestation of land with monoculture, alien (often invasive) species can degrade ecosystems, such as natural grasslands (Aguirre-Gutiérrez *et al.* 2023). Offset projects have also led to the eviction of local communities from their land and reinforced injustices against marginalized groups (Lyons and Westoby 2014; Chomba *et al.* 2016; Fisher *et al.* 2018).

At the heart of many of the problems with carbon offsetting is a lack of market regulation, oversight and accountability. The existence of large money flows in any unregulated market creates substantial corruption risks (United Nations Office of Drugs and Crime [UNODC] and the World Bank 2024b) and there are indications that the scale of these risks could expand very rapidly in the coming years. The voluntary carbon market is projected to grow exponentially this decade, from US$2 billion in 2021 to US$50 billion in 2030 (Blaufelder *et al.* 2021). This growth could represent an important opportunity in the fight against climate change and in environmental protection. However, without effective regulation it could instead have a rebound effect and generate significant harms: wasting vast amounts of resources; undermining climate mitigation efforts; harming ecosystems and communities; eroding trust in public and private institutions; and undermining investments in the broader array of nature-based solutions that could deliver substantial environmental, social and economic benefits.

Environment Alert

Carbon offset initiatives, if poorly designed and implemented can be counterproductive by providing a false sense of progress, delaying essential emissions reductions, and even undermining nature-based solutions. Fraudulent schemes can lead to ineffective emission reductions, ecosystem damage, and a loss of public trust, ultimately harming environmental and conservation efforts.

To seize the opportunities presented by carbon offsetting, governments must ensure effective regulation to ensure offset permanence, independent monitoring and oversight, consultation with Indigenous communities and crucially shift the focus from avoided emissions and temporary carbon storage to long-duration carbon removal at source while using carbon offsets as a supplementary measure (Cullenward *et al.* 2023).

While carbon offsetting holds promise for environmental challenges, its effectiveness hinges on responsible implementation. Corruption, fraud and systemic credibility risks in carbon offsetting schemes is a major cause for concern. Using blockchain to underpin carbon offsetting markets could potentially dramatically increase transparency, traceability and accountability, reducing risks such as double counting while increasing market liquidity (Sipthorpe *et al.* 2022; Vilkov and Tian 2023; WEF 2023) but requires further research.

Poorly designed carbon offsetting, can exacerbate social inequities, undermine conservation efforts and fail to deliver promised environmental benefits.

2.8 Polycentricity and diffusion of governance

The role of national governments in global governance is evolving rapidly. In part this reflects eroding trust in public institutions (Section 2.7) and the growing influence of non-state actors, ranging from transnational non-governmental organizations (NGOs), multinational corporations and 'ultra-wealthy' individuals to private military contractors and international criminal networks (Bäckstrand *et al.* 2017; Setzer and Nachmany 2018; Mbeva *et al.* 2023). In part it reflects a recognition that national governments have been unable to address global sustainability challenges—either operating individually or multilaterally. In this context, governments have allowed some relocation of power and responsibilities, engaging non-state actors as agents of change.

At the international scale, the Copenhagen climate summit in 2009 was identified as an important inflection point, which signalled both the limitations of intergovernmental processes and the need for a more decentralized approach to climate governance (Bäckstrand *et al.* 2017). In subsequent years, there have been many signals of a shift towards more polycentric governance, which disperses political authority to diverse centres of decision-making and emphasises experimentation and learning (Jordan *et al.* 2018). The global regulatory regime based on intergovernmental agreements is increasingly complemented by climate action orchestrated by transnational networks of cities, corporations and civil society groups (Bulkeley *et al.* 2018).

While research on polycentric governance emphasises its emergent, bottom-up character, it also acknowledges that states often have an important role in mobilizing subnational or non-state actors (Setzer and Nachmany 2018). For example, legal concepts such as ecocide and rights of nature are increasingly being codified in national legislation, creating the basis for environmental groups or others to bring legal action against companies or public bodies.

There is already evidence of the potential impact of private litigation. For example, in 2021 the Dutch branch of Friends of the Earth (Milieudefensie) won a major decision against Shell. The court ruled that Shell group reduce its Scope 3 greenhouse gas emissions (i.e. including all indirect emissions across its value chain) by 45 per cent by 2030, compared to 2019 levels (López *et al.* 2023).

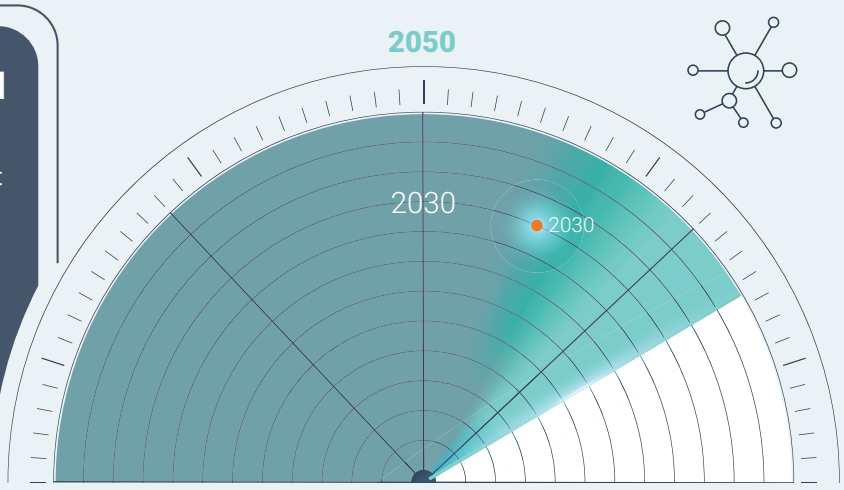
As has long been acknowledged, "more diffuse approaches to governance in all parts of society will only work if there are frameworks in place that assure very high levels of transparency, accountability and integrity" (Organisation for Economic Co-operation and Development [OECD] 2001). Governments have an important role in creating harmonized frameworks that can enable this transparency and accountability.

