Economy and Finance for a Just Future on a Thriving Planet

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Executive Summary

- Our living planet, with its biosphere and climate system, has changed at unprecedented speed since the world's nations gathered in Stockholm in 1972. Changes in the climate and Earth system, which were assumed to unfold in a distant future and only affect future generations, are happening now, with increasing speed and force. We now live in a fundamentally new planetary reality where we are more connected, where the climate system is destabilized, and where the biosphere that supports humanity is becoming more fragile and depleted. This new reality has repercussions for life on Earth, and needs to be the basis for actions aiming to transform the financial sector and our economies towards just futures on a thriving planet.

- Investments are key to a transition to climate stability and biosphere stewardship. Investments impact on key biomes linked to "tipping elements" in the Earth system, and on ecosystems and people who depend on these all over the world. A changing planetary reality creates new systemic risks through domino-effects and feedbacks to economies and the financial sector, which are poorly understood and dealt with today. Financial institutions that mediate these investments play a central part to our ability to shift economies in a direction that promotes a thriving planet for all.

- The responsibility for the new planetary reality lies heavy on high-income countries who represent only 16 % of the world population but whose consumption today is responsible for 74 % of global excess use of natural materials, including biomass, metals, non-metallic minerals and fossil fuels. Moreover, the risks created by our changing planet are not shared equally. Low-income countries with limited historic responsibility are among those suffering the most from the impacts of growing Anthropocene risks. These dynamics further reinforce the already staggering global inequalities.

- The new planetary reality requires us to rethink the indicators for human well-being, macroeconomic performance and financial risks. Indicators for human development must acknowledge human pressures causing the transgression of planetary boundaries and their effects on well-being. Macroeconomic performance indicators need to embed the deep uncertainty engrained in biosphere dynamics to ensure the preservation of natural capital. Financial institutions must recognize a wider set of planetary changes, and develop impact accounting as a core part of capital allocation decisions, and support the open disclosure of Environment, Sustainability and Governance (ESG) data and criteria.

- Economic and financial actors are not equally influential in today's globalized economies. "Keystone actors" corporations, financial giants, central banks, and index providers must play a larger role in helping accelerate action for sustainability, and especially in parts of the economy of importance for the stability of the climate system and the resilience of the biosphere. Engaging with such influential economic and financial groups offer possibilities, but transparency, accountability and strengthened regulation will be key to secure outcomes that benefit sustainability ambitions and a just transition.

- Large-scale behavioral change has a crucial role to play in a shift towards just futures on a thriving planet. Changes in social norms can instigate such wider changes in society, economies and in the financial sector. Policies can be leveraged to shift norms by altering the behaviors of key actors and by changing expectations. This can result in the activation of large-scale behavioral tipping as actions trigger additional actions. Recent international public opinion surveys, the rise of global youth movements, and current sustainability initiatives by influential actors in the economic and financial sector, indicate that the time might be ripe for such policies that help bridge the gap between sustainability rhetoric and action.

- A changing planetary reality poses immense challenges and risks. Yet, a shift towards a just future for all on a thriving planet is possible, and will require actions from the financial sector, macroeconomic institutions and policy-makers that support transformative capacities. Such capacities entail the ability to define a new direction; create enabling conditions; actively contribute to a phaseout of harmful investments and economic activities in a just way; and to help scale up investments for resilience. Financial and economic incentives can, and should, align with system opportunities and acknowledge the need to sustain critical Earth-system processes in support of the biosphere and human well-being for all.

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Preface

> *“Whether humanity has the collective wisdom to navigate the Anthropocene to sustain a livable biosphere for people and civilizations, as well as for the rest of life with which we share the planet, is the most formidable challenge facing humanity.”*

This was the key message and conclusion from the Nobel Prize Summit hosted in 2021. It resembles in many ways the outcomes of the Stockholm conference in 1972, the first ever United Nations conference on the human environment. Fifty years have passed since that historic conference, and while the world is a very different place today, the message remains the same. Astounding progress in human well-being for many and technological breakthroughs have come at the cost of growing social inequality and an increasingly evident climate crisis. Humanity has become a force of planetary change threatening to erode the fabric of life. Yet this daunting prospect of the future is countered by a growing desire to tackle these challenges applying insights from an increasingly vibrant field of sustainability sciences and a formidable human capacity to innovate. Securing a safe and prosperous future for all is still possible.

This report explores the direction the financial sector and our globalized economy need to take to change course. It is a major task, and we present our views with urgency and humility. The insights presented here build on decades of collaborative work within systems thinking, ecological economics, resilience science and Earth system science. It is based on the legacy of the Beijer Institute of Ecological Economics, the Global Economic Dynamics and the Biosphere Program (both at the Royal Swedish Academy of Sciences), and the pathbreaking work done by colleagues associated with the Stockholm Resilience Centre (Stockholm University).

Stockholm+50 offers a unique opportunity for the world to reflect on its progress and failures since 1972. This report offers an important synthesis of how our economies and the financial sector can contribute to this reflection, all with the aim of accelerating towards a more sustainable and just future.

Chapter 1. ***A New Planetary Reality***

Our living planet, with its biosphere and physical climate system, is changing at unprecedented speed. Changes in the climate system and the biosphere, which were assumed to unfold in a distant future and only affect future generations, are happening now with increasing speed and force. We now live in a fundamentally new planetary reality where we are more connected, more connected, at the same time as more abrupt and sometimes irreversable changes happen, the climate system is destabilized, and the biosphere that supports humanity is becoming more fragile and depleted. This new reality has enormous repercussions for all life on Earth, and needs to be the basis of discussions, strategies and actions about how to transform towards just futures on a thriving planet.

Earth has a biosphere, a thin veil around Earth's surface where life flourishes. Earth is the only place we know where a complex web of life exists. We humans have emerged and evolved within the biosphere. Our economies, societies and cultures are deeply embedded within it. The biosphere is our home (Folke et al., 2021).

This chapter summarizes key scientific insights about our changing planet, and the implications for prosperity and development for all. It elaborates how and why climate stability and biosphere resilience are key to prosperity and development, and how the scientific understanding of our complex Earth system has evolved over the 50 years since the Stockholm Conference of 1972. The insights emerging from this body of work are far from trivial. Instead, they highlight how the conditions for collective action within and across national boundaries have fundamentally changed during the last decades. They also force us to rethink the organization of our economies, and the role and responsibility of the financial sector in the Anthropocene epoch – the Age of Humans.

Climate change and the Anthropocene biosphere

Human society has developed and flourished during a remarkably stable period in Earth's history, the Holocene, when global average temperatures varied no more than around 1°C during about 10,000 years (Steffen et al., 2015b). Over the last three million years, the average temperature on Earth has not exceeded 2°C above (interglacial) or 4-5°C below (deep ice age) the pre-industrial average temperature on Earth (14°C). Already now at 1.2°C warming above pre-industrial levels (IPCC, 2018), we have moved out of the stable and accommodating Holocene environment of the last 10,000 years with its well-defined and foreseeable seasons that allowed agriculture to develop and complex civilizations to flourish. The projected changes to the climate system in the next fifty years could be larger and more disruptive than humanity has experienced since the beginning of civilization (Steffen et al., 2018). The impacts on societies, vulnerable communities and ecosystems are far from trivial as elaborated by the Intergovernmental Panel on Climate Change (2022).

However, the climate system and the biosphere are more than just the basis for human civilization. As Folke and colleagues (2021) notes, the biosphere and the Earth system have coevolved with human activity over time, creating a close and inseparable inter-dependence between social conditions, health, culture, democracy, power, justice, human security, and the Earth system and its biosphere.

Since the end of the Second World War, the global human population has increased substantially, while on average also becoming much healthier and prosperous. This was enabled by substantial consumption of resources from

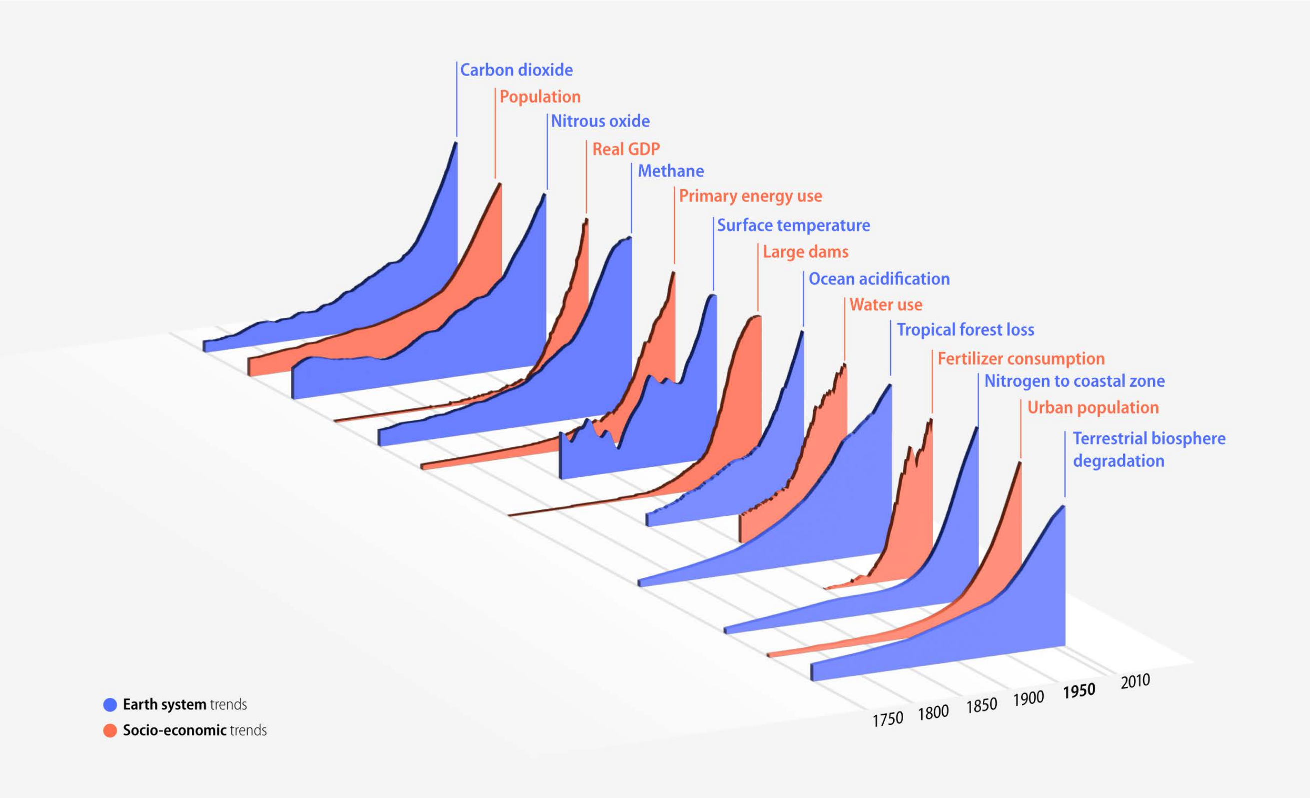


Figure 1 | A changing planet. Our living planet and the climate system have been transformed fundamentally in the last decades through the 'Great Acceleration' – the dramatic growing impact of human activity on the Earth system. Source: (Steffen et al., 2015a).

the planet's oceans, rivers, forests, grasslands and coastal plains and other landscapes, together with a dramatic rise in telecommunications, tourism, and foreign direct investment, all driven by rapidly growing economies across different regions of the now globalized world (Steffen et al., 2015a). As we elaborate in Chapter 4, the benefits and risks of this acceleration have not been distributed equally.

One of the most prominent frameworks to summarize how the Earth system and the biosphere underpin human prosperity in fundamental ways, is the notion of 'planetary boundaries' which identify a "safe operating space for humanity." (Rockström et al., 2009). This space is defined by a number of dynamic Earth system limits beyond which the stability of the life-supporting conditions on our planet becomes uncertain and might drastically change. Threats to this safe operating space include global warming, loss of biosphere integrity (biodiversity loss and ecosystem resilience), chemical pollution and the release of novel compounds, ocean acidification, freshwater consumption and the global hydrological cycle, land system change, nitrogen and phosphorus flows to the biosphere and oceans, atmospheric aerosol loading and stratospheric ozone depletion. The "planetary boundaries" framework has been refined over the years (such as by Steffen et al. 2015b; Persson et al., 2022; Wang-Erlandsson et al., 2022). It has also been noted that the global framing of such boundaries could be misinterpreted in ways that ignores local and regional realities and changes that take place within such defined "boundaries", but still undermine adaptive capacity with detrimental impacts on both people and planet (Biermann et al., 2016; Aguiar et al., 2020).

The stability of the climate system is fundamentally dependent on the resilience of our living planet – the world's oceans, forests, grasslands, wetlands, soils, other ecosystems, and the biodiversity they entail. Biomes such as the Amazon rainforest and the world's boreal forests store an equivalent of about 10 years of global emissions of greenhouse gases (Steffen et al., 2018). Oceans absorb about 25% of our annual carbon emissions, and over 90% of the additional heat generated from those emissions. Forests, wetlands, and grasslands sequester almost 30% of carbon emissions from human activities. The total amount of carbon stored in terrestrial ecosystems like soil, and living plants is almost 60 times larger than the current annual emissions of global greenhouse gases from human activities (from Folke et al., 2021). Recent analyses show that the world would have already breached the Paris Accord 1.5°C-target already today without the capacity of the living planet - our oceans and land-based ecosystems - to absorb human carbon emissions (Rockström et al., 2021). However, this capacity cannot be taken for granted with continued greenhouse gas emissions, and the loss of resilience of the biosphere (Steffen et al., 2018).

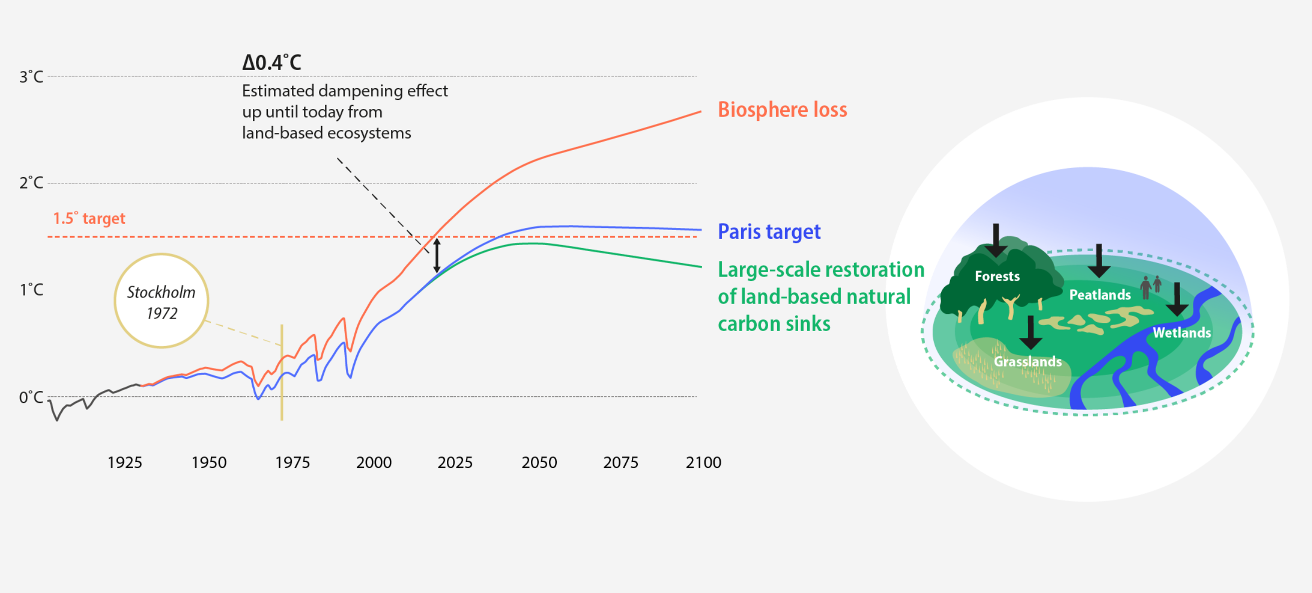


Figure 2 | The importance of the biosphere for the Paris target. The world would already have breached the Paris target without the carbon sinks provided by a resilient biosphere. Source: (Rockström et al., 2021).

Ecosystems also help reduce vulnerability to climate hazards and extreme events (Diaz et al., 2019), and are key for the achievement of the Sustainable Development Goals (Reyers & Selig, 2020). Mangrove forests for example, safeguard 15 million people against flooding every year, and provide at least US$65 billion in flood protection (Menéndez et al., 2020). Hence it will not only be critical to curb human-induced climate change directly through reduction of greenhouse gas emissions, but also to enhance the regenerative capacity of the biosphere and its diversity, to anticipate and adapt to extreme events, and support and sustain societal development for all within a safe operating space.

Simplifying the planet

These shifts in the climate system unfold in parallel with other unprecedented changes: a mass extinction and the simplification of the biosphere through dramatic transformations of land and seascape, all the way down to the deepest oceans (Nyström et al., 2019; Jouffray et al., 2020). While this transformation has been accompanied with considerable social benefits such as increased and stable food production, it has also resulted in losses of diversity and resilience, which make ecosystems and societies more vulnerable to the repercussions of a changing climate (Hendershot et al., 2020). Resilience refers to the capacity to live and evolve with changing circumstances, predictable or surprising, incremental or abrupt. It includes not only how to persist and adapt to changing circumstances, but more importantly, also the capacity to transform towards sustainable futures by preparing for and making use of the windows of opportunity that change provides (Folke et al. 2021).

Human activities have directly altered at least 70% of land surface, approximately 85% of wetland area and over 66% of the ocean (Diaz et al., 2019). Nearly 40% of all productive land and 70% of global freshwater is being used for agriculture (Foley et al., 2011). Perhaps most shocking, over 96% of Earth's mammal biomass is now accounted for by people and our livestock – with less than 4% made up by elephants, whales, moose, monkeys and other wild species (Bar-On et al., 2018). Moreover, the increase in agricultural crop production in the last decades has been achieved through an ever-increasing reliance on fewer global crop commodities that are produced and exported from an increasingly limited number of countries (Heslin et al., 2020). 80% of the world's population today lives in countries that import more calories than they export (Kummu et al., 2020).

These trends are paralleled by an overall homogenization of the food produced globally (Khoury et al., 2014, Nyström et al., 2019; Díaz et al., 2019). Such homogenization results in losses to the pool of genetic variation that underpins the long-term resilience of agricultural and food production in the face of environmental change (IPBES 2019), as well as the increased use of pesticide and herbicide due to the loss of insect diversity and natural pest control (Klein et al., 2007; Potts et al., 2010). According to estimates, loss of animal pollinators – mostly bees – affects more than 75 percent of global food crop types (Klein et al., 2007) and puts $235 billion to $577 billion in global crop output at risk annually (IPBES 2019), with inequitable implications for human nutrition (Chaplin-Kramer et al., 2014).

By transforming much of the planet into cropland monocultures, forest plantations, filled wetlands, and fish farms, humans have changed the properties of the biosphere to such an extent that new types of global risks could emerge that affect the long-term ability to provide food, fibres, fuel, and jeopardize food security for a growing and wealthier human population (Nyström et al., 2019). Shocks previously occurring locally within one sector risk becoming 'globally contagious' and more prevalent as sectors are intensified and become more intertwined (Keys et al., 2019). For example, droughts or crop pest outbreaks can spill over to seafood production, since fish farms increasingly depend on agricultural crops to produce their feed. Gains in resource efficiency and production often trade off with the cultural diversity (e.g., through small-scale food production systems) that underpins collective well-being in different ways across the globe (Sterling et al., 2017).

Since the world's governments gathered at the Stockholm Conference in 1972, not only the continents, but also the ocean has seen an unprecedented increase in the intensity and diversity of uses. From the shoreline to the deep sea, these rapid human-driven changes on the oceans known as the 'Blue Acceleration' are having major social and ecological consequences, and raise serious concerns about potentially unsustainable growth trajectories and systemic inequity in the current ocean economy (Jouffray et al., 2020; Österblom et al., 2020). Most benefits accrue to a small portion of the global population, while most harms, including those from climate change impacts, fall on the most vulnerable.

Emerging diseases and the loss of diversity of life

New diseases and agricultural pests are an increasingly disruptive force to society. Commonly referred to as emerging pests and pathogens (EPPs), they include insects, plants, or microbial organisms. Their effects range from impacts on food security, biodiversity conservation, and natural resource management, to those of social equity, health, and safe technology (Jørgensen et al., 2019). Three forces of global change drive the trend of EPPs as a growing sustainability challenge (Carroll et al., 2014; Jørgensen et al., 2019). First, as human land use expands to take up more than 75 % of the Earth's ice-free land surface, potential EPPs are likely to come in first contact and emerge globally in human habitats. Second, denser human trade and travel networks mean EPPs are more likely to spread between continents and to emerge regionally. Third, human use of technological inputs—such as biocidal agents in resource production and health systems—has increased exponentially and acts as a selective agent for re-emergence through the spread of resistant or more virulent variants. While pandemic pathogens are an obvious example of the large consequences EPPs can have on society (Galaz et al., 2017), they are but a small and unrepresentative sample of the diverse influx of EPPs to society, and their possible domino-effects on society.

One related feature of our new planetary reality is the decline in the habitats available for all animal and aquatic life within the biosphere (e.g., Powers & Jetz 2019; Segan et al., 2016). As just one example, on average, large terrestrial mammals have been extirpated from 75% of their natural ranges since the evolution of modern humans (Faurby & Svenning, 2015). With decreasing forests, poorer freshwater and marine habitats, and declining food availability for non-human species, the number of species currently threatened with extinction is unprecedented in human history: an estimated 1 million species of animals and plants (Ceballos et al., 2015; Ceballos et al., 2017; Díaz et al. 2019). Why does this matter? It matters because species and biodiversity perform critical functions in the biosphere, functions that generate essential ecosystem services to human wellbeing, that provides predictability, stability, and insurance in the flow of such services, and that builds resilience to meet uncertainty, surprise and the unknown.