Signal of change **17**

New tools for rerouting global financial flows

POTENTIAL DISRUPTION

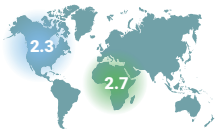
Governments in the world's biggest economies require businesses to report on the social and environmental impacts of all their operations and stringently penalise firms for harms caused. Declining share prices and investments in unsustainable businesses lead to a paradigm shift in corporate governance.



PERCEPTION SCORE **7**

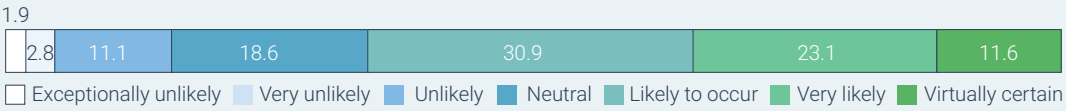
EXPECTED TIMEFRAME **3-4 years**

REGIONAL VARIATION



INTENSITY OF IMPACT (positive or negative)

LIKELIHOOD OF OCCURRENCE
(% proportion of respondents)



There is growing global support for actions that reconfigure financial systems in ways that can help mitigate inequalities, eradicate extreme poverty and address environmental crises. The need for a transformation to the financial systems was clearly expressed at the Africa Climate Summit and its Nairobi Declaration, during India's G20 presidency in 2023 and at the African Union Summit in 2024. Similar calls were made through the Summit for a **New Global Financing Pact** and the **Bridgetown Initiative**. The UN Common Agenda (2023) describes the existing international financial architecture as "entirely unfit for purpose in a world characterized by unrelenting climate change, increasing systemic risks, extreme inequality, entrenched gender bias [and] highly integrated financial markets". The agenda highlights the need for a broad array of actions and reforms to the global financial architecture, including lowering sovereign borrowing costs; massively increasing and reorienting cheap development lending by development banks; making businesses more sustainable; increasing incentives to invest in the low-carbon, net-zero transition; identifying positive business opportunities associated with a more sustainable and inclusive economy; aligning the financial system with the Paris Agreement via Article 2.1.c.; reforming fiscal systems to reduce tax avoidance; and increasing transparency in financial flows.

There are promising signals that aspects of this agenda are being put into effect; for example, the introduction of a global minimum corporate tax rate of 15 per cent at the start of 2024, agreed by 135 countries (OECD 2024). Perhaps even more influential are measures that aim to reorient financial flows to and from sustainable businesses and shift the focus of corporate decision-making away from short-term profit maximization towards broader social purpose.

Under the UN's Race to Zero campaign, over 14,000 non-state actors, including financial institutions, business and small and medium enterprises (SMEs), have committed to halving their emissions by 2030 and striving for a net-zero economy by 2050. Such voluntary action is swiftly being institutionalised in policy and regulation. This is of global importance because the decisions of multinational enterprises can impact social and environmental outcomes across entire value chains, including in lower-income areas.

Environment Alert

Reforming financial systems presents an opportunity to tackle environmental challenges. By reorienting financial flows, promoting sustainable business practices, and demanding greater transparency, environmentally responsible decision-making can be incentivized throughout global value chains.

Multiple environmental, social and governance (ESG) reporting initiatives have emerged in recent years that provide tools for businesses to track and report their social and environmental impacts (Tsang *et al.* 2023; Chopra *et al.* 2024). For example, the UN Principles for Responsible Banking; EU Corporate Sustainability Reporting Directive (in force since January 2023); the Global Reporting Initiative; the International Sustainability Standards Board.

These important developments will be amplified with more robust, standardized, comprehensive and binding systems that can better compare performance, hold firms to account and redirect financial flows.

Encouragingly, there are signals that binding, non-financial reporting may become much more rigorous and effective. The recently adopted United States Securities and Exchange Commission (US SEC) Rules to Enhance and Standardize Climate Related Disclosures for Investors responds to investor demand for more consistent, comparable and reliable information on climate-related risks and their financial effects on companies. The increased data availability and transparency will allow investors to take such information into account in investment decision-making and may help correct the present mispricing of climate risk and climate-associated opportunities. The European Union's new Corporate Sustainability Due Diligence Directive (Patz 2022) goes further, creating an obligation on very large companies to identify, prevent, mitigate and end actual and potential human rights violations and environmental harms in their own operations, as well as those of subsidiaries and business partners along the value chain, and compelling them to issue 1.5°C-aligned transition plans. Failing to comply will lead to huge financial penalties and civil liability for damages caused.

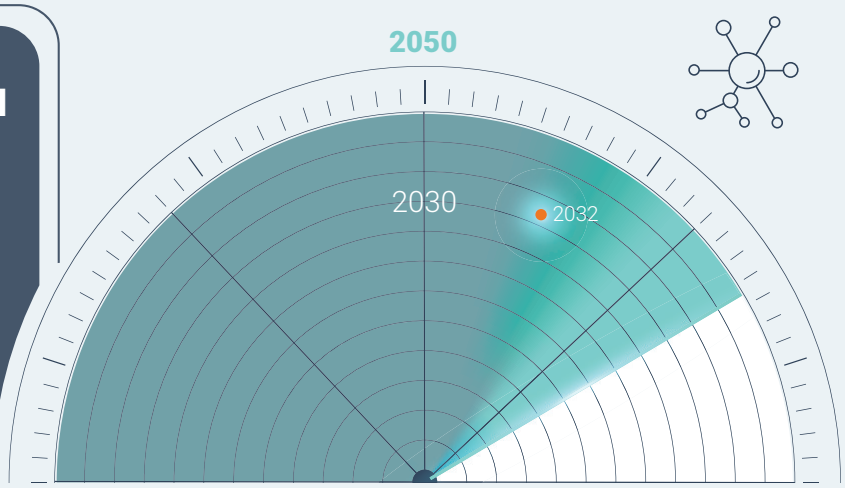
Worldwide, jurisdictions are adopting taxonomies that label net-zero aligned economic activity to create greater transparency, direct financial flows towards climate-supportive activities and prevent greenwashing. Finally, the Basel Committee Pillar 3 disclosure requirements compel large banks to release the level of net-zero alignment of their sector holdings and their Green Assets Ratio (GAR), both of which help enable greater transparency in unlocking the financial flows necessary for a sustainable future.

Signal of change **18**

Local, network-driven resilience

POTENTIAL DISRUPTION

Frustrated by the failures of national governments and enabled by digital technologies, networks of local communities become the primary driving force behind global actions to increase resilience.

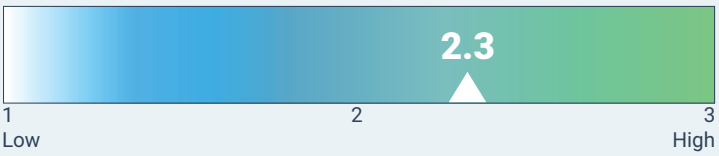


PERCEPTION SCORE **13**

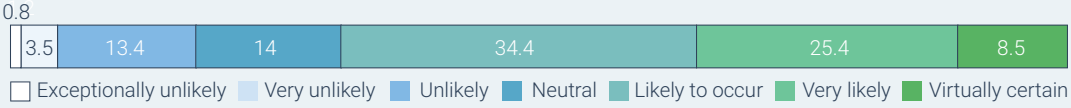
EXPECTED TIMEFRAME **7+ years**

REGIONAL VARIATION

INTENSITY OF IMPACT (positive or negative)



LIKELIHOOD OF OCCURRENCE
(% proportion of respondents)



Exceptionally unlikely | Very unlikely | Unlikely | Neutral | Likely to occur | Very likely | Virtually certain

Communities and local-level networks and initiatives play a major role in coping with short-term shocks and build long-term resilience and adaptive capacities. They are increasingly necessary as governments, under pressure from financial, social and environmental challenges, often fail to address the nuanced needs of local communities and vulnerable populations. Rural and urban communities also serve as important incubators of innovation and experimentation with novel ways of living or working (Steward 2018; Olmedo *et al.* 2023).

This agility is facilitated by the availability of strong local networks and dedicated community engagement that encompass a diverse range of actors, including individuals, community-based organizations, grassroots initiatives and informal support systems that also draw from the traditional and local knowledge of indigenous peoples, women and other vulnerable populations most affected by climate change (Datta 2018; Datta 2024). All this plays a pivotal role in fostering resilience by providing social support, sharing resources and facilitating collective action (Adger *et al.* 2018). Promising signs are emerging that the agility and transformative capacity offered at the level of cities and local network-communities make it possible to radically reconfigure things like energy or mobility systems at these scales much more quickly than at a national scale.

The success of these bottom-up initiatives is supported by robust local government leadership that provides the necessary governance and structural arrangements as well as important connections with national authorities in a way that complements ongoing initiatives (Khaldoun *et al.* 2018; Panday 2018; Gbadegesin *et al.* 2022). Cities and local governments can also build on their deep community connections to inform their environmental stewardship strategies, which provides complementary top-

down mechanisms for the implementation of adaptation and mitigation measures. This is possible through the development of policies and programs that address specific environmental challenges faced by their citizens. Unlike broader national initiatives, they can be more pragmatic in their approach. There are numerous examples of cities across the globe—from Montreal to Barcelona, Cape Town to Busan and Surat to Bogota—that demonstrate this local government nimbleness in areas like monitoring and reducing emissions, water management, improving public transportation, managing waste effectively, and protecting green spaces. The promotion of the '10/15 - minute city' (Di Marino *et al.* 2022; Logan *et al.* 2022; Salvador *et al.* 2021) and 'Smart City' initiatives further exemplify this focus on local solutions (Ismagiloiva *et al.* 2019; Irvine *et al.* 2022; Yang *et al.* 2024). By showcasing innovative solutions and best practices, they can inspire others to follow suit.

Environment Alert

Strong cities and local communities that are supported by robust local leadership and governance are the bedrock of environmental resilience in a complex world. From coping with immediate crises to fostering long-term adaptation, empowered communities with robust social networks can experiment and innovate to address environmental challenges faster than centralized systems.

Despite their potential, cities, community-based approaches and local level networks and initiatives face various challenges, including limited resources, unequal power dynamics and institutional barriers (Oliver-Smith 2019). Addressing these challenges requires concerted efforts to foster collaboration, strengthen local governance structures and promote inclusive decision-making processes (Cutter *et al.* 2019). Leveraging technology and digital platforms can enhance the reach and effectiveness of community-driven initiatives, enabling greater connectivity and knowledge exchange (Meier and Selanikio 2018). The pivotal role of cities, community-based approaches and local level networks and initiatives in fostering resilience speaks to the continuing need to foster collaboration, empower communities and integrate diverse perspectives from the traditional and local knowledge of indigenous peoples and women in resilience-building efforts, which ultimately promotes more effective and agile governance.

2.9 Mobilising insights from Foresight: Shifts, signals and the SDGs

The surest way to know the future is to shape it. Information from foresight only becomes valuable when it is used to guide action, and is woven into the fabric of an organization. Taking strategic decisions about appropriate policies, institutions and resources, based on signals of change, offers a clear opportunity to reduce or increase, as appropriate, the chances of these signals becoming trends. However, to realize the full potential of foresight, signals of change must be considered in specific contexts, accounting for regional priorities and perspectives.

The previous sections have mapped out important global shifts and signals of change that could shape planetary health and human wellbeing. The combination of disruptions and opportunities point to broader, interrelated insights about how societies could tackle the challenges ahead. It is important

to note that no signal of change can be considered too small to completely dismiss. Like the tiny parasite that invades an oyster and causes a pearl to form, or the pebble that begins an avalanche, small changes now can become world-altering changes later. We ignore them at our peril.

The signals of change point to major opportunities to advance progress towards the SDGs, particularly the environmental dimension. For example, actions to address SDG 13: Climate Action will necessarily resolve the signal of change of ancient microbes from thawing permafrost. Restoring and maintaining ecosystems and biodiversity will assist in Climate Action, while also mitigating zoonoses spillover. Addressing SDG14: Life below the water and SDG15: Life on land will maintain ecosystem services and so facilitate poverty alleviation. Annex 2 shows the SDGs mapped against the shifts and signals of change and points to where action can ensure desirable futures and preparation for disruptions.