Another driver behind the new planetary reality is the rapid urbanization of what has been referred to as the "urban century" (Elmqvist et al., 2019). The majority of the world population now live in urban areas, for the first time in human history (UN Population Division, 2018). Urbanization of the world population has come with benefits such as access to education, health facilities and jobs, but also bring negative consequences such as social disparities, insecurity, pollution, loss of biodiversity and lack of contact with nature that all affect urban mental health (Ventriglio et al., 2021). Cities both cause pressures and have to deal with their planetary-wide impacts on the climate and the biosphere. While urban areas are responsible for 70 % of global greenhouse gas emissions, 90 % of cities are situated along coastlines and thus increasingly vulnerable to the effects of global warming (Elmqvist et al., 2019). While actions to address local sustainability challenges on city levels are often needed, it is key to consider global biosphere effects and spill-overs beyond city as well as country borders (Engström et al., 2021).

Connectivity, complex systems and tipping points

The impacts of increased global connectivity and complexity today differ from those identified by the international community in Stockholm in 1972. They are another key feature of our new planetary reality that creates novel challenges and opportunities for policy-making, the finance sector, and society.

The anatomy and impacts of global connectivity for sustainability have gained considerable interest amongst sustainability scientists in the last decade. The mechanisms for these complex cross-sectoral and cross-regional connections are often referred to as 'telecoupling' (Liu et al., 2015). This terminology has its roots in the climate sciences, and the phenomena due to what is known as 'teleconnection', whereby climate and environmental change in one region of the world can drive weather and environmental changes in another (Diaz et al., 2001). It has become clear, however, that similar cross-continental connections can emerge through economic activities, trade connections, transportation networks, financial economic linkages, and information flows. Examples include policy-induced land use changes in one region that influence precipitation patterns in other countries (Keys et al., 2012), and deforestation policies adopted in one country that lead to additional forest extraction and degradation in others (Meyfroidt et al., 2010). Global changes such as trade patterns, capital flows and information availability increasingly shape local vulnerabilities and opportunities. Such connectivity creates difficult challenges for the problem-solving capacities of institutions and policy-making. Spill-over effects and unexpected consequences of economic and policy decisions are common, and will require novel governance approaches with the ability to steer away from systemic risks, and identify and mobilize action where synergies for both people and planet are possible (Galaz, 2019; Bowen et al., 2017; Engström et al., 2021; Folke et al., 2005). As Brodie Rudolph and colleagues (2020) note however (and as we elaborate in detail in Chapter 7), such connectivity also offers opportunities to support transformations. Networks of innovators can share insights faster in ways that accelerate learning, as well as mobilize collectively to create enabling governance structures.

Key aspects of these global changes are technological advances and their wider impacts on behavior, norms, economies and institutions (Arthur, 2011). The acceleration and expansion of human activities into a converging globalized society have been supported by the discovery and use of fossil energy and by innovations in social organization, technology, and cultural evolution (Ellis 2015; van der Leeuw 2020). Further technological innovation and change such as advances in robotics, synthetic biology and artificial intelligence are likely to continue shaping Earth's life support system and offer both opportunities and risks (Folke et al., 2021; Galaz et al., 2021).

The sum of all of the technological objects manufactured by humans, or the so-called "technosphere", is a fundamental part of our changing planet. It's weight on the planetary system is estimated to be on the scale of 30 trillion tons, or 50 kilos for every square meter of Earth's surface (Zalasiewicz et al., 2017). Technological innovations are giving this infrastructure the ability to process information continuously, reason, remember, learn, solve problems, and at times even make decisions with minimal human intervention through artificially intelligent machines and increased automation (Markolf et al., 2021). Hence, we face not only unprecedented climatic and ecological conditions, but also the influence of increasingly intelligent autonomous systems with the ability to create novel connections between the social, the ecological, and the technological (Galaz et al., 2021).

But the world is not only increasingly connected and changing at an unprecedented speed. Some of these connections evolve into what can be defined as complex adaptive systems (Levin, 1998; Folke, 2006). Such systems are prone to abrupt, and at times irreversible, shifts with important implications for human development. The terminology differs between different fields of research, including regime shifts, catastrophic shifts, tipping elements, and tipping points, describing a system that crosses a critical threshold and shifts to a significantly new system trajectory or pathway (Lenton, 2013; Rocha et al., 2018; Scheffer et al., 2001). Evidence of such shifts can be found in multiple social-ecological systems and at multiple geographical scales from the local (e.g., a lake) to the global (e.g., the Earth system). Many shifts are associated with the loss of key ecosystem services that underpin livelihoods, economic activities and human development (Biggs et al., 2018; Lenton et al., 2008; Rocha et al., 2018).

'Tipping elements' in the climate system are a good illustration of these phenomena. The melting of sea ice on the Greenland and Antarctic ice sheets is one example as the melting surface changes its reflective properties resulting in self-reinforced warming. The alteration of critical biomes such as the large forests in the Amazon basin and the boreal forests in Canada and the Russian Federation is another example of interacting changes that could lead to the transgression of tipping elements (Lenton et al., 2008; IPCC, 2021).

Many of these biomes identified as critical for the climate system are changing rapidly because of a combination of direct and indirect human pressures. The potential tipping of the Amazon rainforest into a savanna or open woodland is being driven by the combined stresses of climate change and direct human-driven deforestation due to expanding soy plantations, for example (Nobre et al., 2009; Galaz et al., 2018b). The human activities that drive the Great Acceleration are rapidly changing the internal dynamics of many tipping elements (Lenton et al., 2008; Lenton et al., 2019), subsequently risking the long-term stability of the climate system through proposed tipping cascades (Steffen et al., 2018).

The precise timing and impacts of such abrupt shifts on people and their well-being are highly uncertain (Hoegh-Guldberg et al., 2018; Wang & Hausfather 2020; IPCC, 2021). Another complicating factor is the fact that such abrupt shifts can result in domino effects between climate and ecosystems with potentially large, yet unquantifiable impacts on economies and livelihoods. A recent synthesis based on 300 case studies and a review of more than 1,000 academic papers (Rocha et al., 2018) shows that ‘regime shifts’ in one biome or ecosystem can trigger similar irreversible shifts in other biomes, sectors and/or regions. One clear example is the atmospheric recycling of moisture, whereby moisture captured in vegetation evaporates, and is transported in the atmosphere over long distances before falling down in another location as precipitations. The Amazon rainforest for example, depends on moisture recycling as an important water source, and large disturbances in this cycle could lead to shift of this biome from rainforest to savanna. Changes in moisture recycling in the Amazon can also affect mountain forests in the Andes as well as nutrient cycling in the ocean by altering sea surface temperature, which leads in turn to regime shifts in marine food webs. As Gleeson and colleagues (2020) explore, such complex connections between the biosphere and hydrological cycles should be investigated at the planetary level.

At times however, such abrupt shifts can also unfold in social systems in ways that result in positive shifts towards sustainable pathways (Otto et al., 2020). We elaborate examples such as these in Chapter 6.

Understanding Anthropocene risks

Complex systems and increased connectivity through ‘telecouplings’ can both enhance and undermine the resilience of people and planet. Remittances can help families cope with a suite of problems in troubling times (Adger et al., 2002; Naudé & Bezuidenhout 2014). Global information and communication technologies have proven critical to help coordinate national responses and facilitate information sharing between scientists during the COVID-19 pandemic. Local and national vulnerability to food scarcity and shocks has been mitigated partly through international food trade (Porkka et al., 2013). However, global connectivity can also result in independent cascading failures such as ruptures, shocks or propagating disturbances, known as globally networked risks or systemic risks (Helbing 2013; Centeno et al., 2015).

There is a growing interest in the environmental and ecological dimensions of such risks, including climate change, deforestation, extreme weather events and natural resource constraints (UNDP, 2020; Galaz et al., 2017; Keys et al., 2019). As the recent increases in food prices all over the world illustrate, while international food trade can help mitigate local stresses food production, it also creates transboundary connections that allow for shocks to food production to cascade through the global network of agricultural trade (Heslin et al., 2020). Furthermore, resource extraction facilitated through trade has created vast geographical connections where environmental degradation in one country is hidden or masked through complex supply chains. Transboundary food trade for example often masks unsustainable groundwater extraction in food producing countries (Dalin et al. 2017). Global seafood trade allows countries and corporations to compensate for species loss from local marine ecosystems (Crona et al., 2016).

The speed, scale and connectivity of the Anthropocene lay the foundation for challenging and unevenly distributed ‘Anthropocene risks’ (Galaz 2014; Keys et al., 2019). Stresses and shocks can move swiftly from local to global and back again. They may also interplay across sectors in a society, rapidly affecting ecosystems, food security, economies and human health. Such risks and their impacts on human development are however difficult to quantify with greater precision due to their multilevel and complex adaptive system properties (Keys et al., 2019). The impacts of a changing planet on human development will not only depend on changes in frequencies and magnitudes of shocks, such as droughts, floods and extreme weather events, but also on the anatomy of connectivity across land, oceans and climate, as well as the vulnerability of important biomes and ecosystems underpinning human development.

These examples illustrate an important shift in the state of our planet, and in our capacities to deal with such disturbances. The fact that our planet has been transformed from forested landscapes, living oceans, and biodiverse ecosystems to simplified and increasingly homogenized production systems, increases social and ecological vulnerabilities to long-term change and abrupt shocks. These may lead to abrupt biosphere changes, changes that a previously resilient biosphere could absorb.

The networked features of global change and the resulting risks that emerge from them create a new planetary reality. Our economies and the financial sector play a key role as societies strive to avoid maladaptation and instead enhance resilience including transformative capacities (Olsson et al., 2022; Biggs et al., 2012, Folke et al., 2005) to what is likely to become a more turbulent future.

Chapter 2. *Finance and Our Living Planet*

Investments are key to a transition to a net-zero world, climate stability and biosphere stewardship. The institutions that mediate these capital flows are therefore central to our ability to shift our economies in a direction that promotes a thriving planet. This chapter elaborates how investments impact on key biomes linked to "tipping elements" in the Earth system, and ecosystems all over the world. It also presents a synthesis of current understanding of domino-effect and feedback risks between climate, ecosystems and the financial sector. The chapter concludes with a discussion about how a new planetary reality changes the way systemic risks are understood and dealt with in the financial sector.

Investments, and the financial institutions mediating capital flows, are increasingly viewed as instrumental for the transformation needed to achieve a prosperous future for all (Crona et al., 2021). Today's globalized economy relies heavily on the financial sector to allocate capital for its operation. The influence and responsibility of financial actors to contribute to a transformation towards a just and safe future for all thus becomes increasingly clear, particularly for economic sectors that have tangible impacts on ecosystems and people's livelihood dependencies. Examples include tropical and boreal forests (Galaz et al., 2018a), oceans (Jouffray et al., 2020), and many habitats around the world which are critical for biodiversity, indigenous communities and for sustaining ecosystem services (Yang et al., 2021; Dempsey et al., 2022).

The growing interest in "green," "net zero," or "climate friendly" investments in the last decades is in many ways a reason for hope. The number of signatories of the *Principles for Responsible Investment* (PRI) reached 4,000 this year (Segal, 2021). A synthesis conducted by the Global Landscape of Climate Finance (2021) recently showed that total climate-related financial investment has steadily increased over the last decade, reaching USD 632 billion in 2019/2020. New estimates show that almost 40% of all assets managed in European Union-domiciled funds in 2021, are marketed as "sustainable" (Wilkes, 2022). The International Monetary Fund's analysis show a similar global trend with a record-high growth in 2021 for Environmental, Social and Governance (ESG) debt issuance reaching USD $1.6 trillion (+116% compared to 2020, from IMF, 2022). This growth is likely to continue as countries and financial institutions such as the Glasgow Financial Alliance for Net Zero (GFANZ) and multilateral development banks follow up on their commitments after COP26 and the Glasgow Climate Pact (Robins and Muller, 2021).

The limits of "green" and "sustainable" investments

While this growing interest should be a cause for optimism, there are still considerable challenges facing the world's ambitions promote transformations towards sustainable societies and economies through an increased engagement from the financial sector. For example, while ESG and climate investments have certainly seen a rapid growth in the last decade, the increase in climate finance is not yet enough to help achieve the Paris Agreement target of limiting global warming to 1.5°C above pre-industrial levels (Climate Policy Initiative, 2021), nor the ambitions of the Sustainable Development Goals (OECD, 2021). Despite this emphasis on greener investment and the global rhetoric to "build back better" since the beginning of the COVID-19 pandemic, G20 countries have still directed around USD 300 billion in new funds towards fossil fuel activities (SEI et al., 2021).

Recent analyses also show that the combined economic effects of the COVID-19 pandemic in combination with the war in Ukraine are widening the economic gap between rich and poor countries of the world. Many developing countries were forced to cut budgets for education, infrastructure and other capital spending during the pandemic. The war in Ukraine seems to put these countries in an even more challenging situation with higher energy, food and other commodity prices, higher inflation, and increased volatility in financial markets (United Nations Inter-agency Task Force on Financing for Development, Financing for Sustainable Development Report, 2022).

The challenge is not only related to the total volumes of funding, but also to which sectors these investments are directed. The financial sector has for a long time centered their work on sustainability on the reporting of GHG emissions and capture. As a result, financial risks are consistently viewed to evolve from climate change alone, rather than from the wider suite of changes in ecosystems and the Earth system (Crona et al., 2021). While a number of recent initiatives have tried to broaden the scope to also include a wider range of ecological and environmental changes (such as the *Taskforce on Nature-related Financial Disclosures: TNFD*), it is clear that both governments and investors are underdelivering in preparing for a more turbulent future. For example, of the $3.38 trillion of proposed longer-term post-covid recovery investments, only 15% is currently "green" with a focus on cutting greenhouse gas emissions or air pollution, with just 3% directed towards contributing to a more resilient biosphere (Rockström et al., 2021, p. 4).

The strong interest amongst policy-makers and the financial sector around SDG-classified investments and ESG-funds also overlooks some of the more complex political and economic drivers that undermine the protection and stewardship of ecosystems and the biosphere. These includes (as we elaborate in Chapter 3) harmful subsidies, tax avoidance and evasion, and national debt in developing countries which all pose serious obstacles to the protection of nature and biosphere stewardship (Dempsey et al., 2022; Galaz et al., 2018b). As we also elaborate in Chapter 4, current metrics of Environmental, Social, and Governance (ESG) risk and financial materiality have serious shortcomings, and are not likely to help either governments or the financial sector to prepare to our new planetary reality (Chapter 1).

Finance on a changing planet

This section takes a closer look at how the financial sector is currently contributing to the profound transformation of ecosystems, biomes and our living planet. We also explore the state of knowledge about the combined impacts on the financial sector created by interacting changes between climate and ecosystems.

Sleeping Giants in the Climate System*

Large-scale shifts in the climate have occurred in the history of planet Earth before. Climate tipping elements are key to understanding this phenomenon, and for evaluating the risks of such shifts happening again (Lenton et al., 2008). As we elaborated in the previous chapter, both past evidence, climate models and current observations indicate that parts of the Earth System and associated processes can cross shift rapidly, changing their internal dynamics and driving feedbacks with large impacts on the climate system as whole. This is why these tipping elements also have been referred to as "sleeping giants".

Two important terrestrial 'sleeping giants' are the Amazonian and boreal forests. Both are sensitive to rising temperatures and changes in rainfall. These biomes are also under pressure from economic activities, such as logging, mining and deforestation caused by expanding agriculture production. The Amazon rainforest is also the world's most biodiverse biome and pulls large amounts of carbon out of the atmosphere. It supports the livelihood of millions including indigenous communities (Garnett et al., 2018) and holds between 135 and 180 billion tons of carbon in its soils, trunks and roots (Steffen et al., 2018). Almost 20% of the Amazon forest has disappeared since the 1960's to give place to infrastructural development and agricultural activity, such as soy production and cattle ranching.

Modeled estimates indicate that the Amazon rainforest is close to crossing a tipping point where major parts of the forest could begin a process of die-off and gradually turn into a savanna-like state. Models estimating such shift, based on only temperature rise or deforestation in isolation, show these to occur at temperature increase of 3-5°C or 40% loss of original tree cover (Salazar et al., 2007; Sampaio, et al., 2007). However, more recent analyses suggest that deforestation in combination with warmer temperatures and increasing forest fires could lead to the transgression of a tipping point as early as at 20-25% deforestation of pristine levels – only slightly more than the current levels (Lovejoy & Nobre, 2018). If the Amazon were to "tip" into a savanna-like landscape it would store vastly less carbon, it would likely burn more often, and taken together it would turn from a net carbon sink to a net carbon source (total carbon flux minus fire emissions). There are indications that this process has already begun (Gatti et al., 2021), and thus all measures to halt this biome's progress towards a tipping point are necessary and urgent. In its 2021 synthesis, the Intergovernmental Panel on Climate Change (IPCC) noted that abrupt responses and tipping points cannot be ruled out (IPCC, 2021a). IPCC also noted that the Amazon could cross a tipping point during the 21st century due to the combined stresses created by deforestation and a warming climate.

* This section builds on Galaz et al., 2018b, and Gaffney, et al., (2018). *Sleeping financial giants – Opportunities in financial leadership for climate stability*. Global Economic Dynamics and the Biosphere programme (Royal Swedish Academy of Sciences), Future Earth, and the Stockholm Resilience Centre (Stockholm University).

Boreal forests are the largest biome on land and play a critical role in the climate system. These forests sprawl across Canada, Russia, Alaska, and Scandinavia. They comprise about 30% of total forest area on the planet and store vast amounts of carbon (about 340 billion tons). The combination of rising temperatures, as well as increased insect attacks, intensity and frequency of wildfires, and logging activities are leading to decreases in boreal forest cover and increasing carbon emissions. Research indicates that as much as 40 billion tons of carbon could be emitted by boreal forests to the atmosphere by 2100 with a 2°C temperature rise, and even more if a tipping point is crossed. This tipping point is currently estimated to lie somewhere around a 3-5°C rise in global average temperature. Changes in these forests will most likely also affect surface albedo (e.g. dark forests absorb heat, white snow reflects heat), potentially amplifying Arctic warming (from Steffen et al., 2018).

The connection between the financial sector and a changing Earth system might seem vague at first glance. As recent studies indicate, however, financial institutions and investments are contributing to the destabilization of sleeping giants in the climate system (Galaz et al., 2018a, b). In simple terms, investors provide capital through equity, loans and bonds to companies producing or trading soy, beef, timber, pulp, paper, and other commodities. These economic activities constitute stromg drivers behind changes in forests that undermine the stability of sleeping giants, such as the Amazon rainforest and the boral forests. Companies operating in deforestation prone sectors in the Amazon for example, receive considerable financial flows from not only national development banks and other direct subsidies (Nepstad et al., 2014), but also through international loans and payments. Data shows that a majority of the latter capital flows are transferred from or via tax haven jurisdictions, creating serious challenges for transparency and tax fairness, and as a result also for sustainability and biosphere stewardship (Galaz et al., 2018b, we elaborate on this issue in Chapter 3). The direct funding of economic activities that undermine natural capital and resilience is a general and global problem. According to the influential *Dasgupta Review on the Economics of Biodiversity*, “existing private financial flows that are adversely affecting the biosphere outstrip those that are enhancing natural assets, and there is a need to identify and reduce financial flows that directly harm and deplete natural assets” (p.474) (Dasgupta, 2021).

Figure 3 below illustrates this important point, and shows the two types of investments (equity and credit) to trading companies operating in two major deforestation-

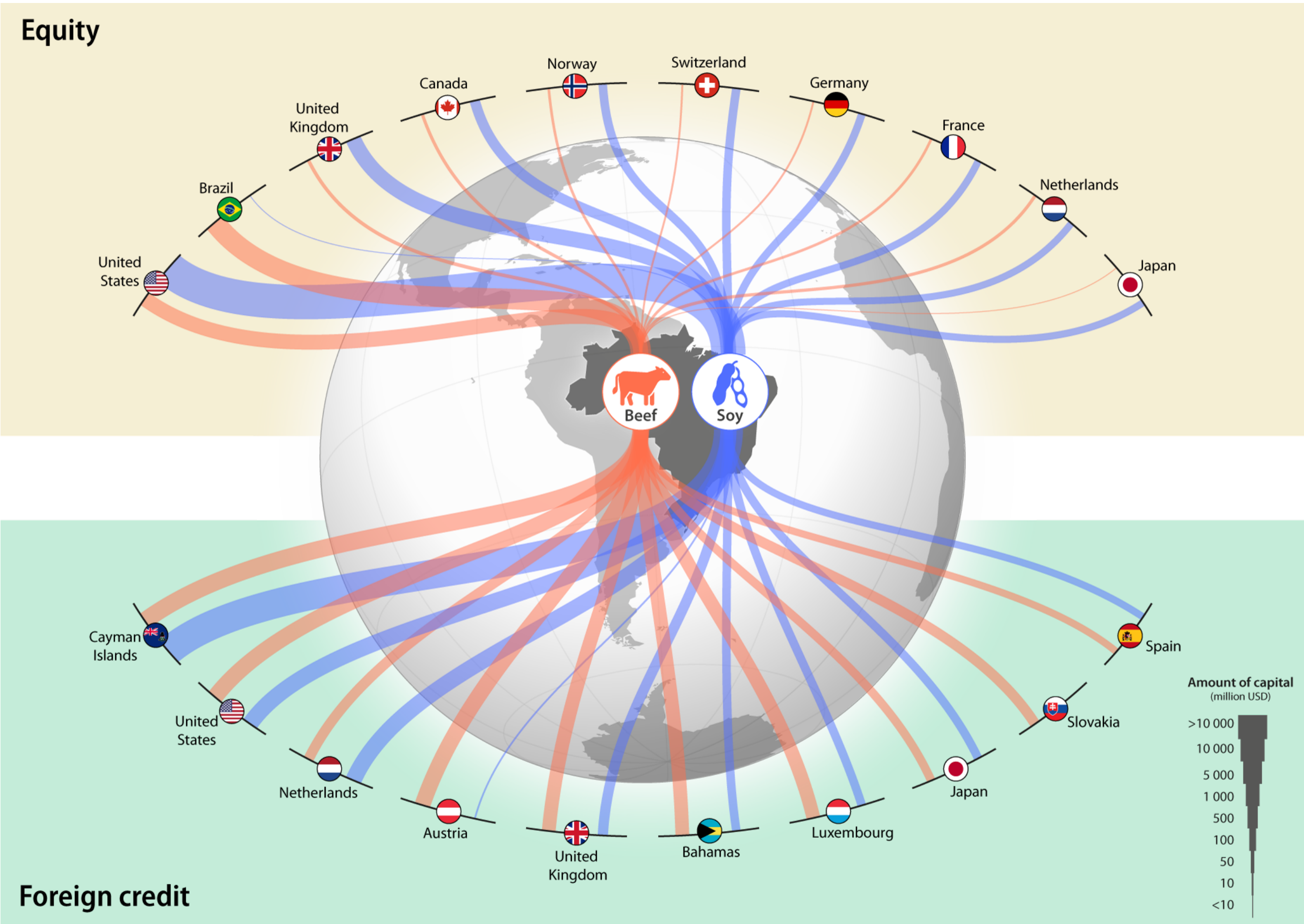


Figure 3 | Equity, and foreign credit to deforestation-risk economic industries in the Brazilian Amazon. The data from this image is based on the methods and analysis presented in (Galaz et al., 2018a and Galaz et al., 2018b). Updated data from these cases have been provided by Ami Golland (equity, based on data from Orbis values for year 2018) and by Alice Dauri-ach (foreign credit, based on data from the Brazilian Central Bank, 2000-2018).

risk industries operating in the Brazilian Amazon: soy and cattle. The top of the image shows the investments of the top-10 countries through stock ownership in nine strategically selected companies operating in these two sectors. The bottom of image shows the total credit received by the same companies from corporations and financial institutions (such as banks) located outside of Brazil during the years 2000-2018. The global nature of ownership is notable, with US-based financial institutions clearly on a leading position. Another insight is related to the prominent role tax haven jurisdictions (such as the Cayman Islands and The Bahamas) play for foreign credit to these industries. The selected companies received a total of USD 21.5 billion in foreign credit from tax havens over the period, which represents 57.6% of all their declared foreign credit. As we elaborate in Chapter 3, such extensive uses of tax haven jurisdictions are associated with numerous problems that undermine sustainability and biosphere stewardship.

As we elaborate in detail in Chapter 5, many prominent asset managers and financial institutions (including banks and pension funds) also have significant ownership in all sectors connected to the stability of the Amazon rainforest, and also boreal forests (Galaz et al., 2018a). While asset managers are rarely the underlying owners, they can be argued to have a duty of care to their investment beneficiaries to invest and use their influence in ways that promote economically, ecologically and socially sustainable activities. Large asset managers such as the "Big Three" asset managers BlackRock, Vanguard and State Street seem to play an underestimated, yet important role in this context through their relatively large combined ownership in industries with impacts on sleeping giants (see Chapter 5).

Ocean Finance*

Our planet's vast oceans are changing rapidly. The ocean covers more than 70 percent of Earth's surface, and plays a crucial role in the climate system. It provides ecosystem goods and services that sustain life and support the well-being of billions of people worldwide (Sumaila et al., 2020). The extent of human pressures on the world's oceans is unprecedented (Jouffray et al., 2021) and result from a changing climate, overextraction, direct habitat damage, and pollution (Sumaila et al., 2020). In parallel, ocean-based industries are growing at an unprecedented pace through technological innovation and increasing human demand for food, energy, material and space. The ocean is widely seen as the next economic frontier and as the solution for sustainable future human development. There are serious concerns, however, regarding who these developments benefit, stewardship of the ocean commons, and the emergence of unprecedented ocean risks that could have large impacts on vulnerable states and communities (Jouffray et al., 2021; Tokunaga et al., 2021; Blasiak et al., 2020).

Ocean finance can play a key role in assisting transformation towards sustainability, both as enablers and gatekeepers. In its first role, the finance sector can help bridge a vast "ocean finance gap" by acting in ways to unlock capital and increase finance to a resilient ocean economy for all. As Sumaila and colleagues (2020) show however, less than 1 percent (USD13 billion) of the total monetary value of the ocean has been invested in sustainable projects with a vast majority supporting large-scale activities that counter the delivery of the Sustainable Development Goals. In addition, SDG 14 ("Life Below Water) remains the least funded goals of all. While an estimated USD175 billion per year is needed to fund SDG 14 (Johansen & Vestvik 2020), it received just below USD10 billion in total over the period 2015-2019 (OECD, 2021).

The financial sector can in principle, act as gatekeepers by deciding what to finance and under which conditions. Indeed, as much as the ocean finance gap is a reality when it comes to sustainable investments, the 'Blue Acceleration' also illustrates that billions of dollars are currently entering the ocean economy and fueling the development trajectory of ocean sectors with little if any sustainability consideration. A focus on who and what is financing this Blue Acceleration can therefore unlock powerful leverage points to redirect corporate finance (Jouffray et al., 2019).

Harmful subsidies through for example government payments that incentivize overcapacity and lead to overfishing, for example, remains a major concern. Such subsides not only have major environmental implications, but also threaten low-income countries that rely on fish for food sovereignty (Sumaila et al., 2021). The extensive use of tax haven jurisdictions and the limited engagement by the financial sector on issues of tax fairness also remain as serious obstacles as the world strives to combat illegal and unregulated fisheries around the world (Belhabib & Le Billon, 2020; Ford & Wilcox, 2019; Galaz et al., 2018b).

Zoonotic Disease Risks

Zoonotic diseases are on top of global agendas due to the COVID-19 pandemic. The impacts of emerging and re-emerging infectious diseases on human health and societies can be devastating as illustrated by Ebola, SARS, MERS, and COVID-19 whose impacts propagate through trade connections, travel networks, and fragile health systems and communities (Di Marco et al., 2020). The specific mechanisms that connect factors such as climate change, deforestation and urbanization with the emergence and re-emergence of such diseases are complex (Alimi et al., 2021;

* This section is based on Jouffray J-B, Blasiak R, Nyström M, Österblom H, Tokunaga K, Wabnitz CCC, Norström AV (2021). *Blue Acceleration: an ocean of risks and opportunities*. Ocean Risk and Resilience Action Alliance (ORRAA) Report.

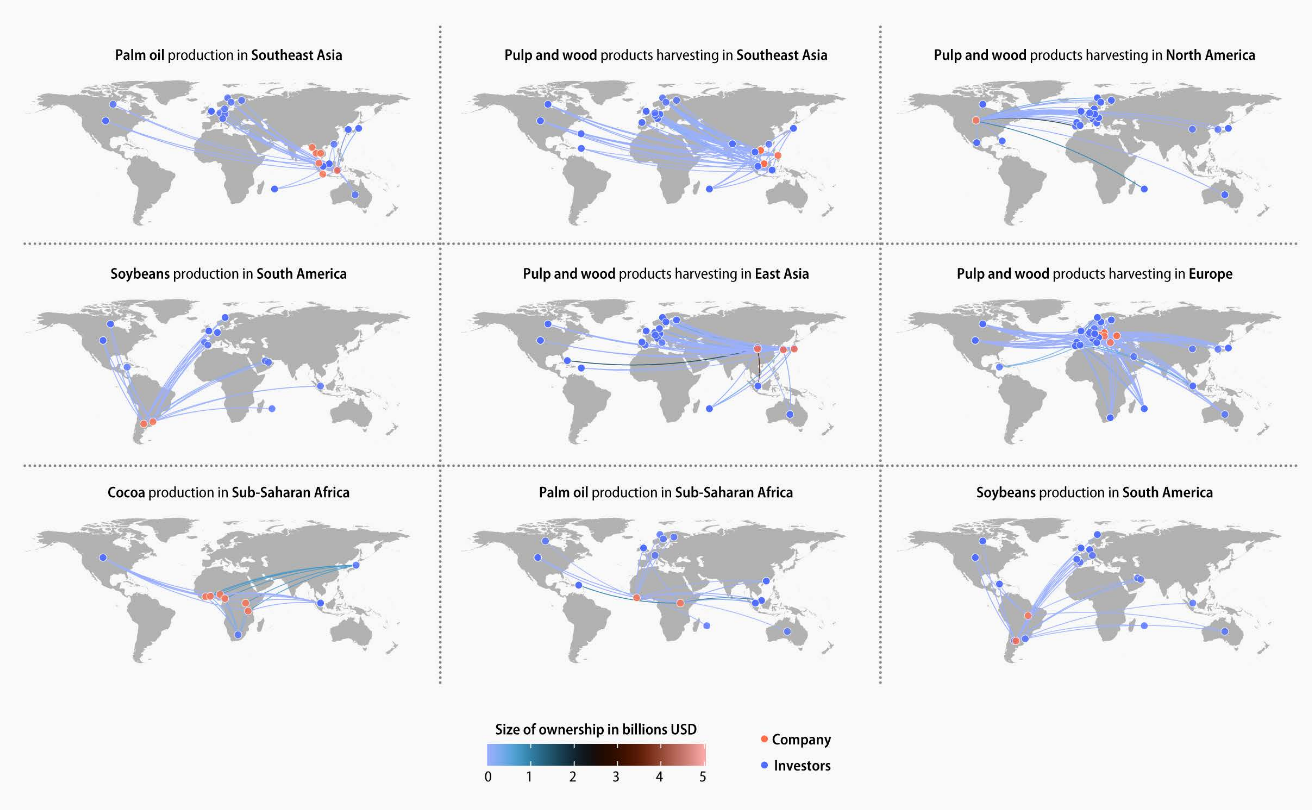


Figure 4 | Global connection of investments through equity. Financial investments shape our living planet, and indirectly also zoonotic disease risks through investments in industries associated with various forms of land-use change in known zoonotic disease hot-spots. The figure shows the global characteristics of such investments in nine identified hotspots, as well as the respective investment size through equity in USD. Purple nodes are where companies and investors overlap geographically. Note that the figure is a simplified data-based illustration. Source: (Galaz et al., 2022).

Carlson et al., 2021). There is an increasing recognition that various forms of environmental and ecological changes, including deforestation, the expansion of agricultural land, and increased hunting and trading of wildlife can be linked to the emergence of such diseases (Allen et al., 2017; UNEP and ILRI 2020; Di Marco et al., 2020). Zoonotic risks are also likely to increase substantially in the near future due to the combined effects of climate and land-use change (Carlson et al., 2022).

To what extent financial investments affect zoonotic disease risks has yet to be explored in detail however. This is critical because financial investments in economic sectors that increase deforestation risks or that lead to the expansion of agriculture, in addition to their direct impacts, may lead to increased zoonotic spill-over. Indeed, reduced biodiversity, land fragmentation and habitat loss create new patterns of interactions between pathogens, non-human animals, and humans.

Figure 4 summarizes our analysis of the connection between investments (through equity) in industries with known connections to zoonotic disease risks. The selected circled regions and biomes have been identified by Allen and colleagues (2017) as "hot-spots" where emerging and re-emerging disease risks are primarily driven by anthropogenic land-use change. Our analysis has a number of limitations that we elaborate in (Galaz et al., 2022). It is important to note however, the global nature of financial investments associated with increased emerging and re-emerging disease risks. Quantifying these risks is challenging, but also illustrates the following. First, it illustrates how our changing planetary reality produces novel and poorly understood domino-effects and systemic risks to the finance sector. Second, it shows the responsibility of financial institutions to acknowledge that they are not only influenced by planetary change, but in fact are contributing to these changes directly and with possible large repercussions.

Domino-effects and systemic risks

Our understanding of the direct impacts on the financial sector by climate change has grown considerably the last years. However, the largest and least predictable risks of a changing planetary system are likely to be those that emerge from second-order or domino effects, which make them difficult to quantify with precision. Battiston and colleagues (2017) for example, note in their analysis of data for shareholders of listed firms in the European Union and in the United States that climate related financial risks are not only direct, but could be considerable due to the interconnected features of financial investments. The United States Financial Stability Oversight Council noted in its report in 2021, that while climate change could be viewed as an emerging threat to financial stability in the U.S., there was also

Box 1. How much do we know about financial risks created by domino-effects across climate and ecosystems?

There is a growing recognition that changes in the climate system and ecosystems are closely integrated, posing novel and unfolding risks to the financial sector. Environmental-related risks are often classified into physical and transition risks. Physical risks arise from changes in weather patterns or other environmental changes, such as the impacts of droughts or floods on company operations or physical infrastructure. Transition risks emerge as the result of policies or shifts in consumer values that emerge as a response to, for example, national or international climate targets. Both physical and transition risks are expected to have an impact on the likelihood and magnitude of other financial-related risks including market and credit, insurance, operational, and liability risks. Understanding how interacting climate and ecosystems risks affect the financial sector is becoming increasingly urgent. Our systematic literature review of 75 selected publications shows that, while there is a growing interest in climate related risks, their connections to ecological change is systematically underdeveloped. Existing research including data availability and methods development also have a heavy emphasis on financial risks towards European and USA-based financial institutions, thus ignoring potentially large impacts on fragile countries and other large economies such as India, China and Brazil.

From: Sanchez et al., (2022)

a critical need to "improve the availability of data and measurement tools, enhance assessments of climate-related financial risks and vulnerabilities, and incorporate climate-related risks into risk management practices and supervisory expectations for regulated entities […]" (FSOC, 2021, p.3).

There is also a growing interest in financial risks resulting from the loss of nature and biodiversity tied to forest, food, and land sector, each entailing complex domino effects between financial investments, climate and ecosystems (Kedward et al., 2020; Crona et al., 2021; see van Toor et al., 2020 for an analysis of these for the Netherlands; McCarthy & Piotrowski, 2022 for the United States; Svartzman et al., 2021b for France; ECB, 2021; Johnson et al., 2021). Biodiversity loss such as the decline in pollinator species for example, could affect global food production and as a result, cause commodity price inflation. Economies that to a larger extent depend directly on the productivity of natural resources such as agriculture, fisheries, forestry, could also see their sovereign debt affected by the loss of biodiversity and the degradation of ecosystem services (Agarwala et al., 2022). For example, recent modeling results indicate that abrupt negative changes in ecosystems by 2030 could be more damaging than the COVID-19 pandemic to Indonesia's debt sustainability (NFGS-INSPIRE, 2022: p. 50f).

Current risk frameworks also seem unable to grapple with the interactions between climate, ecosystem and financial systems, and the potential for cascades and threshold effects (tipping points) (Crona et al., 2021; NFGS-INSPIRE, 2022). Such complex systems behavior challenges conventional notions of climate risks created by, and to the financial sector. As summarized in (Crona et al., 2021), there is an urgent need to rethink such risks from direct, short-term and linear, to indirect, long-term and non-linear. Our review of the literature in this domain shows that such risks indeed are poorly understood, and thus remain a critical area of inquiry and policy-making (Box 1).

Seizing the opportunity – the power of investors to accelerate action for biosphere stewardship

The financial sector can play a key role in supporting actions for biosphere stewardship, thereby helping to accelerate a just transformation that builds, rather than undermines, resilience of our home. Seizing this opportunity will require deep changes in the way it perceives and acts on its influence. The finance sector can engage in promoting the sustainable and equitable stewardship of key biomes including the world's oceans and marine resources in several ways. We summarize some of these leverage points below, many of which apply across the cases earlier discussed in this chapter.

Leverage points for influence

Debt and equity offer potentially powerful pathways for influence in industries that are modifying our living planet and climate system (see Box 2).

The last years have seen an increased interest by the financial sector to use this influence, in particular to help slow down deforestation in the Amazon in the last years. One noteworthy example of this includes a letter by 230 investors with over USD16.2tn in assets under management calling on companies to take urgent action after the intense deforestation-linked fires in the Amazon in 2019. During COP26 in Glasgow in 2021, over 30 asset managers with more than USD8.7tn in assets under management pledged to tackle agricultural commodity-driven deforestation. However, similar investor initiatives focusing on tackling rapidly changing boreal forests are still lacking. Furthermore, recent analyses reveal a systematic lack of policies relating to and engagement in deforestation risks from the financial sector (Thomson, 2020), including a majority of the institutions that signed the mentioned public investor letter (Global Canopy, 2020).

Box 2. Understanding the influence of shareholders

Shareholders have three different ways to influence publicly listed corporations: First, investors might (threaten to) divest from companies by selling their shares. Investors in index funds, however, are not able to divest from individual firms because they track entire indices. Moreover, the material effects of divestment have been found to be small at best (Plantinga & Scholtens, 2021; Broccardo et al., 2020; Cojoianu et al., 2021) – even though there may be an important ideational impact by the divestment movement through challenging the 'social license to operate' of fossil fuel firms (Jahnke, 2019). The main reason that divestment does not have a significant material effect is that the vast majority of publicly listed firms do not finance themselves by issuing new shares, but via retained profits or by issuing bonds. Hence, it is not possible to 'starve' fossil fuel firms of capital by investing only in "green" or ESG funds. Second, shareholders (that is, primarily their asset managers) can use the influence provided by their shares for voting at annual general meetings, including the election of new board members (Krahnen et al., 2021). Finally, asset managers are thanks to their ownership able to influence the top management of their portfolio firms via private engagements. Voting and engagements have been found to offer the highest impact (Kölbel et al., 2020).

Financial influence can at times be concentrated in the hands of a limited number of investors (see also discussion in Chapter 5). Previous research has referred to these powerful investors as "sleeping financial giants" in the case of forest biomes related to tipping elements in the climate system (Galaz et al., 2018b; Gaffney et al., 2018). In partnership with other financial institutions, these investors could help change the destructive path of key biomes. In addition, such giants could help develop investments that explicitly promote the resilience of critical biomes by engaging with companies and forming alliances with similar minded investors. Examples of topics for engagement include measures to achieve effective zero deforestation in supply chains; design of effective and fair tax policies; and the promotion of forest rehabilitation through reforestation, afforestation, and forest management practices protecting human rights and biodiversity (from Gaffney et al., 2018, see also Nobre & Nobre, 2020 for the Amazon, and Astrup et al., 2018 for boreal forests).

There are other ways that the financial sector can – and should – engage to contribute to actions towards biosphere stewardship. Banks for example, are particularly influential given their ability to monitor companies in detail and to tailor loan terms (Jouffray et al., 2019). The so-called *Poseidon Principles*[*] for example, provide a sector-specific framework for integrating climate considerations into lending decisions and promoting shipping decarbonization. The signatories – 27 leading banks jointly representing US $185 billion, or about half of global shipping finance – incentivize shipowners to decarbonize their fleets by lowering their interest rate as they decrease their emissions.

Multi-lateral development banks (MDBs) can play an important role as well. MDBs and public sector financing can help de-risk investments by the private sector, and also are a ready source of (too rare) investable projects for private sector investors. Ten multi-lateral development banks recently pledged to "further mainstream nature into our policies, analysis, assessments, advice, investments, and operations, in line with our respective mandates and operating models".[**] Together these banks disburse over US $220 billion annually. Over the past decade, they have begun driving this shift, through a suite of nature-positive investment priorities, demonstrated in numerous countries and sectors, and now being scaled and standardized (Mandle et al., 2019).

Stock exchanges are also interesting in the context of sustainability disclosure and performance as they can act as regulatory bodies via their listing rules, both at the time of the listing and on an annual basis. The Tokyo Stock Exchange alone, for example, alone concentrates 53% of the combined revenue of the world's largest 45 publicly-listed seafood companies, while the exchanges of Tokyo, Oslo, Korea and Thailand together account for 86% of revenues (Jouffray et al., 2019).

Insurance companies too, can act as powerful gatekeepers for sustainability. Sumaila et al. (2020) outline three key roles in particular: institutional investors – by choosing to support clients and projects that contribute to sustainability and divesting from those that do not; risks managers – by communicating recommendations for more sustainable practices to their clients; and risks carriers – by prohibiting or restricting access to insurance to clients that engage in unsustainable or illegal practice. An example here would be the coalition of insurers against illegal, unreported and unregulated fishing (Olano, 2017).

Reconceptualizing risks

Each of these pathways of influence for the financial sector can complement each other, and in principle offer a forceful support for ambitions to accelerate climate and sustainability action. Addressing the connected nature of

* See https://www.poseidonprinciples.org/finance/

** Joint Statement by the Multilateral Development Banks: Nature, People and Planet, online https://ukcop26.org/mdb-joint-statement/

risks will not only require investors to engage in new ways and on new topics, but also new methods to assess such risks.

Translating climate risks including physical, transition and liability risks into actionable information for the finance sector remains highly challenging (NFGS, 2018; Fiedler et al., 2021). Additionally, improved accesses to data, risk disclosure policies, refined risk models and stress testing will have its limitations however. Chenet and colleagues (2021) argue that climate-related financial risks are characterized by radical uncertainty whereby the probabilities of different outcomes are impossible to calculate (see also Bolton et al., 2020). Such uncertainties can be created by for example multiple possible climate futures, and the complex pathways and propagation mechanisms that connect climate change to on-the-ground impacts. The fact that many of these risks lack historic precedent pose additional challenges to conventional financial risk management tools and indicators (Chenet et al., 2021; Crona et al., 2021; Kedward et al., 2020) because past behavior may not be sustained. This point has been made repeatedly by ecological economists exploring the connections between economic policies and the non-linear features of ecosystems and the climate (Crépin & Folke, 2015).

With these considerations in mind, a precautionary approach to financial policy and regulation could be more apt for our new planetary reality. Such policies focus on the stability of the system as a whole by mitigating the systemic financial risks, rather than on the regulation of individual institutions is one such proposed approach (Chenet et al., 2021; Kedward et al., 2020). One central feature of such policies is their empowerment of central banks and supervisory authorities by granting them with the mandate and tools to prepare for worst-case scenarios, and act in ways to reduce the likely emergence of instability before market participants recognize the surfacing of risk and adjust their behaviors. The identification, exclusion, or discouragement of activities that increase deforestation risks as one example, could be done via such policy tools (Kedward et al., 2020). A precautionary approach to financial policy and regulation requires the development of core indicators rather than on sophisticated risk modeling (Chenet et al., 2021). Chapter 4 elaborates on such indicators in more detail, and Chapter 5 explores the tentative influence of central banks and financial regulators on these matters. We put these recommendations in a broader context in the report's final Chapter 7.

Chapter 3. ***The Co-Evolving Nature of Inequality***

Inequality is persistent, and associated with multiple social and health problems. Risks are being exacerbated by current Anthropocene challenges. As the world strives to accelerate action toward sustainability, inequality may, therefore, prevent socially sustainable solutions. High-income countries carry a larger responsibility for the new planetary reality and its detrimental consequences. This chapter focuses on the interplay between inequality and the biosphere, and high-income countries' responsibility for ecological break-down. It presents the vicious cycles of inequality related to human and biosphere relations. The chapter also discusses the reinforcing role that tax havens have on inequality and environmental destruction.