The commitments to achieve the SDGs and carbon neutrality rest on empowering and amplifying actions from all parts of society. However, such unity is challenging in the current context of eroding trust in governments, increasing social polarization and geopolitical tensions. These tensions imply an urgent need to forge a new social contract.

In addition, identifying ways to increase resilience and steering innovation towards sustainable outcomes will require governments and societies to use agile and adaptive governance approaches. This will mean empowering communities and private enterprise to experiment and innovate, guided by goals, targets and visions at different timeframes or scale. Introducing shorter-term targets emphasizes the scale and speed with which transformations are needed, and enables unintended consequences to be dealt with in an agile and flexible manner.

To facilitate more agile and flexible governance, data, information and knowledge across different disciplines—environment, social, economic, agriculture and so on—will be essential. This encompasses information on non-traditional and indigenous knowledge. Technological advances are creating a huge increase in available knowledge. However, there is a need for more integration of data, knowledge and actions to plug major gaps in data, information and their accessibility for integrated decision making.

Part 3

Managing change and building resilience: A future for planetary health and human wellbeing

This report shows that humanity has a stark and urgent choice to make: continue to destabilise planetary health and risk losing humanity's life support system, or build a future that embraces equity, addresses the underlying drivers of environmental degradation and achieves sustainable development. What humanity decides now will shape the world that future generations will inherit.

There are challenges. However, there are also signals of opportunities. Innovations offer novel ways to address social and environmental problems or create new ways of meeting needs or organizing governance. Crucially, just as the impact of multiple crises is compounded when they are linked, so are solutions. There are already many actions underway that would address the global shifts identified and potential signals of change. There is hope.

Delivering on this hope starts by asking a simple question and acting on it: what kind of world do I want my future self and my descendants to live in? It continues by ensuring that the people who will live the longest in this future—the youth of today and those yet to come—are considered and, where possible, represented in decision-making. The surveys and regional workshops that formed the basis for this report emphasised this by pointing to a need for intragenerational equity, which addresses equity within people alive today, and intergenerational equity, which is concerned with generations not yet born.

The principle of intergenerational equity is codified in multiple international agreements, such as the 1992 Rio Declaration, the Paris Agreement and the SDGs (Kreilhuber and Kariuki 2020; United Nations Chief Executives Board [UNCEB] 2023). However, these principles were established centuries ago. Concepts such as 'seven generations', attributed to Native American Haudenosaunee (Iroquois) philosophy, emphasize the obligation to consider the impacts of decisions over the next seven generations (Da Costa *et al.* 2021). The Māori concept of Kaitakitanga means guardianship of the sky, sea and land, and implies a duty of care from one generation to the next (Krishil 2021).

Embedding these principles and addressing the huge environmental and social challenges ahead will require the voices and knowledge of all society—nationally and globally. This will only be possible if the burdens and opportunities are shared fairly, and if youth and other marginalized groups are given a voice. The world needs a new social contract.

3.1 Shared values: A new social contract

The idea that the different parts of society are bound together in a web of trust and reciprocity—a social contract—is found in cultures and religious traditions across the world. Humans rely on each other for safety, security and a sense of belonging. In Kiswahili, it is known as Umoja: a belief that strength stems from unity. Ubuntu, of African origin, emphasises the connections of individuals with their surrounding world (Etieyibo 2017).

The resilience of any society depends on the cohesion of individuals, communities, civil society, businesses and governments (Bouwer *et al.* 2021). In Martin Luther King's words: "It really boils down

to this: that all life is interrelated. We are all caught in an inescapable network of mutuality, tied into a single garment of destiny. Whatever affects one directly, affects all indirectly" (King 1967).

However, this social contract is being ignored in many places of the world: where short-term profit and individual success have become dominant, to the detriment of most of the world— and even to the future of those who benefit the most now.

A new social contract is identified as a priority in the UN Secretary General's report 'Our Common Agenda' (UNSG 2021). It was also highlighted repeatedly during the foresight process that underpins this report. Participants and experts called for a more active role for citizens in shaping their societies and for increased accountability and transparency from leaders. They also called for a rebalancing of priorities, with greater attention to planetary health and human wellbeing of communities. They urged leaders to place the environment at the heart of a social contract, providing a foundation for efforts to tackle poverty and inequality.

The idea that the social contract should include a focus on humanity's relationship with the environment has emerged relatively recently in academic literature (O'Brien *et al.* 2009; Huntjens 2021; United Nations Research Institute for Social Development [UNRISD] 2021; Heffron and De Fontenelle 2023). But in many cultures, the notion that humanity has responsibilities towards nature is much older. It is particularly evident in indigenous communities and traditional knowledge systems that recognize the interconnectedness of all living things, and the importance of maintaining a healthy relationship with the natural world (Århem 1996; Brand *et al.* 2023; Ohenhen and Abakporo 2024; Parker and Tanana 2024).

From the foresight process, three areas stand out as important opportunities to renew the social contract and increase society's resilience: engaging and embracing a broader and diverse range of stakeholders including women, indigenous and local peoples; giving young people a stronger voice; and rethinking measures of progress.

Embracing the views of a more diverse group of stakeholders

The active participation of individuals and groups in the decision-making processes that affect their lives is central to social cohesion and trust in government. Forging a new social contract with actions that reverse the worldwide trend of declining public engagement in and support for democratic processes is a priority (International Institute for Democracy and Electoral Assistance [IDEA] 2023).

Technological and social innovations are increasing the range of tools that could achieve this. Digital platforms can enhance public participation by enabling citizens to express their concerns and participate in shaping environmental policies. At the same time, tools and international cooperation that combat mis/disinformation and lasting investments in building societal resilience and media and information literacy are essential. Citizen assemblies and processes such as participatory budgeting can increase cohesion and transparency, along with an understanding of the trade-offs inherent in public policy decisions (Ahn *et al.* 2023). Open communication and access to the data that support decision-making can likewise build trust and ensure public scrutiny of policy processes (UNEP 2023e). Governments can support local resilience by providing the funding and tools to support analysis and decision making.