Inequality is a persistent feature of today's world, and brings about disparities in people's ability to cope with a new planetary reality (Chapter 1). Moreover, high levels of inequality are associated with higher levels of societal and health problems, including physical and mental health, drug abuse, education, obesity, trust, and violence (Wilkinson & Pickett, 2009; Pickett & Wilkinson, 2015). This holds for both low- and high-income countries. The levels of income inequality differ dramatically between countries. In China, Europe, and the United States combined, the top 1% share 33% of total wealth today, while the bottom 75% share only around 10% (Zucman, 2019). Greater inequality in a society may lead to weaker economic performance and cause economic instability (Stiglitz, 2012). Furthermore, increasing income inequality may also lead to more societal tensions and increase the risks of conflict (Durante et al., 2017). Wealth discrepancies across countries can undermine the achievement of agreements and actions to tackle global problems such as climate change (Vasconcelos et al., 2014). High inequality is also linked to a lack of social trust (Kanitsar, 2022). As inequalities are persistent, they need to be actively counteracted to improve societal outcomes.

Inequity and vertical and horizontal inequality

While inequality simply refers to an unequal distribution of, e.g., resources, inequity implies that there are perceptions of a lack of fairness underlying differences in opportunities to acquire those resources. Inequity, therefore, highlights the need to account and compensate for unfair competitive disadvantages among individuals or systems to avoid reinforcing cycles of inequality. Inequality can be either vertical or horizontal. Vertical inequalities occur between people in a given society and can relate to incomes or educational attainment. Horizontal inequalities are inequalities between groups that share similar characteristics, for example, ethnicity or gender, and can be referred to as group inequality (Stiglitz et al., 2019). High levels of group inequality have been associated with discrimination, conflict, and lack of concern for the commons, which hampers socio-economic development and the handling of natural resources in ways that benefit society (Collier, 2007; Hillesund et al., 2018).

Inequalities and ecological breakdown

Differences in the wealth of nations are mirrored in the socio-economic and environmental trends of the 'Great Acceleration' (see Chapter 1; including, e.g., GDP, investments, and water use, all of which are higher in rich countries). Consumption in high-income nations whose populations represent 16% of the world population is responsible for 74% of the global excess use of materials, including biomass, metals, non-metallic minerals, and fossil fuels (Hickel et al., 2022). The USA alone is responsible for 27% of this global excess use, EU-28 high-income countries 25%, while China is responsible for 15%. The rest of the Global South (including low-income and middle-income countries of Latin America and the Caribbean, Africa, the Middle East, and Asia) is responsible for only 8% of the global cumulative material overshoot (Hickel et al., 2022, see Figure 5). Similarly, estimates of ecological footprint have also pointed to

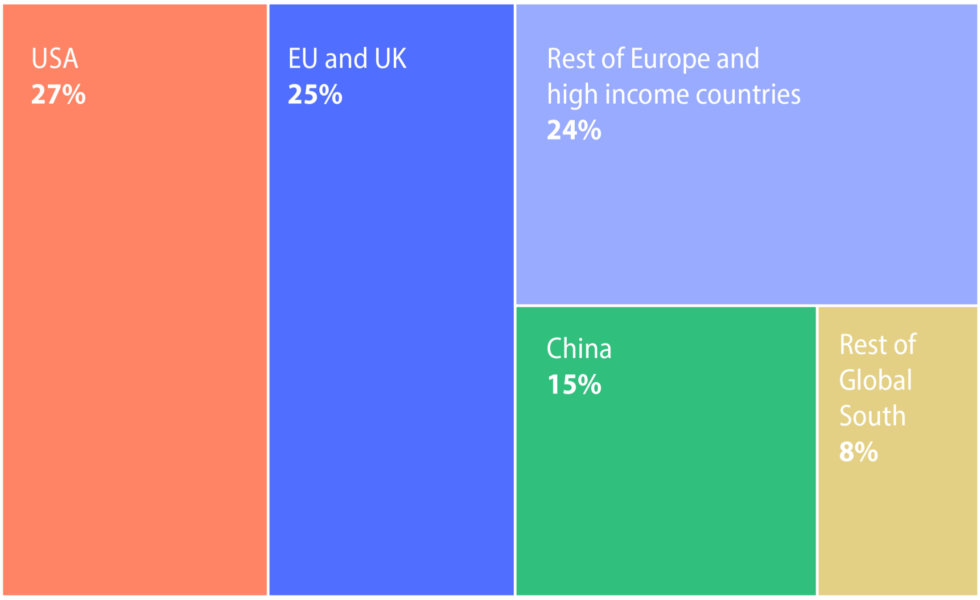


Figure 5 | Responsibility for excess resource use, 1970-2017. USA, Europe, and other high-income countries are responsible for 76% of excess resource use at the end of the analysis period. China is responsible for 15%, and the rest of the Global South is responsible for 8%. Source: Hickel et al., 2022.

this disparity between nations where close to 50% of humanity's impact on the biosphere can be attributed to some 16% of the global population (Barrett et al., 2020).

The interplay between inequalities and the biosphere

While the actions of a limited number of high-income countries and individuals have disproportionate impacts on the biosphere, the consequences of a degraded biosphere tend to have more severe impacts on low-income countries and/or individuals, resulting in amplified inequalities in society (Hamann et al., 2018). For example, Jafino et al. (2020) suggest that up to 132 million people will be pushed into extreme poverty by climate change by 2030. This increase is expected to result directly from the consequences of global warming, and from the costs of mitigation and adaptation. The expected impact on the poorest has been characterized as a "vicious cycle", whereby *initial* inequality makes disadvantaged groups suffer *disproportionately* from the adverse effects of climate change, resulting in greater *subsequent* inequality (Islam & Winkel, 2017, p.2). This outcome stems from the varied exposure and susceptibility to climate change, as well as different abilities to cope with harmful conditions.

A more concrete example includes the Netherlands and Bangladesh, two low-lying countries, at high risk of rising sea levels due to global warming. The Netherlands, however, is a high-income country with capacities to build infrastructure and social preparedness to limit the impacts of rising sea levels. Bangladesh, on the other hand, does not have the capacity to develop large-scale coastal protection projects, and is therefore likely to suffer greater consequences from rising sea levels. Simultaneously, the Netherlands plays a much larger role in global warming, with current emissions of 8.8t CO_2-eq. per capita compared to only 0.5t CO_2-eq. per capita in Bangladesh (Climate Watch, 2020). Additionally, the Netherlands is also responsible for a greater share of historical emissions (Friedlingstein et al., 2021).

Hence, high-income economies, like the Netherlands, with disproportionate impacts on climate and the larger biosphere, are better prepared for dealing with risks, shocks, and surprises compared to countries like Bangladesh, which have had a relatively small historical environmental imprint. Gradual environmental change, more frequent extreme weather events, and pandemics, alongside limited capacities to mitigate consequences, risk worsening the consequences and exacerbating inequalities among countries. As referenced above, disproportionate pressures on the poorest may force people back into poverty and trigger social tension, conflict, and migration (World Bank, 2022). Given the likelihood of a rapidly changing planet with new systemic risks (see Chapter 1), the global community will need to address vicious inequality cycles (Figure 6) to achieve just futures on a thriving planet. The case study in Box 3 illustrates how historical heritage can give rise to unequal preconditions that limit resilience to shocks on the island of Hispaniola, home to both Haiti and the Dominican Republic.

Unequal access to biosphere resources

Access to biosphere resources may also be limited by unequal access to technology and know-how. For example, transnational corporations often extract, process, distribute, and profit the most from raw materials in low-income nations. They also have control over marine genetic resources by accumulating patents on genes, with a single corporation responsible for 47% of all registered marine sequences (Blasiak et al., 2018). On a global level, only a handful of transnational corporations are shaping the global intertwined system of people and planet through

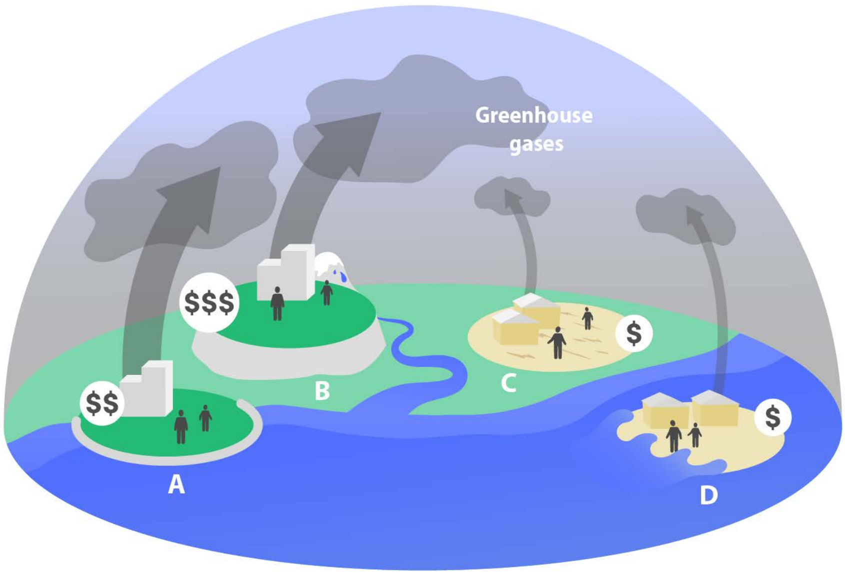


Figure 6 | The skewed distribution of responsibilities and vulnerabilities. While many high-income countries (A and B) carry a historical responsibility for high emissions that are causing global warming and sea level rises, some of them (A) also need to significantly adapt to these consequences and have the ability to do so. Other high-income countries (B) are less vulnerable to the direct consequences of global warming and therefore might want to spend less to mitigate its consequences. At the same time, lower-income countries (C and D) have limited historical responsibility for ecological breakdown, but are hurt at least as seriously by consequences. With fewer resources to adapt to or mitigate impacts of climate change, C and D are significantly burdened by potential shocks they did not create. Such shocks may include sea level rises causing flooding, as well as extreme weather events causing droughts. This exacerbates the inequality between countries and will have complicated consequences in our globalized society. This simplification, however, hides the fact that the rich populations in lower-income countries heavily contribute to excess resource use.

their extraction and use of ecosystem services (Chapter 5, Folke et al., 2019; Österblom et al., 2015). In addition, transnational corporations often benefit from low-income countries' weak institutions and lack of environmental protection regulation (Schneider et al., 2020).

Unequal access is also prominent for global commons such as fishing in international waters. International waters, also referred to as "the high seas", are areas outside the exclusive economic zones (EEZs) of nations, and make up two-thirds of the ocean, or roughly 50% of the surface area of the planet. Given that these waters are not under the jurisdiction of any nation they can be fished by anyone, which has resulted in the overexploitation of many species. For example, stocks of tunas have declined by around 60% during the last half-century (Sumaila et al., 2015). This is especially alarming as these fisheries often target high trophic fish in areas with low primary productivity that need long times to recover (Pauly & Christensen, 1995). Access to the high seas is largely limited to coastal nations with vessels geared for long-distance fishing. Vessels flagged to high income and upper middle income counties are responsible for 97% of the trackable industrial fishing on the high seas (McCauley et al., 2018). These counties are eroding the ecological riches of the planet, an injustice that probably will escalate in the coming decades as other industries (e.g., mining) move out into the oceans (Jouffray et al., 2020).

Disproportionate impacts on the biosphere as a result of market concentration may occur at any stage of a value chain. In Indonesia's palm oil industry, for example, corporate consolidation among palm oil processing facilities may put them in a position of power relative to independent smallholder oil palm farmers, especially since fresh palm oil bunches must be processed within days of harvest. The farms, in turn, may face market incentives to expand plantations and contribute to deforestation (Heilmayr et al., 2020). While some palm oil mills are engaging in dialogues and certification schemes such as the Roundtable on Sustainable Palm Oil (RSPO) to minimize deforestation risks, the documented impacts of certification on deforestation remains murky (Carlson et al. 2017). High global demand for palm oil, consumer markets that aren't generating significant premiums for certified palm oil, inefficient regulations, and the displacement of

Box 3. Historical heritage giving unequal preconditions, limiting resilience

Haiti and the Dominican Republic are both located on the island of Hispaniola, with largely the same ecological prerequisites, but with very different societal outcomes (Sheller & León 2016). Haiti is one of the poorest countries in the Western Hemisphere, while the Dominican Republic has a thriving tourism industry. Despite the Eastern part of Hispaniola, where the Dominican Republic is located, having slightly more favorable agricultural prerequisites, historical events and unequal treatment by colonizing powers have been more determining factors in the unequal prosperity of the two nations (Sheller & León 2016). The devastating effects of the 2010 earthquake and Hurricane Matthew in 2016 on Haiti have resulted in an even further escalating gap between both nations, as Haiti has had limited means to rebuild or mitigate the consequences of extreme weather events. This illustrates how reinforcing mechanisms can generate major inequalities between two nations with largely the same ecological conditions.

other forms of agriculture, are contributing to continued deforestation pressure in many parts of Indonesia. Creating a more equitable palm oil supply chain that does not result in deforestation requires collaboration among oil palm farmers, palm oil mills, and multinational corporations that integrate palm oil into their products. Special care should be taken to assure that achieving sustainability does not come at the cost of greater inequality via the exclusion of independent smallholder farmers from the value chain (Grabs et al. 2021). A better understanding of the interplay between sustainability initiatives and their impacts on individuals is therefore needed (Österblom et al., 2022).

Tax havens as reinforcing mechanisms of inequality*

The role that tax haven jurisdictions play in the global economy has gained considerable attention in international media. The terms 'tax havens', 'offshore financial centers', or 'financial secrecy jurisdictions' are debated, but they share the following features: zero or low taxes, lack of effective exchange of information; lack of transparency, and no requirement of substantial activity. The release of classified documents through leaks and investigative work like the 'Paradise Papers' in 2017, the 'Panama Papers' in 2016, and the 'Bahama Leaks' in 2016 all offer a rare glimpse into the way individuals, corporations, and financial institutions engage in aggressive tax planning, tax avoidance, and, at times, even money laundering, by exploiting the opacity offered by tax haven jurisdictions. One of the latest political events is the recent reporting about the connections between Russian oligarchs and billionaires, and the extensive use of tax havens as a means to avoid not only taxes but also international sanctions following Russia's war on Ukraine (Harrington, 2022; Tognini, 2022).

There is considerable case-study based evidence of the connections between uses of tax haven jurisdictions to channel investments to corporate activities, environmental degradation, and, at times, also environmental crimes. This includes investigative reporting on land deals linked to deforestation in Indonesia (Mongabay & The Gecko Project, 2019), and the mining sector in Zimbabwe (De Luca, 2021), Burkina Faso (Fitzgibbon, 2017), Sierra Leone, and Ghana (Stoddard, 2021). Both extractive activities have not only large negative environmental and social impacts, but can also lead to considerable losses of tax revenue due to aggressive tax planning through the use of subsidiaries located in tax haven jurisdictions. Recent estimates reveal that governments in sub-Saharan Africa are losing between $450 and $730 million per year in missing corporate income tax revenues as the result of profit shifting through tax haven jurisdictions by multinational companies in the mining sector (Albertin et al., 2021).

The extensive use of tax haven jurisdictions to transfer loans and payments also figures prominently in sectors that contribute to deforestation in the Brazilian Amazon, as well as to illegal, unreported, and unregulated fishing globally (Galaz et al., 2018a; Ford & Wilcox, 2019). As we showed in Chapter 2 (Figure 3), such uses by financial institutions and corporations remain an issue in sectors linked to deforestation in the Amazon.

While transfers to tax haven jurisdictions are not illegal *per se*, they are known to reduce financial transparency and undermine the capacities of national governments to promote biosphere stewardship and achieve the Sustainable Development Goals by eroding their tax base (Galaz et al., 2018a; Dempsey et al., 2022). Thus, such uses reinforce inequality by allocating economic resources and risks in unequal ways. Investors and governments can, and should, play an active role in trying to address these issues and promote tax fairness. One key aspect is related to the need for tax transparency in extractive sectors with a large impact on people and the planet. The work advanced by partnerships like the *Extractives Industries Transparency Initiative* (EITI) where countries commit to, for example, disclose information about beneficial ownership and strengthen public oversight of extractive sector agreements, is critical to inform public debate and decisions. Disclosure of beneficial owners of all companies in the extractive industry value chain, including subsidiaries, is also a key step in combating illicit financial flows.

However, investors as well as governments also must find ways to engage on tax fairness issues in concrete ways. The *UN Principles for Responsible Investment* (PRI) has highlighted the need for investors to view tax as a systemic issue that could undermine market performance and jeopardize overall portfolio returns by exacerbating inequalities and contributing to other negative consequences (Ravishankar, 2021). It is clear now that the lack of transparency offered by tax havens is playing a part in driving negative environmental and social outcomes in the extractives industries. PRI is encouraging investors to assess their investments not only from a tax efficiency perspective (i.e., minimizing tax liabilities while ensuring compliance with the letter, but not necessarily the "spirit" of the law), but also from a responsibility and fairness perspective i.e., by recognizing their fiduciary duty to address aggressive tax behavior and give due consideration to the broader societal consequences of aggressive tax planning (PRI, 2021). There are several ways in which investors can engage with companies on these matters (Karananou & Guha, 2015). Topics for engagement include asking companies about their use of tax havens to assess whether these are legitimate or not, and requiring large

* This section builds on the moderated online conversations *"Transparency, taxes and our planet – understanding the implications of financial opacity and tax avoidance on sustainability"* hosted by the Beijer Institute of Ecological Economics (Royal Swedish Academy of Sciences), and the Extractive Industries Transparency Initiative (EITI) on March 8th, 2022, as a contribution to this report and to Stockholm+50.

multinationals to disclose taxes paid in each country. Investors could encourage portfolio companies exposed to the extractives sector to ask their business partners for basic (beneficial) ownership information. Additional multi-stakeholder partnerships such as the *Addis Tax Initiative* (ATI) can also play a key role in this regard by mobilizing across governments, developing partners, civil society, and the private sector. Extractive sectors that modify the resilience of our living planet (see Chapter 2) should be prioritized as this work continues.

Concluding remarks

Inequalities are typically a product of historical injustices, often reinforced through persistent feedback loops between society and the biosphere (Hamann et al., 2018). Breaking these feedback loops, is, therefore, crucial for biosphere stewardship toward just futures on a thriving planet. In the meantime, the Anthropocene is bringing ever-increasing environmental challenges that are bound to amplify inequalities over the 21st century. While the most endowed are also those who contribute the most to triggering Anthropocene risks, the poorest are likely to be those who will suffer the most. Access to biosphere resources is unequal, and influential financial actors together with transnational corporations are in a better position to take advantage of vulnerable situations by exploiting resources under poor institutional stewardship. A signficiant shift, however, would come if these corporations chose instead to take leadership toward a just and sustainable future, which they should benefit from too in the longer run. Equitable solutions are urgently needed to strengthen the resilience of the biosphere, where those in most need should be given the opportunity to prosper while restoring just biosphere stewardship. After all, the ultimate goal is to establish and sustain the conditions necessary for current and coming generations to live and thrive in a resilient biosphere.

Chapter 4. Indicators for people and planet

Indicators can track progress towards just futures on a thriving planet. The new planetary reality requires indicators that make the human dependence on a well-functioning biosphere explicit. Current conventional indicators that aim to assess societies' socioeconomic performance, macroeconomic development, and various forms of risk to companies and financial institutions do not accurately capture the human pressures on the planet. This has major repercussions for short- and long-term risks for people, societies, and economies.

The new planetary reality outlined in Chapter 1 highlights that human societies and economies have changed the properties of the biosphere. Our living planet has left the stable Holocene conditions that allowed agriculture to develop and civilizations to flourish, and has entered a new geological epoch, the Anthropocene. The biosphere has experienced such extreme impacts and become so fragile that new global risks are emerging that diminish its long-term ability to provide essential life-supporting functions, such as food production and climate regulation (Nyström et al., 2019). Future human and geological development are now intertwined (Hamilton, 2017). The Anthropocene is characterized by planetary-scale human pressures that threaten our societies and economies with potentially disastrous consequences for human well-being, macroeconomic development, and invested capital (Crona et al., 2021, Keys et al., 2019).

This new understanding of interconnections, dependencies, risks, and impacts – accumulated since the Stockholm Conference in 1972 – needs to be reflected in the indicators used to assess social and macroeconomic developments and investment decisions. In other words, indicators need to internalize our societies' and our economies' dependency and impact on a well-functioning biosphere. Failing to do so will, at best, make the indicators irrelevant and, at worst, make them dangerous if they lure us into a false sense of progress despite continued detrimental impacts to nature and societies. These impacts will, in turn, undercut the basis of future macroeconomic and financial performance, and the wealth of nations (Dasgupta, 2021).

This chapter further unpacks current opportunities for, and barriers to capturing noted social-ecological interdependencies in our assessment of change in human wellbeing, macroeconomic development, and financial investments. First, we briefly outline the role of indicators in assessing the underlying state of affairs in each domain and what this implies in the new planetary reality. We then discuss and examine three categories of indicators: composite indices for human well-being; indicators of macroeconomic performance; and non-financial measures of corporate and investment performance relating to environmental, social, and governance (ESG) factors. While there are an almost infinite number of indicators from which to select, we have chosen to focus on a limited set of indices or measurement frameworks that have emerged as dominant in their respective domain, and which explicitly attempt to capture aspects of social and/or environmental sustainability. The chapter ends with a few concluding remarks on the necessary directions ahead given the new planetary reality laid out in Chapter 1.

Tracking foundations for human progress in a new planetary reality

Indicators are measures used for a multitude of purposes, including for tracking changes over time, informing decisions, and/or for assessing performance in a given domain*. Key performance indicators (KPIs) are generally used to evaluate progress towards a set target at the level of an individual operation. The choice of performance

* Parts of this chapter embarks from the Stockholm Resilience Centre's contribution to the 2020 Human Development report , *'Planetary Change and Human Development'* (Galaz et al., 2020).