Strong local engagement filters upward. Communities that are heard and can express their views support robust national institutions. In turn, secure and stable states are more inclined towards multilateralism, which is the strongest bulwark against shocks.

Giving young people a stronger voice

Young people will bear the consequences of today's decisions for decades to come. In some developing regions that are particularly vulnerable to climate change, young people make up a large part of the population. In other regions, smaller youth cohorts face the burden of financing the expanding population of pensioners in many parts of the world. In any event, young people face a difficult inheritance from earlier generations.

The energy, creativity, passion and resilience of young people serve as a powerful reminder that lifting youth voices and participation can ignite positive change that reverberates far beyond political or sociocultural boundaries. Yet, all too often, there is a lack of representation and influence in political debate. Achieving intra- and inter-generational equity will require the active engagement of young people in decision-making at national and international levels, with special considerations for participation from developing and least developed countries.

The youth and regional sense-making workshops were unanimous in calling for more involvement in decision-making, and a more powerful youth voice at all levels of governance.

A new framework for prosperity

A new social contract would entail a fundamental reimagining of the role of businesses and markets. Current economic systems reward businesses for focusing narrowly on maximizing short-term financial returns for shareholders and externalizing environmental and social harms. Consequently, humanity's resources and ingenuity are largely invested in activities that cause widespread harm across globalized value chains.

At the national scale, GDP has long been the primary measure of economic performance, which has a number of well-documented shortcomings (Stiglitz *et al.* 2008; Dasgupta 2021; Nature 2022; Managi and Kumar 2024).

Throughout the foresight process, the demand for alternative economic and wellbeing measures was strongest among young people, who criticized GDP for marginalizing many essential dimensions of wellbeing and sustainability (Mazzucato 2018). The need for new indicators, such as those that are considered through wellbeing economies (Fioramonti *et al.* 2022), to address both health and environmental issues has been widely acknowledged (Hosseini *et al.* 2023). The Inclusive Wealth Index is one such metric, conveying human, social, manufactured and natural capital. Information on these capital stocks can help in guiding investments that will be essential to achieve the SDGs (UNEP 2024b).

Elements of a new beyond GDP framework that the UN Secretary-General called for have already been developed. For example, the recent proposal for a Multidimensional Vulnerability Index offers a valuable tool to support governance, helping the international community to understand the specific development needs of Small-Island Developing States and Least Developed Countries and deliver targeted and effective assistance (UN 2024b).

Corporations and markets could also play a very different role to contribute to the adoption of alternative measures of prosperity, serving as engines for prosperity, social cohesion and healthy environments. To do so, they need to be guided and constrained by values such as solidarity, fairness, responsibility, resilience, sustainability, dynamism and humility (Carney 2021). The same values would be at the core of the new social contract.

Already there is some evidence of change, notably in the emergence of ESG metrics and their integration into binding legislation (Signal 17). A similar shift is apparent in growing calls for a shift in the economic paradigm towards 'stakeholder capitalism' that acknowledges corporate obligations to a broad range of stakeholders, including the environment (Rajan 2019; Schwab and Vanham 2021). An overarching complementary tool that emerged through the foresight process is the development of a 'wellbeing or liveability index', which would combine physical environmental and social and cultural dimensions of human and community wellbeing with data on material living standards with other key wellbeing determinants, such as environmental aspects, cost of living, physical spaces, cultural and mental health and poverty (Paul and Sen 2020). It could be particularly useful at the regional or local community scale, providing insights into the successes or limitations of policy interventions (Paul and Sen 2020).

The proposed 'liveability index' can build on the existing complementary measures mentioned above. As such, it would provide a valuable input to the monitoring, learning and knowledge sharing processes that are integral to agile and adaptive governance (discussed below). It could also provide an important signal to guide investments and actions by national governments and international bodies, such as regional development banks.

Integrating these indices into a comprehensive 'liveability index' could more effectively measure success in achieving the SDGs and environmental goals. Drawing together these kinds of indicators into a new framework will only contribute to real change if the framework is embedded into the strategic planning and decision-making processes of governments at all scales, and citizens are empowered to contribute. To be effective, new knowledge may need to be accompanied by new processes, rights or institutions.

3.2 Agile and adaptive governance for a sustainable future

Across many of the signals of change identified in Part 2, accelerating change has emerged as a core theme. Communities across the world face more frequent and severe disruptions as the effects of climate change intensify and the interdependence of globalized systems causes localized crises to spread. In parallel, rapid technological advances, powered by an exponential growth in computational power, are transforming how we live, work and interact. These changes create opportunities to meet material needs in more sustainable ways. But they also bring risks and uncertainties, potentially jeopardizing privacy and human agency, undermining democratic governance and contributing to conflict.

How can new technologies be developed and used in ways that promote sustainability? How can communities find ways to adapt to the changing context and environmental conditions to ensure their resilience? Part of the answer lies in promoting agile, adaptive governance, which puts an emphasis on empowering communities and fostering innovation across society, while using long-term targets and visions to guide these dispersed processes.

Facilitating communities to engage, experiment and learn

Cities and communities have an essential role in achieving sustainability transitions. They are often places of learning, innovation and creativity, enabling the potential for systemic change at the local level (Signal 18). Yet communities also face specific vulnerabilities and challenges in a rapidly changing global context.

Empowering communities to take ownership of their resilience strategies enhances their adaptive capacity and fosters self-reliance (Holling 2018). Encouraging women's participation and enhancing their roles as agents of change is essential for sustainable development (Bryan *et al.* 2024). It allows them to co-create responses that speak to their needs (Pelling *et al.* 2015; Asian Development Bank [ADB] 2020; Leal Filho *et al.* 2023). This also creates space for the meaningful inclusion of gender and indigenous perspectives into resilience-building efforts, which drives cultural continuity and enhances the effectiveness of interventions by aligning them with local values and practices (Whyte *et al.* 2020) that ultimately improves trust.

Governments and international organizations can support community goals by providing funding or insurance and removing legal barriers to engagement and experimentation (Pisor *et al.* 2022). They can also invest in establishing coherent monitoring frameworks, to collect and organize data and information about environmental change and the outcomes of local initiatives. The availability of such data, information and knowledge is crucial to inform agile decision-making.

Public authorities can also support the creation of horizontal networks between communities that allow ideas to be shared and adapted to new contexts, as well as coordination of response efforts (Aldrich 2019). Local networks and community engagement are particularly critical in supporting indigenous cultural preservation by providing education on sustainable resource management, adaptation strategies and coping mechanisms (Berkes 2018; Datta 2018).

Environmental goals and targets

The overall goals and boundaries for the environment are established in international agreements, such as the SDGs and global biodiversity and climate targets. They are typically long-term targets. But these goals are only a first step. At the international level, translating the goals into shorter-term, measurable and high-impact targets and indicators, allowing for agile course correcting or setting more ambitious targets as necessary, could mark a significant initiative to help facilitate implementation. At the national level, shorter-term global goals could be integrated into national legislation with plans that set clear obligations and parameters for economic activity and innovation, while addressing established environmental targets.

Transforming economies and societies to achieve prosperity within environmental limits will inevitably be disruptive, but it can be a just transition. This can be achieved through dialogue that fosters collaboration between governments, businesses and civil society to co-create effective and just solutions. At regional and local levels, stakeholders can be brought into the fold of the community to build shared visions for the future that can reconcile their competing interests, mobilize and inspire action, and deliver on national goals and targets. Ultimately, shared values such as a healthy environment, social equity and justice provide the compass for navigating complex challenges, developing goals, targets and visions at all levels of governance and, ultimately, guiding decision-making and fostering collaboration.

3.3 Guiding governance through data and knowledge

It will be difficult to navigate the challenges ahead without a transformation in the knowledge systems that support governance. Creating and implementing a new social contract requires the creation of open knowledge sharing platforms that empower citizens, as well as new metrics that go far beyond GDP to create a much richer representation of the health of societies and ecosystems. Supporting agile and adaptive governance depends on monitoring and assessing the impacts of innovation, experimentation and systems that enable information to be shared horizontally and vertically to guide investments and actions. But the needs and value of leveraging data and knowledge extend far beyond this.

Integrating and improving monitoring

Stronger and better integrated systems to monitor and understand environmental change to track what's coming down the line and across systems will support better decision making. Monitoring is currently undertaken by a diverse range of actors, including international organizations, governments and non-governmental actors. It also employs a wide range of techniques, with Earth observation from satellites increasingly providing a primary source of information[1].

At national and sub-national levels, public institutions are also very active in collecting data to monitor environmental change and support the enforcement of legislation. For example, the Group on Earth Observations (**GEO**), the Global Earth Observation System of Systems (**GEOSS**) and **Copernicus** provide substantial remote sensing data. Earth observation data from organisations like US National Aeronautics and Space Administration (NASA) are being used to support assessment of vulnerability and exposures of communities to environmental changes. They provide open access to data, software and tools available through NASA's Earth Observing System Data and Information System (**EOSDIS**) for scientists and decision- makers (Langlois *et al.* 2023).

For these investments and activities to be effective in increasing the knowledge base, supporting governance and decision-making, monitoring must be integrated and any gaps addressed in a coordinated manner. Actors such as the World Business Council for Sustainable Development and the World Economic Forum can potentially play an important role in increasing coordination.

A key issue for monitoring relates to scale: while local monitoring is easier to implement, global level impacts are important to measure as local issues become global issues and vice versa. Advancements in AI and computational power can be leveraged to collate and analyse large volumes of data in short timeframes, making it possible to accelerate responses to major environmental changes and events. Linking AI and Earth Observation, with appropriate ground-truthing, can enable the development of a globally linked and integrated monitoring network covering land-use change, biodiversity, water (surface and ground), climate, air and marine domains.

[1] At present, three UN-mediated global monitoring schemes exist, addressing climate systems (GCOS), ocean systems (GOOS) and terrestrial systems (GTOS). GTOS and GCOS have a joint Global Terrestrial Network for Glaciers (GTN-G), helping to understand the role of glaciers for climate and hydrology. The OECD supports Earth observation from satellites, aircraft, and drones, with in-situ measurements or ground-based monitoring across countries and regions.

It is also critical that monitoring of the state and trends of environmental systems is complemented with more knowledge about 'tipping points'—thresholds after which complex systems can change rapidly and irreversibly. At present, environmental monitoring is insufficiently focused on these thresholds (Hewitt and Thrush 2019). Tipping points are usually discussed in relation to ecosystems or earth system processes, such as the reversal of the Atlantic Meridional Overturning Circulation (AMOC) and melting of the West Antarctica ice sheet. But positive tipping points are increasingly being explored, for example in the literature of sustainability transitions, which focuses on the transformation of unsustainable socio-economic systems (Arora and Stirling 2023; Calisto *et al.* 2024).

Finally, the imperative for improved monitoring of the diverse range of policy interventions that are being adopted and implemented at various levels of governance would aid international organisations to focus efforts and resources where it is needed. Better tracking of policy instruments and institutional structures would provide a basis for exploring and understanding what works best in different contexts. It would also provide a basis for civil society groups to advocate for changes that lead to the development and uptake of more effective and locally relevant policies. Such tools would help identify where governments or donors could best invest to protect people and planet, while strengthening national institutions.

Combining data, information and knowledge, and making it accessible

Generating data and knowledge across disciplines and portfolios to inform effective governance is an essential first step. But its true value can only be realized when it can be accessed and analysed in ways that offer new insights.

In part, this means taking better advantage of the opportunities created by recent technological advances. In the era of big data, the internet of things and AI, combined with supercomputing, the opportunities for analysis of complex data sets are expanding rapidly. Insights from combining monitoring and other data across disciplines will better enable not only the nature of problems to be identified but also the ability of solutions to be identified quicker, supporting agile governance.

In a world where we are sometimes drowning in information, there is also a more basic need for platforms that enable people to access and navigate the information they need. Data driven assessments, foresight, global environmental monitoring and citizen science can all be used to support understanding and decision making. Platforms to enable insights into implementation of the environment-related SDGs and multilateral environmental agreements—along with measures of poverty, vulnerability and economic welfare—are entirely possible with current tools. UNEP's World Environment Situation Room (WESR) aims to do this. WESR is a UNEP tool that aims to support environmental governance by integrating geospatial data, digital libraries, data driven assessments, foresight, global environmental monitoring and citizen science. It also provides insights into implementation of the environment-related SDGs and multilateral environmental agreements. Efforts have also been made to consolidate the definition, data collection and monitoring of key variables including for climate, biodiversity and ocean.