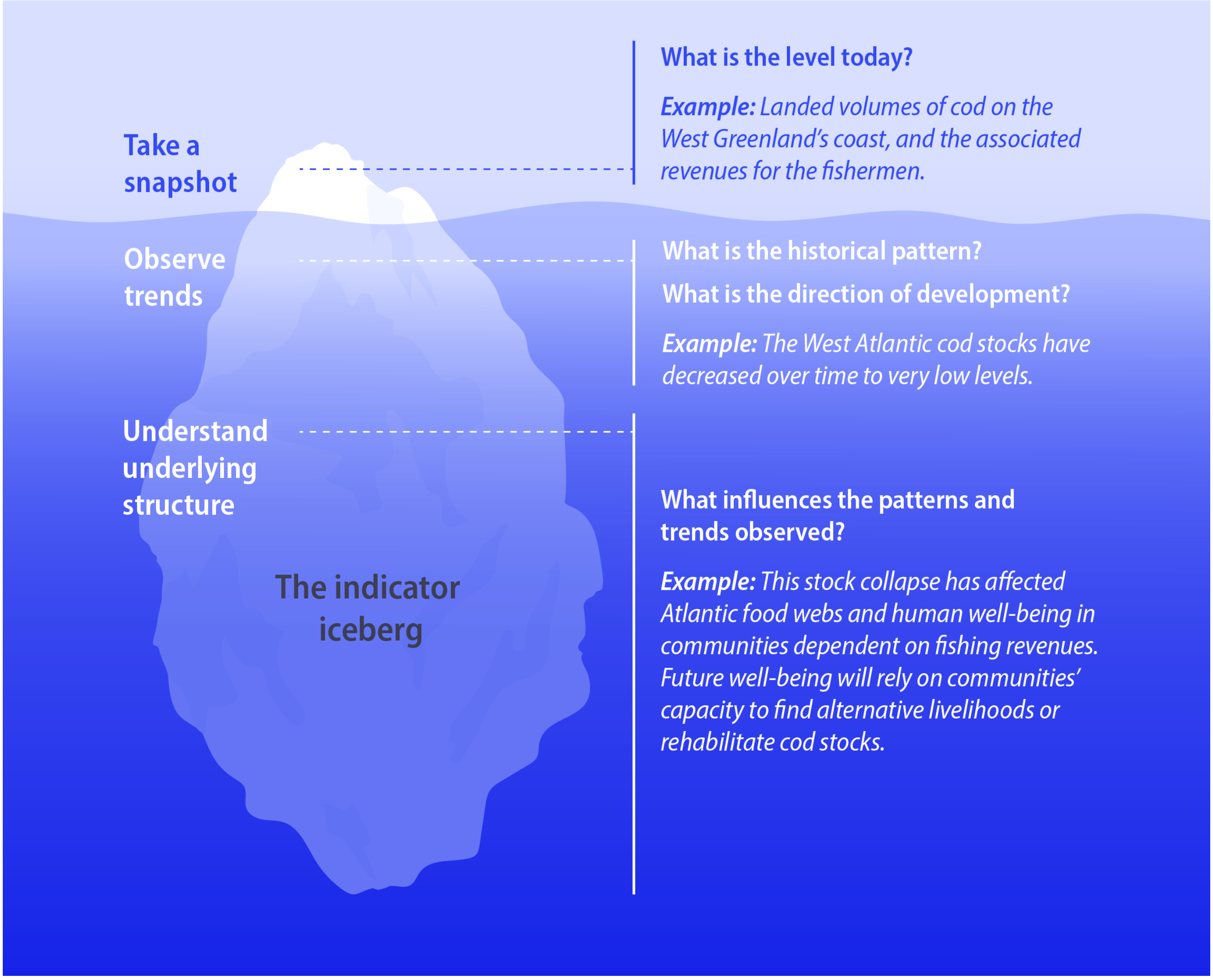


Figure 7 | The iceberg metaphor. By only focusing on what is above the surface, there is a risk of missing trends and losing the understanding of the underlying structures and values that give rise to the situation.

indicators also shapes the trajectory of business and policy decision-making. As specific indicators are selected, operations are often streamlined to achieve the targeted objectives as efficiently as possible, and typically begin to prioritize differently than they would have done with another set of evaluative indicators (Haider et al., 2015; Meadows, 1998). For any organization, be it an individual business, a national or local government, or a financial institution, the chosen performance indicators need to be appropriate for the reality in which performance is assessed. A new planetary reality is changing the conditions for human progress and activities, and therefore, our measures to assess human well-being need to reflect and account for this. Indicators for macroeconomic performance and risks to and from investments also need to account for this new reality. The iceberg metaphor used in systems thinking (Figure 7) can be a useful heuristic for understanding what indicators account for these changes.

The top of an iceberg is the only part that is visible above the surface. This generally represents around 10% of the total volume of the iceberg. Metaphorically applied to our discussion on indicators, the top of the iceberg corresponds to a measurement taken at a single point in time, providing merely a snapshot of performance rather than a meaningful assessment of change or progress. In the context of human well-being, this could be the average lifetime of a population or the rate of inequality (the latter discussed in Chapter 3), captured as an annual value. For macroeconomic performance, it could represent the unemployment rate. In the financial domain, it is akin to the share of annual greenhouse gasses emitted by the companies in an investor's portfolio.

To analyze the actual performance, one needs to understand trends or patterns, and this means looking at changes above and just below the surface, both over time and across space. The same indicators captured by the top of the iceberg can be used, but when analyzed as a time series, they can suddenly provide an assessment of the direction of development. The changing life expectancy or inequality in a country could be used to assess how human well-being has developed, while the changes in unemployment or the volume of greenhouse gasses emitted through investments indicate a directional change.

The lowest levels of the iceberg represent underlying structures and values. Thinking at this level focuses on what influences the patterns and trends observed, and also makes explicit the values, assumptions, and beliefs that determine why we set certain targets, and thus focus on specific KPIs. Faced with the reality of the Anthropocene, it is at this deeper level that we need to interrogate and challenge conventional truths about what the foundations for human well-being, macroeconomic development, and long-term investment risks really are. Figure 7 exemplifies different types of indicators that contribute to investigating changes in human well-being and incomes driven by developments in the West Atlantic cod stocks. The indicator iceberg can be applied to cases at local to global levels, for example to study the role of a stable climate for securing future human well-being (IPCC, 2022).

The scientific understanding of the foundations of human well-being and economic prosperity has grown considerably since the Stockholm Conference in 1972. It now recognizes that interconnections across space and time create dependencies and risks for both human well-being (e.g., pandemics), economies (e.g., systemic failures due to supply chain shocks), and a functioning biosphere (e.g., cascading ecological regime shifts) (Centeno et al., 2015; Platto et al., 2021; Rocha et al., 2018). There is also overwhelming evidence that human well-being is deeply connected to a well-functioning biosphere and the various services that healthy ecosystems provide, such as a stable climate, pollination, clean air, and water filtration (Folke et al., 2016). This has been visualized by representing the Sustainable Development Goals (SDGs) as a hierarchically layered 'wedding cake' to illustrate that the biosphere foundation provides essential functions that not only support but make possible, the social and economic pillars (Figure 8).

Such a nested conceptualization of the SDGs highlights that well-being depends on a healthy biosphere and that our economies are underpinned by social and natural assets (Folke et al., 2016; Brand-Correa et al., 2022). The biosphere dependence of human well-being is at odds with the concept of "weak sustainability", in which degradation of natural resources is acceptable as long as increases in the stocks of other types of capital can compensate for it. A fundamental critique against such a conception of sustainability is that it assumes complete substitutability (Barton & Gutiérrez-Antinopai, 2020; Purvis et al., 2019). For example, weak sustainability implies that current catastrophic losses in insect populations are acceptable as long as pollinating services can be replaced by mechanized means (robot bees). Similarly, it assumes that losses of wetlands or mangroves can be substituted by man-made flood defenses. However, bees, wetlands, and mangroves fill a multiplicity of ecological functions that may support a range of other environmental

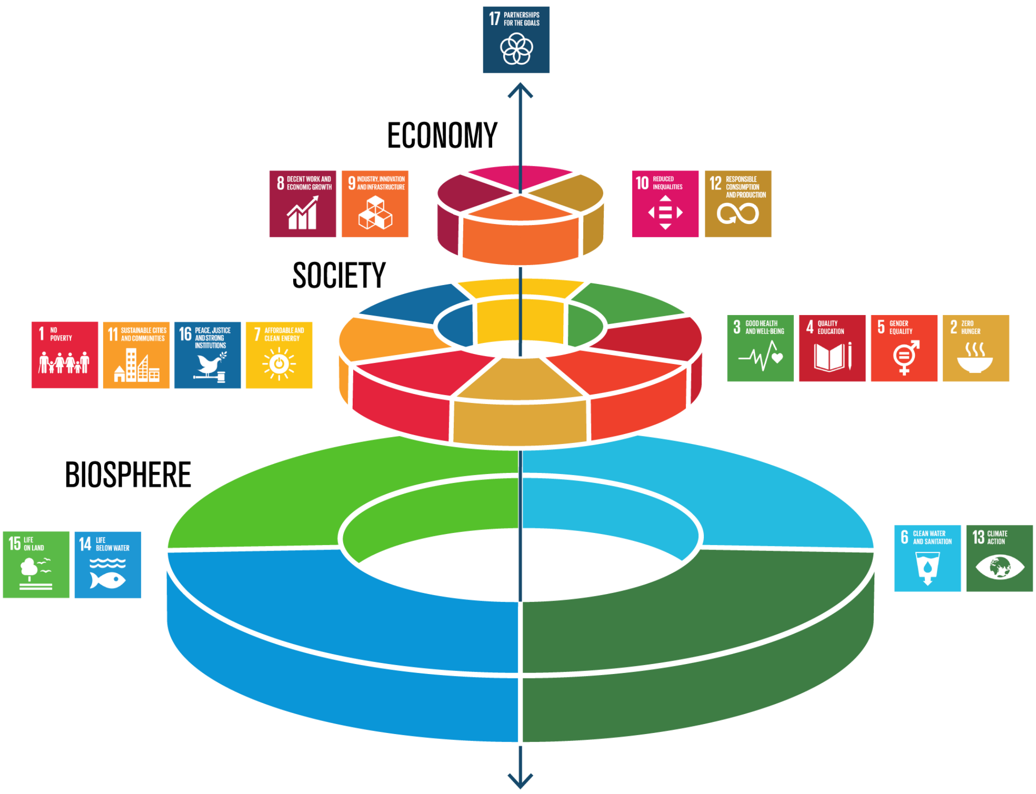


Figure 8 | The 17 Sustainable Development Goals positioned in relation to the biosphere foundation and the safe operating space for humans on Earth. Redrawn from Rockström and Sukhdev as presented at the 2016 EAT Forum. See also Folke et al., (2016).

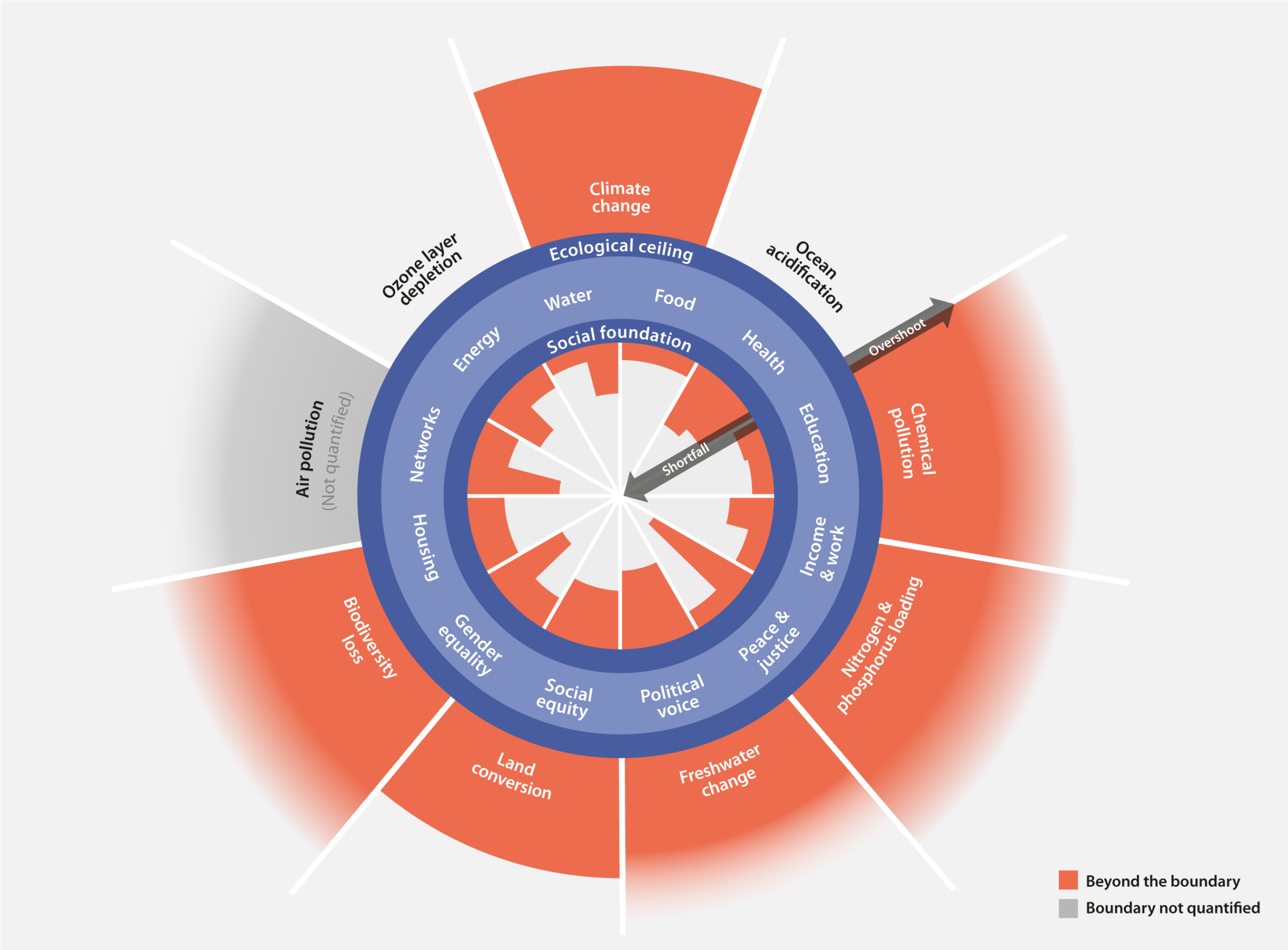


Figure 9 | The "doughnut" of social and planetary boundaries. Based on (Raworth, 2017). The figure has been updated to reflect recent research on the water boundary (Wang-Erlandsson et al., 2022) and chemical pollution (Persson et al., 2022).

goods and services that would not be replaced with man-made substitutes designed to fill one of their specific roles.

The emerging understanding of risks since the Stockholm Conference in 1972, noted above, stems from a scientifically grounded awareness that changes in both natural and socio-economic systems often happen abruptly (see Chapter 1). This necessitates an overview and monitoring of underlying structures, including links and causal relationships between different variables (Biggs et al., 2015; Walker & Salt, 2012).

Indicators of human well-being on a thriving planet

What constitutes a good life has been a central question since the dawn of civilizations as evidenced by all cultures that have left written records (Dasgupta, 2021; e.g., Plato's perspective on what constitutes a good life is discussed in Russell, 2005). A new planetary reality emphasizes that the biosphere foundations for human well-being are at risk. Therefore, indicators of human well-being must acknowledge the sustainability of human well-being by incorporating planetary pressures that risk jeopardizing the well-being of future generations. There is yet no country that meets the basic needs of its residents at a level of resource use that could be sustainably extended to all people globally (Fanning et al., 2022).

Two prominent approaches to human well-being are the human needs approach (Doyal & Gough, 1991; Gough, 2017; Max-Neef, 1991) and the human capabilities approach (Nussbaum, 2011; Nussbaum & Sen, 1993; Sen, 1985). The human needs approach proposes needs that should be met for all people, and which can be objectively measured. The capabilities approach sees freedom as society's primary goal and focuses on people's capabilities to achieve outcomes that they themselves value and 'have reasons to value' (Sen, 2001, p. 291). While both approaches recognize the need to incorporate ecological dimensions in human well-being, they don't explicitly acknowledge their foundational basis as discussed here.

An illustration combining human-induced environmental pressures and human well-being was introduced by Kate Raworth in relation to the 2030 Agenda negotiations

Box 4. Case study: Planetary pressures-adjusted Human Development Index (HDI). By Yanchun Zhang, Chief Statistician, UNDP Human Development Report Office

To account for intergenerational inequality the UNDP Human Development Report Office has proposed combining the HDI with a planetary-pressures adjustment to signal changes needed to navigate the Anthropocene. The adjustment to the HDI recognizes that easing the disruptions of planetary processes requires reducing CO2 emissions and closing material cycles.

The trajectory of countries over the last three decades shows different paths for different levels of human development. Countries with low and medium levels of human development have been able to significantly improve social and economic conditions without imposing a comparatively high burden on the planet. In contrast, in countries with high and very high human development, improvements in well-being and rising pressure on the planet have gone hand in hand.

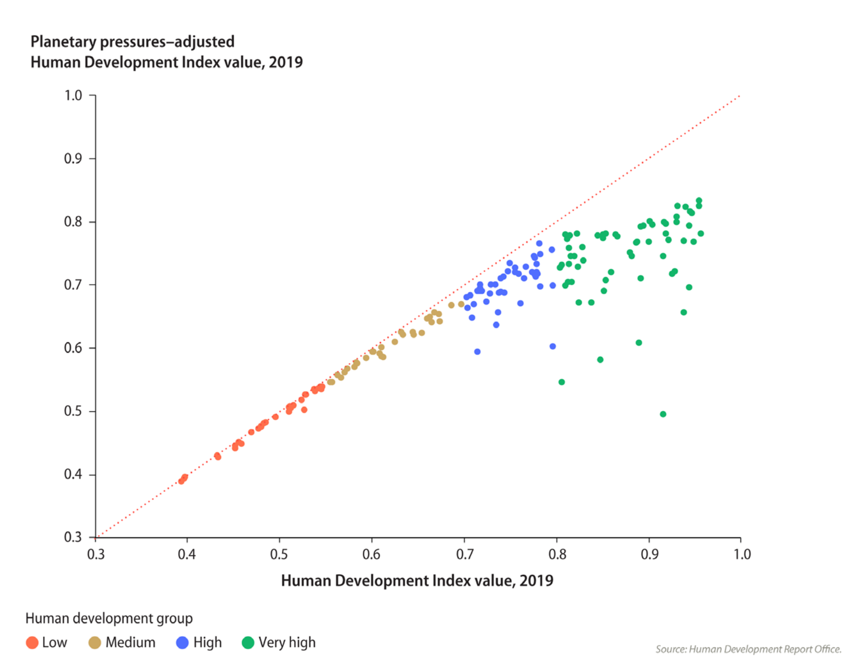


Figure 10 | Planetary pressures-adjusted Human Development Index. From UNDP (2020)

(Raworth, 2012; 2017). Raworth emphasizes that while humanity must stay within the ecological ceiling defined by planetary boundaries, there is also a social foundation that has to be guaranteed to allow for human flourishing. The combination can be illustrated in the form of a doughnut, Figure 9. The social foundation of the "doughnut" shares characteristics with both the human needs and human capabilities approaches. The ecological ceiling and the social foundation of the doughnut have further been quantified for different countries to assess their performances in these dimensions (see O'Neill et al., 2018; Fanning et al., 2022).

Raworth's "doughnut" is an example of an approach that acknowledges and considers the underlying structure of the iceberg metaphor through its inclusion of planetary boundaries. There has been a parallel development of weighted composite indices that include a limited number of indicators combined in one number. These composite indices have the advantage of enabling comparisons between societies in a single dimension. They are, by definition, contingent on weighting attributes against each other in mathematical functions that are not always straightforward, and that rely on a limited set of assumptions.

Already in 1990, the Human Development Index, HDI, was introduced, guided by Amartya Sen (UNDP, 1990). HDI is a composite index of life expectancy, education, and per capita income. Its development was an important step in broadening the notion of progress to variables beyond simply per capita income. The HDI was later combined with an inequality adjustment to account for the skewed distribution of life expectancy, education, and income in the assessed societies. In 2020, the Human Development Report introduced a new index, the Planetary pressures-adjusted HDI (UNDP, 2020, see Box 1). This new index, which contains indicators of environmental pressures, is also a considerable step forward compared to earlier indices that did not incorporate any environmental dimension.

Incorporating environmental pressures is a way of acknowledging the importance of intergenerational inequality as environmental pressures risk having negative consequences for the well-being of future generations. Nevertheless, countries with dangerously high emissions and material footprints still score well also on the Planetary pressures-adjusted HDI (Hickel, 2021). This includes Ireland (0.83) with its annual emissions of 7.7 tons CO2 per capita, which is several times in excess of what would be compatible with safe carbon budgets, and Switzerland (also 0.83) with a material footprint of 32 tons per capita, which is nearly five times more than what has been suggested as a maximum sustainable level (Ibid.; Fanning et al., 2022). The high scoring of these two countries, despite their considerable environmental impact, can be attributed to the planetary pressures' adjustment factor, which does not incorporate the countries' position in relation to estimates of planetary boundaries. Instead, it is a relative measure related to the countries with the highest emissions and material footprints. It has therefore been argued that the index is unable to capture the sustainability of human development (Hickel, 2021).

An alternative index, the Sustainable Development Index, SDI, is better at accounting for the actual environmental pressures of economic development. SDI changes some of the fundamental assumptions of HDI. First, it introduces an adjustment in the form of a sufficiency threshold of per capita incomes at $20,000. This threshold is defended by referring to studies that indicate that incomes above a certain level begin to have net negative social and ecological consequences (see further argumentation and references for this in Hickel, 2020; and related empirical estimates in Collste et al., 2021). The SDI further adjusts the 'development index' with an 'ecological impact index', which, similar to the Planetary pressures-adjusted HDI, incorporates both carbon emissions and material footprint. However, the value of the ecological impact in SDI is set in relation to planetary boundaries, rather than to the highest resource extracting countries as done in the Planetary pressures-adjusted HDI.

While SDI accounts for environmental pressures, it does not adjust for inequality. In a seminar organized by UNDP as a contribution to this report, Yanchun Zhang from the Human Development Report presented an experimental index combining the Planetary pressures-adjusted HDI with an inequality adjustment .

A comparison of the two composite indices suggests that the SDI is the only index that incorporates ecological limits. However, as any composite index, SDI and HDI both build on aggregating multiple types of values in a single measure, implicitly implying they can be substituted for each other, which may not necessarily be true. For both measures, very different situations could end up being represented by the same number. For example, a rise in life expectancy could exactly make up for a given increase in material footprint or emissions.

The risks of sudden, unexpected, and non-linear change, which are key features of the Anthropocene (Chapter 1), are currently not captured by the SDI nor the HDI. Neither of them monitors the consequences of environmental pressures. They thus would need to be complemented with dashboards of indicators that focus on monitoring slow changes and unexpected connections, and also on identifying possible thresholds that may trigger abrupt changes if crossed. Furthermore, only looking at indicators or groups of indicators is not enough. They need to be assessed within broader frameworks identifying essential dynamics, possible reinforcing feedback loops, unexpected connections, and thresholds. Such frameworks could include various kinds of knowledge and tools that support the study of these phenomena, for example, simulation models, scenario analysis, and resilience assessments (Crépin et al., 2017; Biggs et al., 2021).

Macoeconomic indicators that account for natural capitals

The sustainability literature has long been emphasizing the need to incorporate environmental and human concerns in national accounting metrics (World Commission on Environment and Development, 1987). The Inclusive Wealth Index (IWI) and the Gross Ecosystem Product (GEP) are two approaches working towards this goal.

The IWI (Dasgupta et al., 2021) is the calculated social value of three types of capital assets measured in dollar terms: all natural resources, sinks, processes that support production and life (natural capital), people's health, knowledge, skills (human capital), and manufactured capital. The IWI is a measure of stocks (capitals) and thereby measures prerequisite conditions to achieve human well-being (Ibid.). If descendants have more capital available compared to what they inherited, they are likely to be better off, and their standards of living would be at least as high as earlier generations. This has been referred to as the capital approach to sustainability (Stiglitz et al., 2019).

The Inclusive Wealth Report 2018 provides a picture of the changes in capital assets from 1990 to 2014. Across the 135 countries included in the analysis, the index increased by 1.8 percent per year over 25 years. In contrast, the global average GDP growth rate was 3.4 percent over the same period. Two-thirds of the countries increased their inclusive wealth per capita (Managi & Kumar, 2018). Natural capital has declined by 0.7 percent per year while other capital types have increased (ibid.). The stock composition in different capital and its change over time provide relevant information as this may influence future

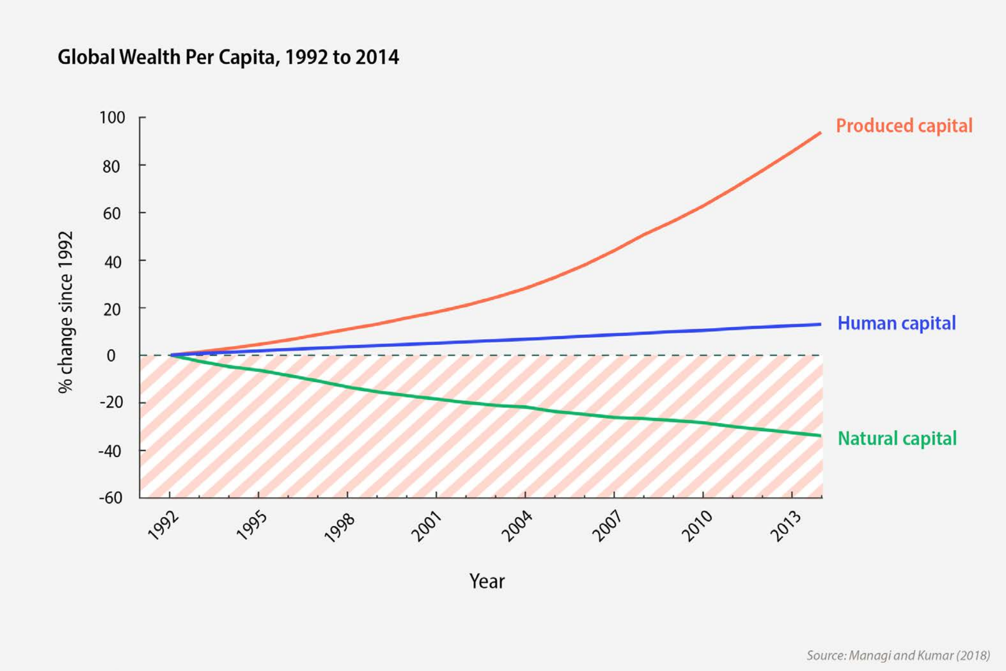


Figure 11 | Global wealth per capita, 1992 to 2014.

development (Figure 11). Depleting capital over time leaves less capital for future generations to thrive, and for nature to be resilient. In contrast, if natural capital components are increasing, it gives more opportunities for future generations to fulfill their needs compared to what current generations have and could mean that the degradation of Earth's life-support systems has been halted.

Gross domestic product (GDP) summarizes a vast amount of economic information in a single monetary metric that is widely used in decision-making around the world - but is blind in its design to most values of nature and other vital dimensions of the environment. China's adoption of GEP represents the first large-scale effort to summarize the value of ecosystem services in a single monetary metric, using similar methods as those underpinning GDP measurements (Ouyang et al., 2020). GEP has emerged from an interdisciplinary and international process of mainstreaming natural capital for development. The software platform Integrated Valuation of Ecosystem Services and Tradeoffs (InVEST) developed by the Natural Capital Project is useful as a base to calculate GEP as the aggregate value of final ecosystem goods and services in a given jurisdiction.

GEP is being used in decision-making today, to communicate the benefits of nature to the public, as a benchmark for planning, as a standard for evaluating administrative performance, and as a framework within which to develop public investments and market-based transactions. GEP has been adopted by hundreds of local governments across China. GEP accounting underpins policy and financing instruments, including large-scale land-use designations and payments for ecosystem services, among other key government activities (Ouyang et al., 2016; Mandle et al., 2019). In principle, the accurate tracking of environmental performance would allow decision-makers to be held accountable. It is, however, too early to assess to what extent this has materialized in regions where such metrics have been applied.

Since the recognition of GEP by the United Nations Statistical Commission as a tool aligned with international accounting standards (the System of Environmental Economic Accounts – Ecosystem Accounts; UNSD, 2021), more and more countries are requesting assistance to adopt this system (e.g., Colombia, with support from the InterAmerican Development Bank, Sri Lanka and Mongolia, both with support from the Asian Development Bank).

There are, however, remaining issues with both metrics (IWI and GEP). On their own, they do not track slowly changing elements or assess whether some thresholds might soon be trespassed. Thus, they should ideally be used in conjunction with other measures to capture the state of natural capital in an Anthropocene context.

Despite that planetary boundaries are being breached and human impacts on the planet have amplified, the IWI has, according to its 2018 report, increased globally between 1990 and 2014. To our knowledge there are no global measures of GEP available yet, though using the same underlying approaches (embodied in InVEST), IPBES is making global and regional projections under alternative scenarios for the future (Chaplin-Kramer et al., 2019). Although the aggregated measure of wealth has increased, natural capital has decreased (Figure 11), signaling substantial reasons to worry. Furthermore, some forms of natural assets provide unique goods and services such as key biological species necessary for the existence of entire ecosystems or elements essential to life on Earth (e.g., photosynthesis; carbon sinks, like forests and oceans;

moisture recycling that transports rain from one continent to the other). These are not easily captured by additive metrics.

IWI and GEP also center around the possibility to translate all values to monetary terms. This creates the risk that elements that cannot be meaningfully quantified and valued are not properly accounted for. Rather than omitting what is hard to value in the decision process, or giving them an artificial value that is likely to misrepresent their role, proper decision processes need to account for other qualities than those that can easily, and meaningfully, be valued. This can be done within the broader frameworks previously mentioned such as simulation models, scenario analysis, and resilience assessments (Crépin et al., 2017; Biggs et al., 2021)

Environmental, Social, and Governance (ESG) criteria and the role of finance in promoting a sustainable future for people and planet

If societies' economic activities are changing climate and biosphere so much that it threatens the well-being of current and future generations (Chapter 1), then all actors facilitating the flow of capital to these activities, including regulators, must consider how they can prevent and reverse significant harm, and support more regenerative economies. A growing consensus suggests the financial sector must not only react to, but also actively seek to reduce impact on, the planet and people (Chapter 2). The EU taxonomy is an example of an extensive policy initiative to define what is environmentally sustainable, while the Network of Central Banks and Supervisors for Greening the Financial System illustrates how financial policymakers are increasingly looking to change their practices. However, can the indicators used by the financial sector today accurately capture whether or not financial flows align with ambitions to stay within planetary boundaries? Financial institutions and policymakers have been accounting for sustainability through two main pillars: ESG criteria, and, more recently, through estimates of climate-and biodiversity-related financial risk exposures.

ESG-marketed investment funds have substantially grown in recent years, with record inflows during the pandemic bringing total assets close to $4 trillion by 2021 (Murugaboopathy & Mann, 2021). Similarly, global issuance of green bonds has risen sharply and recently surpassed $250 billion, about 3.5% of total global bond issuance ($7.15 trillion) (Ehlers et al., 2020). ESG encompasses a broad range of investment strategies including corporate engagement and shareholder action, various forms of norms-based, negative/positive screening or tilting of portfolios, sustainability-themed investing, and impact investing. At first, these trends signal a positive trajectory in aligning the financial system with the needs of people and the planet. However, the financing of activities threatening planetary boundaries has continued unabated. Since the beginning of the COVID-19 pandemic, G20 countries have still directed around USD 300 billion in new funds towards fossil fuel activities as reported in Chapter 2 (SEI et al., 2021). So, what is the reason for this apparent incongruence? Below we highlight several major issues with current ESG frameworks and measures which indicate that caution is warranted about investors' current ability to support and align with sustainability goals.

First, ESG ratings are imprecise tools for identifying sustainable investments. ESG metrics are diverse, non-standardized, and can diverge for different companies. These inconsistencies prevent comparison of ESG investment performance, render ESG data noisy and unreliable, and have spurred debates about what reliably constitutes a sustainable investee (Chatterji et al., 2016, Ng & Rezaee, 2015; Berg et al., 2021). Second, ESG ratings lack accuracy. In particular, they lack standardized reporting requirements for most environmental impacts, except carbon emissions. The bulk of the data used by ESG rating providers is self-reported by companies and most of it does not reliably capture environmental or social impact. There may in fact be large discrepancies between what is captured by the environmental pillar scores of ESG providers and what companies actually do to minimize deforestation, as one example (Crona et al., 2021; Crona, 2021).

Third, many current approaches to sustainable investments rely on relative, rather than absolute, measures of impact (i.e., screening), or they are defined by process (i.e., corporate engagement and shareholder action). In the case of the former, it is questionable whether positive screening (the process of finding companies that score highly on ESG factors relative to their peers) in fossil-intensive industries or industries with high deforestation risks can meaningfully contribute to sustainability. Negative screening (the process of finding companies that score poorly on ESG factors relative to their peers) has similar flaws, yet most ESG funds merely exclude coal-producing firms from their portfolios and reduce the weight of large oil companies. Studies show that instead of reallocating capital towards alternative green industries, ESG funds tend to direct investments to tech firms, financial institutions, and real estate (Buller, 2020), which calls into question the actual contribution such funds are making to accelerating the green transition. Process-related ESG investments (i.e., active ownership and shareholder action) display similar problems, as most ESG funds do neither precisely define voting behavior nor private engagements. Hence, investors cannot know whether the ESG funds in which they invest will vote in favor of sustainability issues or use private engagements to push for rapidly reducing greenhouse gas emissions. Studies even show that many of the ESG funds offered by the Big Three credit rating agencies (S&P Global Ratings, Moody's, and Fitch Group, see Chapter 5) have in recent years voted against shareholder resolutions aimed at improving

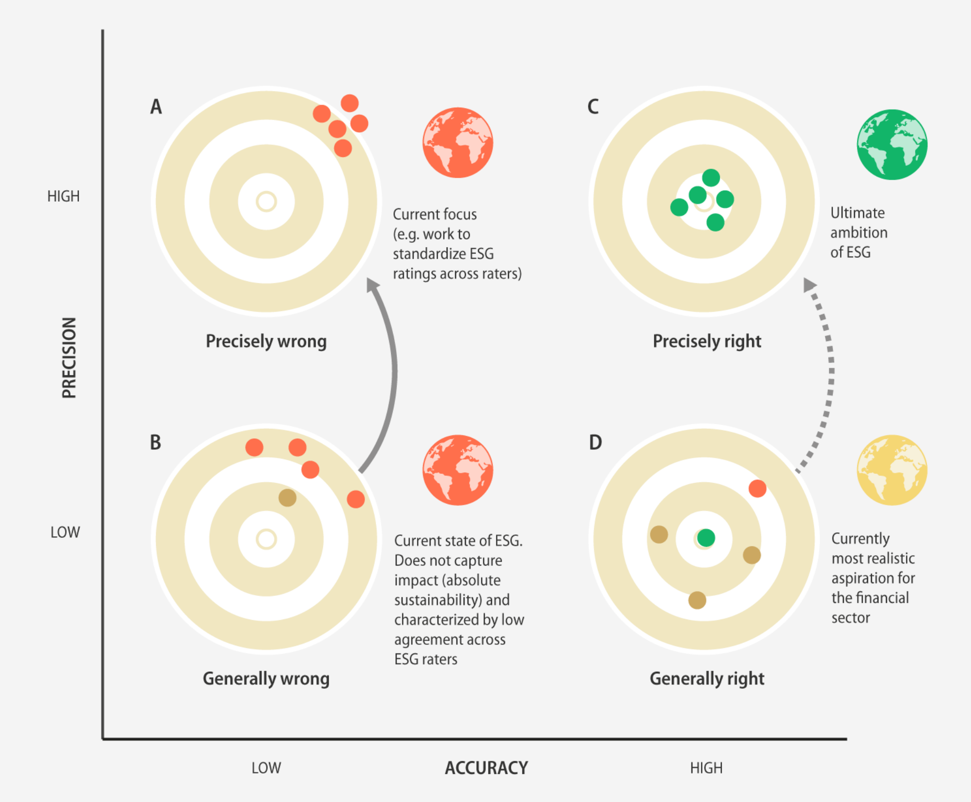


Figure 12 | Accuracy and precision of current sustainable finance approaches (notably ESG) in relation to declared sustainability ambitions. (A–D) Precision is the closeness of any measurements to one another, while accuracy is the closeness of the measurements to a specific desired value. The likely environmental sustainability risk incurred by an ESG focus is indicated by colored globes, where red indicates a high risk of transgressing planetary boundaries, yellow indicates lower risk, and green indicates low risk (best possible option). (B to A) The solid arrow indicates the trajectory currently being pursued, while (D to C) the dashed arrow represents the desired trajectory. Source: Crona et al., (2021).

environmental governance (Golland et al., 2022; Baines & Hager, 2022; Griffin, 2020; Sood et al., 2021). Furthermore, while sustainable change through engagement and action hinges on improving company practices, this approach to sustainable investments is rarely (if ever) associated with any clearly specified or time-bound targets, making progress hard to assess.

Finally, ESG rating providers are almost all private sector-led initiatives. Recent market consolidation has seen many of the originally specialized providers purchased by large consultancies and asset managers, whose for-profit status heralds new conflicts of interest and potential incentives to underestimate exposures to avoid adverse regulatory consequences (Azizuddin, 2021; Eaglesham, 2022). Meanwhile, the proprietary and 'paywalled' nature of ESG ratings and their underlying methodologies is making it difficult to hold the rating providers accountable through external evaluation.

Despite these issues, there has been little to no official involvement of financial regulators in the design and ongoing supervision of ESG initiatives. Instead, policymakers have focused their attention on measurement, disclosure, and modeling of forward-looking exposures to climate-related and, more recently, nature/biodiversity-related financial risks (e.g., Bank of England, 2019; ECB, 2020). Current policy efforts have prioritized correcting market prices to address the market failures caused by a lack of environmental information (Ryan-Collins, 2019), assuming that financial actors will automatically reallocate capital in line with sustainability goals once the relative asset prices incorporate physical and transition risks of environmental change (see Chapter 5). Such policy approaches fail to recognize that noted concerns about the precision and accuracy of ESG also apply to estimates of environmental-related financial risks (Crona et al., 2021). Risks to humans and planet through loss of biodiversity or a changing climate are often hard to quantify with useful enough accuracy due to the radical uncertainty and system complexity (Wassénius & Crona, 2022; Chenet et al., 2021; Kedward et al., 2020). Accounting for such systemic risks will therefore necessitate a move to include qualitative risk assessments, based on explicit normative views about the direction of future policy, technology, and necessary consumer behavior changes.

In summary, the low accuracy indicates that, in their current format, ESG ratings, estimates of environmental-related financial risks, and most sustainable investment approaches are not able to address the root causes of sustainability problems. Without a clear benchmark against which to judge the actual negative and positive contributions of a company to a particular variable, like CO_2 or total area deforested, investments labeled as ESG therefore provide a false sense of progress and an unverifiable promise of sustainable investments (Crona et al., 2021). Hence, standardizing current ESG without incorporating measures of impact may increase precision, but will fail to address accuracy and simply make us more precisely wrong (Figure 12-A). This risks further cementing an unsustainable trajectory and may delay public measures that can drive a low carbon energy transition (Fancy, 2021; Baines & Hager, 2022).

Early concepts of ESG grew out of a socially responsible investment movement that emerged in the 1960s. These early models were motivated by a belief in sustainable development, and focused on capturing absolute assessments of corporate externalities. However, in the wake of the 2004 UN Global Compact report, the major rating providers favored a version of ESG based on metrics that capture financially material risks, such as physical, reputational, regulatory, and transition risks (Eccles et al., 2020). Hence, central banks and financial regulators focus almost exclusively on risks to the private balance sheets of firms only, rather than impacts of finance on the natural world (see also Chapter 2 and Chapter 5).

These are the same risks around which major current norm-setting frameworks (such as Sustainability Accounting Standards Board, SASB, and Task Force on Climate-Related Financial Disclosures, TCFD) also center. However, financially material risk cannot, in most instances, be equated to risk to people or planet. In fact, many detrimental environmental and social impacts caused by company operations may have no immediate direct financial repercussions in today's system of accounting.

The unofficial motto of ESG investing has been "doing well by doing good" through influencing the portfolio firms, with implied beneficial effects on the economy and the environment. However, in its current form, ESG has merely become a tool for investors to manage the financial risk associated with environmental, social, and governance issues (Crona et al., 2021). If, however, an ambition for finance is to help societies transform towards low-carbon economies with minimal impacts on the biosphere, then financial sector norms and practices need to change to become more generally right (see Figure 12-D).

Such a change would not simply be altruistic, but also be about self-preservation. Fund manager stewardship that does not align with what most investors and the public see as swiftly improving ESG issues has been referred to as 'feeble' (Fichtner & Heemskerk, 2020), and it represents a risk of declining credibility, trust, and social license to operate (O'Neill, 2014; Crona et al., 2021). Similar failure to align purported motivations with actions significantly reduced the credibility of the financial sector following the financial crisis in 2008 (de Bruin, 2015).

Avoiding such credibility risks while reducing the risk to the biosphere and societies hinges on rapidly finding ways to incorporate relevant indicators of social and environmental impact. It necessitates a move toward hard-wiring structures and processes in the financial system that ensure capital is allocated to activities that can promote long-term biosphere resilience (do good), while simultaneously reallocating it away from what is doing harm.

Concluding remarks

The new planetary reality requires us to rethink the interlinked indicators for human well-being, macroeconomic and ESG criteria, and the multidimensionality of financial risks. The call for action in all these areas is based on the underlying understanding of humanity's dependence on the biosphere. Indicators for human well-being must not only incorporate environmental concerns, but further acknowledge human pressures causing the transgression of planetary boundaries and their thresholds, which are informed by science. Only then do the indicators meaningfully capture the viability of human well-being.

Indicators for macroeconomic performance must integrate the value of different forms of capital, even those forms of natural capital that are often neglected in national accounting. Tools and approaches to how this can be done were introduced earlier in the chapter. Different types of assets may only be substitutable to a limited extent, if at all, and natural assets, including a livable biosphere, may therefore not be relevantly nor meaningfully translated to monetary values. The study of macroeconomic performance, furthermore, needs to embed the deep uncertainty engrained in biosphere dynamics and its feedbacks to human pressures, including risks of passing critical thresholds, on local levels up to planetary boundaries.

Financial actors must become active stewards of the commons, recognizing a wider set of Earth system processes and developing impact accounting as a core part of capital allocation decisions. There is a need for open disclosure of ESG data and criteria and active engagements by regulators to delineate how they can prevent and reverse significant harm.

Various forms of indicators must be monitored for slow changes in dynamics and possible thresholds that may trigger irreversible changes if passed. Moreover, indicators and groups of indicators must be iteratively assessed within different kinds of frameworks identifying essential dynamics, possible reinforcing feedback loops, unexpected connections, and thresholds. Such frameworks could include all kinds of knowledge and tools for support, including simulation models, scenario analysis, and resilience assessments.

All efforts to find indicators should subordinate to the invaluable nature of a livable biosphere. Only then can we ensure a just future on a thriving planet.

Chapter 5. *The Power of Giants*

Economic and financial actors are not equally influential. On the contrary, our globalized economies are experiencing considerable concentration of influence, possibly putting "Earth's future in the hands of a few." This chapter presents and discusses this emerging global phenomenon with a specific focus on centrally placed economic agents such as "keystone actors," financial giants, central banks, and index providers. We explore the opportunities and limitations of collaborating with such giants to advance sustainability ambitions, and propose pathways to engagement that are effective and just.

It is easy to observe the features of today's highly globalized societies in our everyday lives. Information, for example, travels fast and far through digital platforms. Global supply chains offer not only economic opportunities, but also connect people, nature, and capital in new ways. The globalized nature of corporate activities and finance, and the need to bridge the gap between sustainability ambitions and action, have led to numerous international sustainable finance initiatives driven by government, civil society, and the private sector. A current analysis shows that the number of international initiatives trying to contribute to sustainable finance agendas has grown extensively in the last years, now covering over 115 different partnerships, 5,181 constituent members, and more than 10,000 collaborations between individual financial actors on sustainability issues (Mancini, 2020).

The way such connections evolve is not random, however. Over time, such collaborations and networks can evolve in ways that put some constellations or individual agents in central and influential positions. This phenomenon is highly visible in today's globalized economies (Vitali et al., 2011) as well as in the financial sector (Fichtner et al., 2017). This characteristic can – at best, and if carefully navigated – offer opportunities to accelerate action for a just and safe transition towards sustainability. We elaborate on the potential and limitations of using such centrally placed and influential economic and financial agents as levers for transformative change below.

Keystone actors

The way corporate consolidation affects economies is a well-known topic amongst economists. The dominance of a small number of companies that control a large market share can have several negative sustainability implications, including the ability of such dominant players to impose low prices on suppliers and set barriers to entry in a sector in ways that undermine innovation (Folke et al., 2019). The development and dominance of transnational corporations (TNCs) on our planet is unprecedented in history, and has become a defining characteristic of the Anthropocene (Folke et al., 2019; Österblom et al., 2022b). Such large corporate actors 1) dominate global production revenues and volumes, 2) control globally relevant segments of production, 3) connect ecosystems globally through subsidiaries, and 4) influence global governance processes and institutions.