These platforms—combined with efforts to consolidate the definition, data collection and monitoring of key variables including for climate, biodiversity and ocean mean—would allow countries and organisations to take decisions across portfolios and strengthen implementation, because environmental, societal and economic factors have been taken into account.

“The Earth turns to Gold, in the hands of the wise.”

Jalaluddin Rūmī (1207-1273)

Everyone alive today, particularly those in vulnerable communities, knows all too well what happened when past generations made decisions without considering the future implications. Basing human development on fossil fuels has brought devastating climate change. Dismantling reuse models in favour of single-use plastics has polluted nature. Making products that contain harmful chemicals and compounds, such as lead and mercury, have impacted the health of millions of people. Nobody can travel back in time to warn against this path. We can only try to correct these mistakes, and ensure they do not happen again. The use of foresight tools can assist in this endeavour.

This foresight exercise tells us that paying attention to signals of change and underestimated disruptions, even those that are on the edges of plausibility, can provide insights and early indicators of events and circumstances that could significantly impact future generations. By systematically monitoring and analysing these signals, UNEP and other organisations can anticipate shifts in political will, emerging technological disruptions, or socio-economic changes that can hinder or advance environmental protection efforts—allowing for strategic interventions that address issues before they escalate, ensuring the continuity and effectiveness of climate change planning and environmental safeguarding initiatives.

Change is inevitable. It is up to humanity, the one species that has evolved to the point where it can affect natural processes on a planetary scale, to unite, look forward and ensure that the decisions we make today shape a future that works for everyone, everywhere.

Annexures

Annex 1

Comparative analysis of regional workshop outcomes around the eight critical shifts

Critical shift 1 – The relationship between humans and the environment in flux

Participants in regional workshops universally emphasized the importance of sustainable practices and robust environmental governance frameworks. Key priorities included preserving biodiversity, enhancing community stewardship and implementing nature-based solutions to address environmental changes. Additionally, addressing food insecurity and the adverse effects of pollution on water and air quality were common concerns.

Regional approaches varied according to unique circumstances and developmental contexts. Europe focused on enhanced environmental regulations and nature-positive investments to address biodiversity loss and food system vulnerabilities. North America highlighted multi-species justice and decentralized governance, emphasizing Indigenous stewardship. Africa stressed robust environmental governance and community stewardship, while Asia Pacific called for global cooperation to manage zoonotic diseases and chemical proliferation. West Asia leaned towards technological solutions like AI and renewable energy, and LAC emphasized reconnecting humans with nature through value-based systems and stakeholder involvement in sustainable resource management.

Overall, enhancing environmental regulations and governance, preserving biodiversity and fostering sustainable practices emerged as shared priorities. While Europe, North America, and Asia Pacific focused on biodiversity and climate resilience, Africa, West Asia and LAC emphasized community involvement and local stewardship.

Critical shift 2 - Critical resources: scarcity, competition and the shifting dynamics of global security

The intensifying competition over critical resources such as water, food, minerals and energy is reshaping global security dynamics. Workshops across various regions emphasized sustainable resource management, equitable distribution and community involvement as essential strategies. Europe and North America highlighted sustainable practices and equitable distribution to address resource scarcity and promote stability, with North America additionally raising concerns about the privatization of public goods and corporate ownership of resources.

Africa focused on transitioning to regenerative agriculture and ensuring benefit-sharing for local communities through transparent governance. In West Asia, balancing natural resource distribution and implementing equitable economic development legislation were prioritized, along with local solutions for resource management. LAC underscored the need for territorial, environmental and production transformation, emphasizing collaboration with indigenous communities. Asia Pacific highlighted the challenges posed by worsening food and water scarcity due to climate change, pointing to innovative governance models for managing space resource exploitation and mitigating environmental degradation.

Critical shift 3 - AI, digital transformation and technology – a wave of change

Europe and North America emphasized the importance of robust governance frameworks to address the ethical, societal and environmental implications of AI. Both regions highlighted concerns about the loss of human agency in decision-making and stressed the need for adaptive regulation and ethical AI development. Africa and LAC focused on technological sovereignty, developing local, context-specific solutions and bridging the digital divide. These regions advocated for AI development that prioritizes social and economic equity and stressed the need for policies to enhance digital literacy.

West Asia and Asia Pacific highlighted the integration of AI into informed decision-making and policymaking, with a strong focus on creating smart societies and infrastructures. Both regions recognized the need for up-to-date regulations and collaboration across sectors to ensure the sustainable and equitable use of AI technologies. Concerns about privacy erosion and managing tech-related job losses were prominent, emphasizing the need for well-regulated AI to prevent potential abuses.

Critical shift 4 – A new era of conflict

The rise of armed conflicts—driven by resource competition, climate change and technological advancements—necessitates comprehensive strategies to mitigate their impacts. European and North American workshops stressed the need for robust governance frameworks to manage AI-driven weapons systems and prioritize conflict resolution and sustainable peacebuilding. Both regions linked environmental health to security, calling for integrated policies to address these interconnected issues.

Africa emphasized the importance of localized governance and cross-sectoral interactions for effective resolution to conflicts driven by non-state actors and militias, often fuelled by resource competition. LAC participants noted the rise of social unrest driven by resource competition and socioeconomic disparities, advocating for multi-actor interventions to promote social cohesion. West Asia highlighted the transformative impact of AI and drones, stressing the need for governance to manage these technologies and environmental drivers of conflict. Asia Pacific emphasized the risks of neocolonialism and resource-related conflicts, calling for strict regulations to ensure global security and protect human wellbeing.