This dominance is highly visible in sectors that have direct and indirect influence on the world's oceans, the global atmosphere, vast biomes and other aspects of our living planet. For example, over 70 % of the world's greenhouse gas emissions since 1988 can be linked to a mere 100 companies (Griffin, 2017). Another set of 100 large corporations (the "Ocean 100") account for 60% of total revenues in the global ocean economy (US$1.1 trillion in revenues in 2018), including in sectors such as seafood and offshore oil and gas extraction (Virdin et al., 2021). 4 companies control 84% of the agricultural pesticides market; 13 companies control up to 40% of the largest and most valuable global fish stocks; 5 companies dominate the palm oil sector with over 90% of the market, just to give a few examples (from Folke et al., 2019).

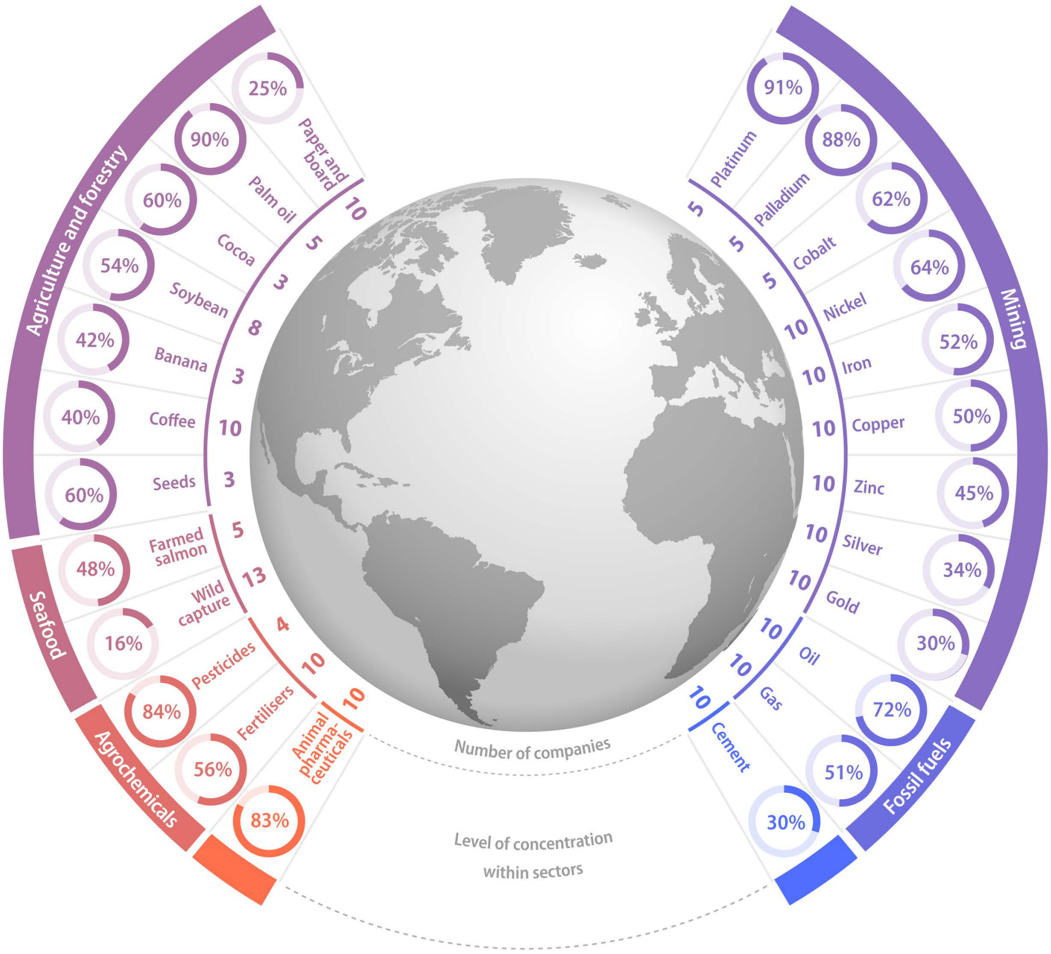


Figure 13 | The biosphere in the hands of a few. The figure illustrates levels of concentration for industries shaping the biosphere through their activities on land- and seascapes. Concentration is measured as, for example, percentage of profits or sales, market share, exports, production, trade volumes or access to resource reserves. Source: Folke et al., 2019.

Transnational corporations (TNCs) not only dominate specific markets, however. They also set global standards that their global web of subsidiaries and competitors need to follow or adhere to. TNCs also shape international policy arenas in ways that align with their interests, and are active on national policy fora on issues that lie close to their business interests (Folke et al., 2019; Österblom et al., 2015; Virdin et al., 2021). To what extent this concentration of influence in the hands of a few corporate actors (and as we will see later, financial actors as well) can be used as an opportunity for accelerated action towards sustainability, or whether such consolidation of influence acts as an obstacle for effective global environmental governance, remains a debated issue (Kinniburgh et al., 2022; Österblom et al., 2022a, Schneider et al., 2020).

The global nature of corporate activities and their impacts on the climate and the biosphere create serious challenges for national governments that operate within the rules supported by weak international environmental institutions. As (Österblom et al., 2022b) notes however, there seems to be a shift amongst corporations away from simpler environmental compliance to engagement with sustainability as a core corporate strategy, at times even leading to a transformation of business models. Such shifts towards sustainability can, at best, lead to notable domino-effects across large supply chains as subsidiaries and subcontractors are forced to also shift their operations to avoid reputational damage, or lost business opportunities.

Engaging strategically with such keystone actors in ways that support transformative actions towards biosphere stewardship and sustainability has proven challenging, but far from impossible. Independent and continuous scientific advice, processes for trust-building, a joint creation and focus on solutions, a growing formalization over time, and international recognition can all contribute to changes that cascade through supply chains in ways that promote learning and the achievement of time-bound goals (Österblom et al., 2022, see also Schneider et al., 2021). Large corporate actors are influential at the system level and can thus operate as role models for industry peers that are likely follow their lead. In this way, they contribute to the development of informal industry norms and behaviors that advance sustainability ambitions. Coherent action by multiple large actors can also signal to policy makers that industry welcomes stronger regulations. However, such actions also risk further cementing the positions of market and political power that such large actors hold, and could therefore undermine incentives for novelty, innovation, and equity (Kinniburgh et al., 2022; Österblom et al., 2022a, Schneider et al., 2020).

It is important to note that investors, and the financial sector as a whole, can play a key facilitating role as corporations begin to consider changing their business practices in ways that align with the Sustainable Development Goals and the Paris Agreement. Sustainability-linked loans, requirements to follow Environment, Sustainability and Governance (ESG)-standards at critical times such as stock-listing, active engagements at Annual General Meetings, and direct engagements as investors with company boards, are all important ways to help accelerate corporate action. Investor engagements such as these are increasingly common with corporations associated with fossil fuel extraction (MacDonald-Kroth et al., 2018), mining activities (Innis & Kunz, 2020), development in the "blue economy" (Sumaila et al., 2020), and extractive sectors linked to deforestation risks (Merino, 2019). Prioritizing engagements with influential keystone actors with disproportionally large impacts on the climate system and the biosphere (for example, the investor initiatives *Climate 100+* and *Nature Action 100*, see also Chapter 2) offer a tangible strategy to accelerate corporate and financial actions for sustainability. Consolidation in the financial sector itself, also offer possible and often ignored pathways for accelerated change.

Sleeping Financial Giants

The concentration of market influence is not only observable amongst global corporations, but also in the financial sector. In the decades before the global financial crisis in 2007-2008, the vast majority of retail and institutional investors used actively managed funds as their main investment option. Well-known stock indices such as the American S&P 500, the British FTSE 100 or the international MSCI World index, acted primarily as benchmarks against which the performance of active funds was compared. Hence, in that period the main function of stock indices was to provide market information (Fichtner et al., 2017; Fichtner and Heemskerk, 2020).

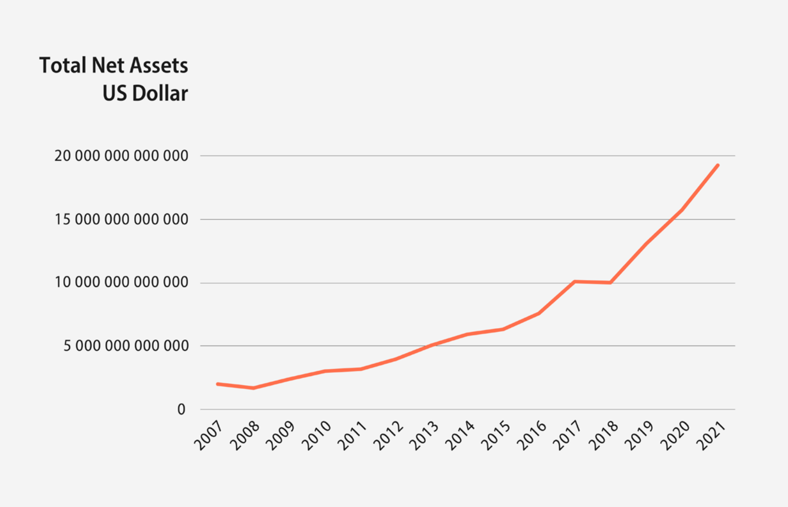
However, the global financial crisis has led to a paradigm shift in global finance as retail and institutional investors are reallocating investments from actively managed funds, into passively managed index funds that simply track indices, such as the S&P 500 or the FTSE 100. Index funds have reached an all-time high in assets under management of well over $15 trillion in 2021, a sum larger than the entire market capitalization of all publicly listed firms in the European Union. From 2006 to 2018, almost $3.2 trillion has been taken out of actively managed equity funds, while US$ 3.1 trillion has flown into index equity funds (Fichtner & Heemskerk, 2020). The main reason for this unprecedented transformation in the investment landscape is that index funds have much lower fees than actively managed funds, but still yield similar returns compared to most active funds. The fees of index funds are often only about one tenth of those of active funds. Index funds benefit from strong first-mover advantages and large economies of scale. That is, the larger an index fund becomes, the more cost-efficient it is (Fichtner & Heemskerk, 2020).

That shift seems to have benefitted a handful of US-based asset managers. Fichtner, Heemskerk, and Garcia-Bernardo (2017) have coined the term the 'Big Three' to characterize the three dominant US passive asset managers BlackRock, Vanguard, and State Street. The large inflows of assets into the index funds managed by the 'Big Three' means that BlackRock, Vanguard, and State Street are becoming ever larger shareholders of publicly listed companies all over the world (Bebchuk & Hirst, 2019).

While the 'Big Three' are not the legal or 'ultimate' owners of the shares they hold, they have a fiduciary duty towards their clients, which includes exerting the voting rights that are attached to the shares. Asset managers also engage in private meetings with the top management of their portfolio firms to discuss corporate strategy. Hence, asset managers could be viewed as the *de facto* owners, meaning that the 'Big Three' accumulate enormous potential influence over publicly listed corporations all over the world. This unprecedented concentration of corporate ownership has led to important discussions about their impacts on market competition and price-finding mechanisms (e.g., Azar et al., 2018; Elhauge, 2016; Braun, 2021).

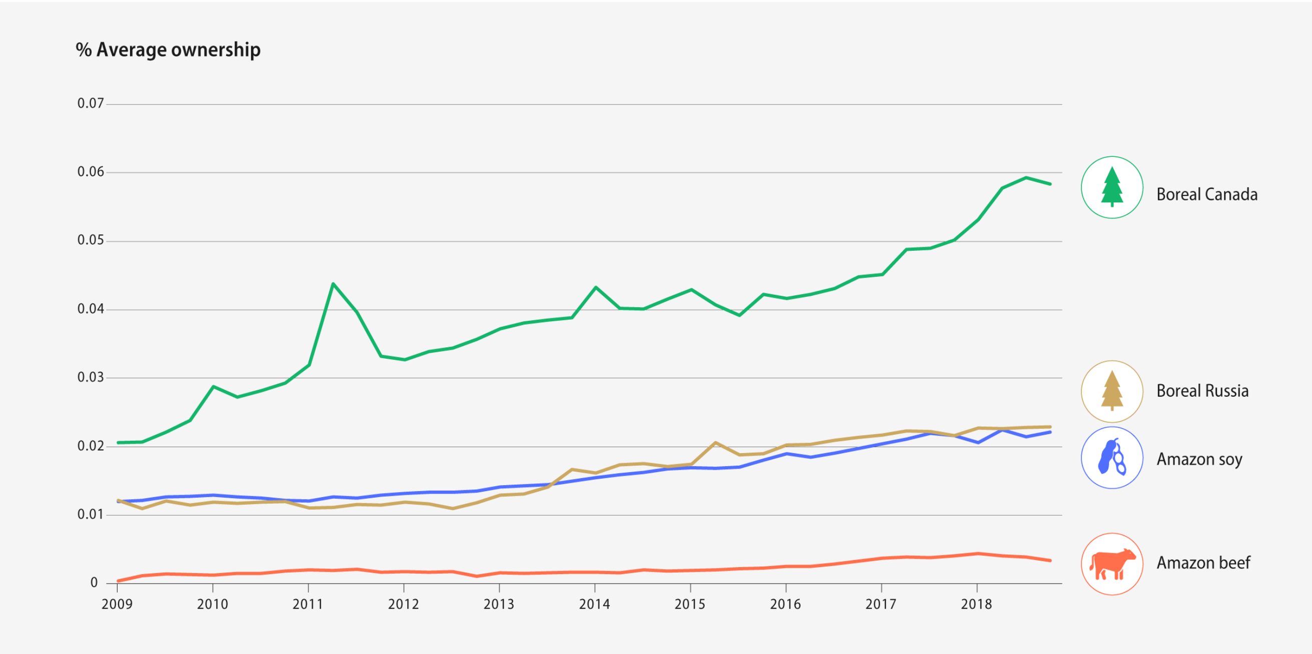
A Dormant and Growing Indirect Influence on Sustainability

If current trends continue, BlackRock, Vanguard and State Street could have a combined voting stake in the S&P 500 firms of over 34% by 2028, and over 40% by 2038 (Bebchuk & Hirst, 2019). Put differently, the 'Big Three' and a few other large asset managers such as Fidelity in the United States and Amundi in Europe are becoming 'financial giants' with an ever-larger influence on the corporate governance of publicly listed companies all over the world, and in economic sectors of critical importance for both people and planet (see examples in Chapter 2). Figure 14a below shows the growing sums of capital allocated to index funds over time (left panel), and Figure 14b the average ownership of the 'Big Three' asset managers in industries affecting biomes linked to "tipping elements" in the climate system (see Chapter 2). As the



← **Figure 14a | Global index funds assets under management (AuM).** Total net assets include both Exchange Traded Funds (ETF) and index mutual funds. Source: data provided by Jan Fichtner.

↓ **Figure 14b | Average ownership of the 'Big Three' asset managers in industries affecting biomes linked to "tipping elements" in the climate system.** Souce: Golland et al., 2022, data provided by Ami Golland.



data shows, the growing ownership and thus influence in these industries mirror larger shifts in global financial markets.

To what extent financial giants have the mandate and incentives to use their growing influence to support sustainability and climate ambitions remains a debated issue (Golland et al., 2022). Hawley & Williams (2000) note, however, that the 'Big Three' could be seen as 'universal owners' – investors that hold shares in virtually all publicly listed companies, and thus, in all industries. As a result, the cumulative long-term return of a universal owner is essentially determined not just by the performance of each individual firm it holds, but by the performance of the economy as a whole. This means that financial giants – in principle – have an incentive to mitigate negative externalities, such as biodiversity loss and climate change (Braun, 2016; Condon, 2019; Fichtner & Heemskerk, 2020; see however Christie, 2021). The 'Big Three' hence may use their influence in ways that help reduce planetary pressures by engaging with key industries (such as keystone actors), and at best even help develop and help boost the resilience of biomes known to be key for climate stability (Galaz et al., 2018b; Crona et al., 2021).

This influence has, for a long time, remained dormant, suggesting that these financial giants indeed were "sleeping" on issues of fundamental importance for sustainability. Several analyses (Golland et al., 2022; Baines & Hager, 2022; de Haas & Kieve, 2017; Doyle, 2018; ShareAction, 2018, 2021; ShareAction & AODP, 2017) show the limited use of their voting power at annual general meetings (AGMs) as these giants have refrained from publicly pressuring firms to improve sustainability in a meaningful way. That however, could be changing. Public statements by BlackRock and State Street have increasingly become more demanding on sustainability and climate issues in recent years. BlackRock (2022) for example, has published very concrete demands regarding how portfolio firms should disclose and reduce their greenhouse gas emissions.

BlackRock has also announced that it will use private engagements with companies in their portfolios to advance this objective, as well as vote against directors of firms that do not meet these standards. In May 2021 for example, the 'Big Three' supported the small hedge activist fund Engine No. 1 in its proposal to elect sustainability-oriented board members against the will of oil giant ExxonMobil. In 2021 Vanguard joined the Net Zero Asset Managers Initiative, and committed to setting targets to cut emissions by 2030 and to achieve net zero by 2050 across its portfolios (Mooney, 2021). Early analyses indicate that more active engagements from 'Big Three' investors in large firms with high CO_2 emissions, do lead to lowered emissions (Azar et al., 2021). It is too early to tell whether these measures represent one-time actions that are primarily designed to generate good publicity, or whether they constitute the beginning of a forceful stewardship by the 'Big Three' on sustainability and climate issues. The influence of these financial giants should nonetheless, not be ignored.

The hidden power of index providers and the limits of ESG-funds

The consequences of the ongoing transformative shift towards index investing will shape the way the financial sector approaches and uses its influence to promote sustainability of publicly listed firms. This not only puts large asset managers such as the 'Big Three' in a central and influential position, but also those financial institutions that create and maintain the indices on which passive funds are based – that is, index providers.

Index providers determine which companies are part of the respective indices. The global index provider industry is, similarly to passive asset management, very concentrated. Just three firms, MSCI, S&P Dow Jones Indices, and FTSE Russell, hold a combined market share of over 70% (Petry et al., 2021). With trillions of dollars migrating from actively managed funds to passive funds, the role of the major index providers has been transformed in the mid-2000s from mere providers of market information, to key gatekeepers in global finance by, for example, defining the minimum corporate governance standards required for membership in benchmark indices (Petry et al., 2021). One example of this gate-keeping power was the 2017 inclusion of Chinese companies in big benchmark indices. In June 2017, MSCI decided to gradually include Chinese yuan-denominated A-Shares into its MSCI Emerging Markets index. FTSE Russell and S&P DJI followed suit in 2018. In 2019, Bloomberg included China into its widely tracked bond indices. Due to this powerful 'steering capital' effect, inflows of foreign capital into Chinese financial markets are estimated to be up to USD 400 billion over the next decade (Makepeace & Ashton, 2020). In March 2022, the major index providers have excluded all Russian firms from their indices due to Russia's attack on Ukraine, triggering automatic selling of company stocks worth an estimated USD 25 billion (Andrew, 2022).

There is a close dependency between major index providers, and the 'Big Three.' This symbiotic relationship becomes especially evident in ESG investing that includes the screening of firms according to environmental, social, and governance criteria. For many investors, ESG is synonymous with sustainable investing. Essentially, ESG funds exclude some firms from their portfolios and give different weighting to others based on proprietary ESG criteria. Currently, ESG is a very promising high-fee business segment both for the 'Big Three' asset managers and the major index providers. Particularly BlackRock and MSCI have very dominant positions in ESG investing globally.

In 2021, ESG index funds (which were virtually non-existent a few years ago) attracted record inflows of over USD 150 billion, more than twice the inflows of 2020. This means ESG funds are among the fastest growing asset classes worldwide. Despite some well-known limitations in existing ESG-metrics (see Chapter 4), most industry observers forecast high growth rates for ESG funds in the coming years (Bloomberg Intelligence, 2021). This puts index providers in an often ignored, yet central position. Major index providers, especially MSCI, act as standard-setters for ESG, because this small group of companies determines how the various E, S and G factors are being operationalized. It is important to note that the growth of ESG funds is primarily motivated by the business opportunities offered by its high-fee structure. This means that the current absence of regulation and standards within ESG investments might result in investment practices, which do not necessarily contribute to addressing sustainability and climate change in a rapid and forceful manner (Crona et al., 2021; Popescu et al., 2021).

Central Banks on a Changing Planet

Central bank and financial supervisors have gained increasing attention as key components in the transition towards a financial sector that actively contributes to international climate ambitions and to the Sustainable Development Goals. Central banks and financial supervisors are public institutions charged with maintaining price and financial stability, typically achieved via their control over monetary policy, their provision of liquidity to the banking system, and via financial regulation and supervision. Given their central role, and the need to rapidly align national economies and the financial sector with sustainability ambitions, some have argued that there is a strong case that monetary and financial policy toolkits should be used to ensure that private financial flows are aligned with national and international transition policies

(Campiglio, 2016; Robins et al., 2021; Dikau et al., 2021; Barkawi & Zadek, 2021). The Intergovernmental Panel on Climate Change (IPCC) recently identified the potential importance of central bank alignment in ensuring 'globally coordinated macroeconomic climate action' (Kreibiehl et al., 2022, pp.15-16).

Whether climate change and the risks to (and from) a changing planetary reality really falls within the mandates of central banks and financial institutions is debated. Concerns over potentially overstepping the limits of central bank independence have so far delayed the implementation of more interventionist green financial and monetary policies. However, a recent systematic analysis of 135 central bank mandates showed that over 50% have a mandate for sustainability, 12% explicitly so, and 40% through the (often secondary) requirement to support government policy objectives (Dikau & Volz, 2021). There also seems to be a growing consensus among central banks and financial supervisors in the last years that climate change poses serious financial risks, and that the management of these risks indeed does fall within the remit of their current mandates (NGFS, 2019; ECB, 2020; Brainard, 2021). More recently, central banks and financial supervisors have also begun to explore the implications of environmental threats beyond climate change, focusing primarily on biodiversity loss in recognition of its potential implications for macroeconomic stability (Van Toor et al., 2020; Svartzman et al., 2021b; Calice et al., 2021; NGFS-INSPIRE, 2022).