A common theme was the transformative role of new technologies in changing the nature of warfare, raising significant ethical, safety and regulatory concerns. Climate change as a critical driver of conflict was also a recurring emphasis, with resource scarcity leading to heightened tensions and environmental degradation exacerbating humanitarian crises. The workshops revealed a shared recognition of the need for comprehensive and integrated approaches to address modern warfare's multifaceted nature, tailoring strategies to regional contexts and fostering cooperation for sustainable peace and security.

Critical shift 5 – Mass forced displacement and migration

Mass forced displacement and migration—driven by conflicts, climate change and economic pressures—present complex challenges across various regions. The workshop in Europe highlighted the persistent inequality among migrant and minority communities, the political instrumentalization of migration and the need for fostering social cohesion and equitable integration. North America stressed ethical and social justice concerns, emphasizing better relocation programs and international regulations to protect migrants' rights.

In Africa, the focus was on the role of conflicts and climate change in driving displacement, with an emphasis on inclusive policies to address root causes, such as conflict resolution, economic development and environmental sustainability. LAC participants echoed this focus, advocating cooperation strategies across the Global South Coalition and comprehensive strategies for climate adaptation. West Asia highlighted localism and local governance as key responses, while Asia Pacific stressed the need for international regulations and integrated health and environmental justice to address climate-induced migration.

Common themes included the significant impact of climate change on forced displacement, necessitating better relocation programs and comprehensive climate adaptation strategies. Ethical and social justice concerns associated with migration were recurring points of discussion, emphasizing policies that protect the rights and wellbeing of displaced populations. Despite regional differences, there was a shared understanding of the need for inclusive and comprehensive approaches to address the multifaceted challenges of forced displacement and migration.

Critical shift 6 – Persistent and widening inequalities

Persistent and widening inequalities present significant challenges globally, with common themes around the need for systemic changes to address income disparities, promote social equity and integrate environmental justice into economic policies. European workshops highlighted income disparity and unequal access to resources, advocating for economic systems prioritizing human and planetary wellbeing. North America focused on rising income inequality and the erosion of the middle class, emphasizing the need for equitable access to education, employment and resources.

In Africa, the focus was on wealth disparities and limited access to education and healthcare, calling for redistributive policies and inclusive economic growth. LAC participants emphasized persistent inequalities exacerbated by political instability and social tensions, advocating for benefit-sharing and comprehensive socioeconomic policies. West Asia highlighted wealth concentration and ineffective governance, promoting local governance and community empowerment. Asia Pacific pointed to private monopolies and market access blocks, emphasizing robust governance mechanisms for compliance and accountability.

Environmental justice intersected with inequality discussions, with poorer communities facing greater exposure to pollution and climate impacts. Regional priorities varied, with West Asia focusing on equitable economic development legislation and Asia Pacific exploring new approaches like Universal Basic Income. LAC emphasized reconstructing the social fabric through inclusive policies. The workshops revealed a shared recognition of the need for comprehensive and inclusive approaches to address inequalities, tailored to regional contexts and fostering international cooperation.

Critical shift 7 – Misinformation, declining trust, and polarization

Misinformation, declining trust and polarization were identified as critical challenges undermining governance and public policy globally. The Europe workshop highlighted the need for building trust and enhancing media literacy to combat misinformation and foster informed decision-making. Africa emphasized transparency, evidence-based decision-making and media literacy to restore trust and combat misinformation, noting the impact of social media in exacerbating these issues.

North America focused on the manipulation of information and AI-powered disinformation, advocating for transparency, accountability and stronger evidence-to-policy mechanisms. West Asia highlighted the rise of mistrust in traditional information sources, emphasizing media literacy and effective

communication among decision-makers, scientists and civil society. LAC stressed the impact of misinformation on governance and social cohesion, advocating for increased transparency and accountability to rebuild trust. Asia Pacific pointed to divisive politics and declining trust in science, emphasizing the need for integration of environmental and social wellbeing in education and enhancing media literacy.

Common themes included the detrimental effects of misinformation on governance and the critical need for media literacy. Regional differences emerged in specific approaches, with North America and LAC focusing on protecting marginalized groups' rights and establishing global governance mechanisms, while West Asia and Asia Pacific emphasized effective communication and educational transformation.

Critical shift 8 – Polycentricity and diffusion of governance

Workshops highlighted the importance of transparency, integrity and diverse stakeholder inclusion in governance structures. Europe, Africa and North America focused on local governance and participatory decision-making for addressing inequalities and fostering sustainable development. West Asia and Asia Pacific underscored local entities and regional networks' role in driving change and building resilience.

Regional differences included Europe's focus on aligning trade deals with sustainability goals and reforming international institutions to enhance multilateralism. Africa emphasized strengthening local governance and community-based solutions to manage inequalities. North America highlighted Indigenous peoples' self-determination and integrating traditional knowledge systems. West Asia advocated for collaboration among decision-makers, scientists and civil society, stressing stronger environmental legal frameworks. LAC called for institutionalizing citizen participation and protecting regional and local environmental leaders. Asia Pacific emphasized new governance models that empower marginalized communities and integrate Indigenous values.

Annex 2

SDGs mapped against critical shifts and signals of change

EMERGING TRENDS AND SIGNALS OF CHANGE	SDGs AFFECTED
Humans and the environment: A relationship in flux	
Ancient microbes hidden in thawing Arctic permafrost	
New emerging zoonotic diseases	
Antimicrobial resistance approaching critical levels	
Unforeseen impacts of harmful chemicals and materials	
Resources, scarcity and shifting dynamics of global security	
Rapid expansion of space activity and orbital space debris	
AI, digital transformation and technology – waves of change	
An emerging exnovation mindset	
Deployment of Solar Radiation Modification	
A new era of conflict	
Autonomous and artificial intelligence weapons systems	
New technologies amplify risks of biological agents misuse	
Mass forced displacement	
Uninhabitable spaces	

Persistent and widening inequalities

Privatized micro-environmentalism

Uninsurable future

Misinformation, declining trust and polarization

Decisions increasingly detached from scientific evidence

Eco-anxiety: An emerging crisis hidden in plain sight

Surging fossil fuels subsidies

Escalating risks of corruption in carbon offsetting

Polycentricity and diffusion of governance

New tools for rerouting global financial flows

Local, network-driven resilience

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