The Network for Greening the Financial System (NGFS), which comprises over 90 central banks and financial supervisors, has recognized that climate change and broader environmental threats such as biodiversity loss are 'sources of financial risk' and that 'central banks and supervisors should […] ensure that the financial system is resilient to these risks' (NGFS, 2020). In the first ever supervisory climate stress test (a pilot exercise), the French banking regulator found that French financial institutions overall had a 'moderate' exposure to climate-related financial risks, but that this result should be interpreted with caution given the constraining assumptions used in the chosen scenarios, such as a lack of feedback effects (ACPR, 2021).

In addition to risks posed by a changing planetary reality to the financial system, financial authorities also need to address their own impacts on the climate system and the biosphere (Adams et al., 2021; Crona et al., 2021, see also Chapter 2). Financial flows and investments decisions contribute to 'lock-in' effects that may severely delay and potentially derail the goals of sustainability transition policies, thus making a structural transition more difficult and costly despite the increasing profitability of green alternatives (Kemp-Benedict, 2018). This is why policy coherence – that is, the coordination between monetary, financial, fiscal, and industrial policies – is important to help minimize systemic risks to financial stability (Robins et al., 2021; Barkawi & Zadek, 2021; Dikau et al., 2021), and to ensure that private financial dynamics do not inadvertently undermine sustainability and climate policies (Kedward & Ryan-Collins, 2022). Such co-ordination between central banks and ministries of finance with the ambition to deliver liquidity stimulus to targeted parts of the economy can be seen in many parts of the world since the fallout of the COVID-19 pandemic (Cavallino & De Fiore, 2020, Chenet et al., 2021).

Box 5. Early quantifications of biodiversity-related financial risks

The central banks and financial supervisors working on biodiversity-related financial risks have undertaken exploratory research aimed at quantifying the magnitude of potential financial risk exposure within domestic jurisdictions. For example, the Dutch central bank, De Nederlandsche Bank (DNB), has quantitatively mapped the physical and transition risks of domestic biodiversity loss, estimating that 36% of Dutch financial institutions are highly dependent upon at least one ecosystem service (Van Toor et al., 2020). An analysis of the European Central Bank's corporate sector purchase program (CSPP) portfolio – which accounts for 20% of the euro-denominated bond market - found that over 40% of the studied assets are potentially exposed to high or very high dependencies on ecosystem services (Kedward et al., 2021a). Using an extended methodology that accounts for upstream effects, the Banque de France has found that all securities held by French financial institutions are to a greater or lesser extent dependent on ecosystem services through their supply chains (Svartzman et al., 2021a). The World Bank has also used these methodologies for Brazil, finding similar results (Calice et al., 2021).

Whilst the financial stability implications of climate change have become widely accepted by financial authorities (Brainard, 2021; Bank of England, 2021b; Alogoskoufis et al., 2021), further analysis into the scale and breadth of biodiversity-related financial risks is complicated by data gaps, methodological challenges, and a widespread lack of understanding about financial materiality related to biodiversity loss. Recent initiatives such as the Taskforce for Nature-related Financial Disclosures and the Network for Greening the Financial System (NGFS)-INSPIRE Joint Study Group on Biodiversity and Financial Stability, aim to fill these gaps (TNFD, 2021; NGFS-INSPIRE, 2022).

Box 6. How central banks and financial supervisors can act to support a just transition towards sustainability

Assessing environment-related financial risks to price and financial stability

- Exploring alternate modelling methodologies – such as input-output analysis, network-based approaches, agent-based models, and stock-flow consistent modelling – in order to capture some of the complex non-linear dynamics not usually accounted for in traditional climate-economy models (see also Svartzman et al., 2021b for a full discussion).
- Focusing quantification efforts on key risk transmission channels where drivers of environmental degradation are particularly interlinked with the financial system. This could involve focusing on financial interactions with ecological tipping points (e.g., Galaz et al. 2018b); or particular sectors – such as those producing 'forest risk commodities' (e.g., Kedward et al., 2021a).
- Mandatory disclosure of portfolio exposure to certain sectors (e.g., fossil fuels, mining, agriculture), as well as risk management and due diligence procedures relating to the financing of these sectors.

Developing prudential policy to address also system-wide vulnerability

- Punitive capital requirements on carbon-intensive sectors (Philipponnat, 2020)
- Climate-aligned systemic risk buffers (SyRBs) – analogous to the SyRBs in wide use across the EU to address several sector- and location-specific sources of systemic risk (Monnin, 2021)
- Countercyclical capital buffers designed to restrict carbon intensive exposures during expansionary credit cycles (D'Orazio et al., 2019)
- Large exposure limits for the most environmentally-damaging counterparties (Schoenmaker & Van Tilburg, 2016; Miller & Dikau, 2022)
- Supervisory limits applied on the basis of the greenness or "dirtiness" of particular activities or asset classes (Dafermos et al., 2021)

Aligning monetary policy operations with broader government goals on the green transition

- Tilting asset purchase portfolios towards purchasing green assets and/or exclude the assets linked to the most environmentally-damaging activities (Jourdan and Kalinowski, 2019; Dafermos et al., 2020).
- Abandon ESG metrics to adjust such portfolios and instead use qualitative criteria, such as exclusions of unsustainable activities, could be used to steer asset purchases in alignment with green transition goals (Kedward et al., 2020; Dafermos et al., 2020; Dafermos et al., 2021).

Interventionist policy actions (*where mandates allow*)

- Funding and refinancing schemes, which provide the financial system with liquidity, could be structured so as to incentivize lending to priority green sectors (van 't Klooster and Van Tilburg, 2020). The People's Bank of China and the Bank of Japan have recently launched green targeted liquidity schemes.
- Policies to steer credit using quantity-based mechanisms, such as maximum lending ceilings (for undesirable sectors) and minimum lending floors (for strategic industries). Such 'green credit guidance' has already been implemented in emerging economies such as China, India and Bangladesh (Dikau & Ryan-Collins, 2017).

Source: Summary by Katie Kedward and Joshua Ryan-Collins, UCL Institute for Innovation and Public Purpose (UK)

From insight to action

A number of international sustainability initiatives have evolved in the last years to help develop and apply these toolkits (TCFD, 2017; European Commission, 2019; BEIS, 2019). Their main strategy is to support new ways to measure and disclose environmental-financial risks as a means of managing these risks (Chenet et al., 2021). This includes the use of tools such as disclosure frameworks, Environment Sustainability and Governance (ESG) metrics, and forward-looking risk modelling in order to improve market transparency (Bailey, 2020; Schnabel, 2020; ECB, 2020; Brainard, 2021; Weidmann, 2021). This approach is grounded in a 'market failure' understanding of environmental threats, which are assumed to result from negative externalities, i.e., the fact that environmental damages are not priced into existing markets (Christophers, 2017; Ryan-Collins, 2019). Internalizing hidden environmental costs and benefits into market prices will

– at least in principle – lead to more sustainable resource allocation, shifting financial flows to more sustainable activities, and mitigating the financial risks associated with exposures to environmental threats and damages.

The European Central Bank (ECB) and the Bank of England for example, are now undertaking climate-related stress tests – exercises which test the resilience of the financial system to a number of future climate-related shock scenarios. They have also announced plans to decarbonize their monetary policy portfolios (Bank of England, 2021c; Bank of England, 2021a; ECB, 2021; Alogoskoufis et al., 2021). After identifying material exposures to biodiversity-related risks within the Dutch financial sector, the Dutch central bank's concluding recommendations focused on the development of biodiversity-related financial disclosure and risk modelling frameworks (Van Toor et al., 2020). The NGFS Study Group's recommendations on the topic of biodiversity and financial stability have focused on the need to develop risk assessment methodologies, such as biodiversity-related scenarios, and signal the importance of accounting for biodiversity to financial institutions under their supervisory jurisdiction (NGFS-INSPIRE, 2022).

These initiatives should all be commended. However, financial policymakers need to acknowledge that comprehensive accounting, reporting, and risk modelling methodologies may take years to become established, by which time some environmental threats may become financially material (Kedward et al., 2021b). The slow progress of voluntary climate risk disclosure initiatives such as the Taskforce on Climate-related Financial Disclosure so far does not provide encouraging evidence in this respect (Christophers, 2019; Ameli et al., 2020; Ameli et al., 2021). In addition, existing climate-economy models, which are used as the basis for existing central bank scenario analysis initiatives, are limited in their ability to provide detailed quantifications of climate risk, given conditions of radical uncertainty (Chenet et al., 2019; Bolton et al., 2020; Svartzman et al., 2021b; Chenet et al., 2021). Biodiversity risks and other risks created by planetary change are subject to additional complexity and uncertainty due to feedbacks, tipping points, and regime shifts (NGFS-INSPIRE, 2022; Li et al., 2018; Crépin & Folke, 2015). As a result, central banks and financial supervisors may fail to deliver on their primary mandates to protect price and financial stability – if, as is feared, these risks emerge over the nearer-term. Financial policymakers should therefore consider how to assess and manage climate- and biodiversity-related and other financial risks on the basis of information available today. Possible policy actions include those listed in Box 6.

Central banks, asset managers, index providers, and 'keystone actor' companies hence are not passive within nor exogenous to the economic and the financial system. Rather, they are centrally placed actors whose decisions help create and shape markets in important ways that have deep impacts on our living planet and the climate system (Braun, 2021). Chapter 7 explores how this influence can be leveraged to help build transformative capacities for people and planet.

Chapter 6. Foundations for Behavioral Change

To shift towards just futures on a thriving planet, large-scale behavioral change has a crucial role to play. As we highlight in this chapter, in order to accelerate change towards sustainability, we need to pay attention to the broader contexts shaping human behavior and how human behavior is co-evolving with changing contexts. This is what we consider foundational for understanding human behavior, which can offer potential for profound and large-scale behavioral change towards sustainability.

Humans and their environments are inextricably connected. Human behavior is shaped by, and in turn shapes, the diverse environments in which humans live and are embedded (Markus & Kitayama, 1991; Schill et al., 2019). These environments (or contexts) include the specific situations in which humans make decisions (conscious or not), the diverse social and cultural groups of which they are a part, and the biophysical and ecological environments around them (see Figure 15a; Schill et al., 2019). While it can be critical to understand what makes people act pro-environmentally in different domains (e.g. save water or reduce fossil fuel consumption, Nielsen et al., 2021; Stern et al., 2016), we focus here on insights with the capacity to achieve profound behavioral change at a societal level, spanning beyond the individual or small groups of actors and including both the private, and public spheres. We therefore turn to insights from work that clarifies and emphasizes the role of broader contexts for behavioral change. These contexts extend significant and durable influences on human behavior, and shape how humans relate to their environments and the biosphere (DiMaggio & Markus, 2010; Gifford, 2014; Hoff & Stiglitz, 2016), providing more or less fertile grounds for biosphere stewardship (West et al., 2018). This understanding is paired with viewing human behavior as dynamic, which implies that human behavior and its contexts are ever-evolving and influencing each other - certain contexts lead to certain behaviors, which in turn create new contexts, and so on (see Figure 15b; Schill et al., 2019).

Changing one's habits, way of life, or approach to doing business can be hard, uncomfortable, unwanted, or simply not an option. But what if one is just doing what everyone else is doing, what is expected, or what feels right or fair? While there might be some important decisions and behaviors that people (seemingly) make relatively independently (Markus, 2016), generally, it is instructive to regard to humans as "socially and culturally wired", meaning that behaviors and how they are perceived are strongly influenced by the broader socio-cultural contexts in which they are enmeshed including the social groups to which they belong (Eriksson et al., 2021; Schill et al., 2019). Moreover, people's actions and wellbeing strongly depend on the biosphere in which they are all embedded (Schill et al., 2019). The intersecting contexts and groups that humans are a part of shape cognitive processes (DiMaggio & Markus, 2010; Lamont et al., 2017; Nisbett et al., 2001; Talhelm et al., 2014; Uskul et al., 2008) emotions (Markus & Kitayama, 1991; Russell, 1991), and motivations (Iyengar & Lepper, 1999; Kyle et al., 2004; Markus, 2016). Furthermore, these contexts and groups come with their worldviews and narratives, as well as their institutions, norms, and shared values (Lamont et al., 2017; Ostrom, 2000; Rokeach, 1968; Tankard & Paluck, 2016). The focus of this chapter is norms and the shared values on which they rest, i.e. what is valued, and what is perceived right and wrong.

We choose this focus because norm changes have been highlighted as a promising avenue to help address global sustainability challenges in their capacity to instigate large-scale behavioral change (Chapin et al., 2022; Davis et al., 2018; Farrow et al., 2017; Nyborg et al., 2016; Otto et al., 2020). Moreover, and importantly, social norms and norm changes are also key to how economies and financial systems operate and change (Elster, 1989; North, 1990; Young, 1998), but have so far gained less attention in economic analysis (Burke & Young, 2011).

Social norms shape expectations and give rise to a sense of obligation, for example to family and community (Young, 2015). They can be seen as the predominant behavioral pattern within a group, supported by a shared understanding of acceptable actions (Nyborg et al., 2016). They are sustained by social interactions through, for example, social sanctioning, coordination benefits, and signalling (such as status). Everyone conforms, everyone is expected to conform, and everyone wants to conform when they expect everyone else to conform (Nyborg et al., 2016; Young, 2015). Social norms rest on social values, which can be regarded as general standards guiding actions and attitudes, but also evaluations and judgements, such as what is important, or what is deemed good and bad of individuals and collectives (Axelrod, 1986; Rokeach, 1968). Hence, norm changes can instigate large-scale behavioral change. So, what do we know about such processes?

The role of social norms for large-scale behavioral change

Social norms typically persist for a long time, but can change quite abruptly. Reinforcing social interactions bolster the new dominant behavior leading to a new period of persistence. These features together create the characteristic pattern for the evolution of norms: long periods of no change punctuated by abrupt change in which an old norm is replaced by a new one (Axelrod, 1986; Nyborg et al., 2016; Young, 2015). For example, the practice of dueling among the upper class in the United Kingdom in the nineteenth century, where both parties were even willing to risk their lives over facing social sanctions and damage to reputations by violating the norm, persisted for a long time but was eradicated within a single generation (Jindani, 2017; Mackie, 1996). Similarly, intolerance towards colonial dependence emerged in just two decades after World War II (Axelrod, 1986).

Certain events may play an important role when norms change (Young, 2015). Such an event could, for example, be the appearance of a "leader" with enough influence to challenge the existing norm and shift or create a broad public opinion. The car manufacturer Tesla, for example, was heavily influential for creating a demand for electric cars by not only highlighting Tesla's design features, but also its benefit in the form of freedom without dependence on fossil fuels. Similarly, the working from home mandates and travel restrictions that were suddenly implemented following the COVID-19 pandemic, led to a dramatic change in work-related travels that may lead to a long-lasting norm change around such travel (Engström et al., 2020).

The influence of leaders and/or certain events to shift public opinions and trigger norm changes highlights the potential role of policy and interventions. Research shows that policy can support the transgression of social tipping points in norms, either by creating tipping points where none exist, or by pushing the system past such thresholds (Nyborg et al., 2016).This was, for example, the case when the ban on indoor smoking was implemented in Norway (Nyborg & Rege, 2003) and the regulation on corporal punishment towards children was implemented in Sweden (Breger et al., 2020). Following these regulations, expectations changed, which led to changes in behavior and norms, which eventually also spread to neighboring countries. In some cases, it might be sufficient for norms to change if the intervention alters the behaviors of a few key actors, thus leveraging the positive feedback effects from social interactions (Kinzig et al., 2013; Nyborg et al., 2016; Young, 2015).

This line of thinking originates from Schelling (1971) and is also incorporated into diffusion dynamics in innovation theory (Rogers, 2010). These ideas long rested on results from formal theoretical models and qualitative observations, which proposed a wide range of possible thresholds for the size of an effective critical mass, ranging from 10% of the population up to 40%. A recent experimental study investigating these observations empirically showed that a dominant social convention can be changed by a committed minority of roughly 25% of a

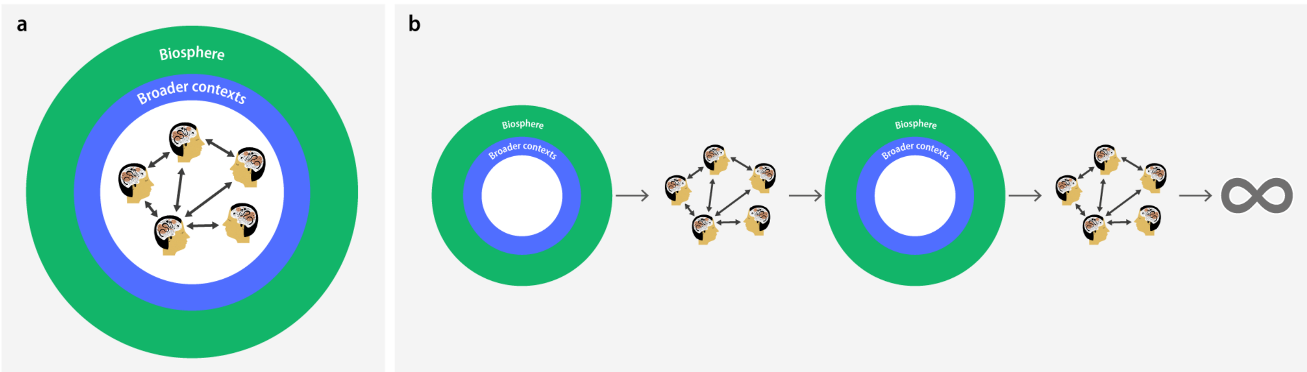


Figure 15 | Foundations for behavioral change. a) Humans are enmeshed in multiple and intersecting contexts (cultural, political, economic, institutional, etc.) and social groups (gender, class, etc.). These 'broader contexts' and the biosphere in which all humans are embedded extend significant and durable influences on human behavior. b) Viewing human behavior as dynamic implies that human behavior and its broader contexts and the biosphere are ever-evolving and influencing each other - certain contexts lead to certain behaviors, which in turn create new contexts, and so on. Source: The illustrations are adapted from Schill et al., 2019.

group (Centola et al., 2018). While the mass value of 25% may not be a general value, results do show that tipping point dynamics can emerge from a small critical mass - thus consistent with previous theoretical expectations.

Social norm changes for sustainability and the role of policy interventions

We now highlight how the above described insights have been used to propose that norm changes can play an important role for tackling sustainability challenges (Constantino et al., 2021; Nyborg et al., 2016; Otto et al., 2020; Winkelmann et al., 2022). For example, these insights have informed the proposal of several promising interventions that could activate changes in behavior leading to less dependence on fossil fuel (Otto et al., 2020). One such intervention is large-scale building demonstration projects, such as carbon neutral cities, which could be important for creating public awareness, for stimulating consumer interest in environmental technologies, and for accelerating their dissemination to other locations. A norm change with respect to building codes for construction and infrastructure projects would have a significant effect on fossil fuel emissions, especially where rapid urban building booms are driving up energy and other resource use. Emissions from buildings account for almost 20% of all carbon emissions (taking indirect emissions into account) (Otto et al., 2020).

Policy interventions can also target to change investors' expectations of other investors' behavior. This is especially promising if investment benefits increase with more people making the same investment (coordination benefits). For example, climate policies that increase the expected relative payoff from green technology investments compared to other investments can trigger a significant shift in green investments, and lead to a new equilibrium where all investors would choose to invest in green technology (Mielke & Steudle, 2018). There is also evidence that a 'divestment movement' by institutional and private investors away from fossil fuels may be the tipping element that can burst an emerging carbon bubble (Ewers et al., 2019). Simulations suggest that even a small share (10-20%) of socially responsible investors is sufficient to initiate the burst of the carbon bubble if conditions are right.

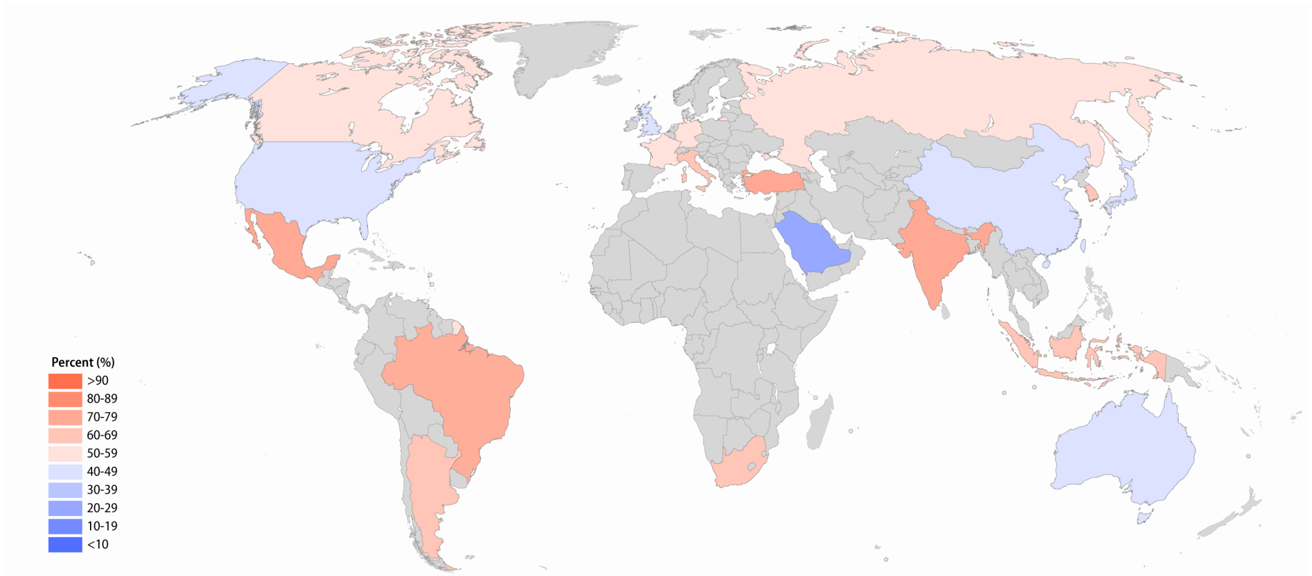
Food production is currently the human activity with the greatest impact on the planetary boundaries, accounting for about 25% of global greenhouse gas emissions (Mbow et al., 2019), 70% of global freshwater use (Willett et al., 2019), and being a major driver of biodiversity loss (IPBES, 2019). Replacing animal-based food products with plant-based alternatives would provide great environmental benefits (Aleksandrowicz et al., 2016; Poore & Nemecek, 2018; Willett et al., 2019). But such a shift on a larger scale is easier said than done. One reason is that the consumption of animal protein throughout history has been closely associated with status, power, and wealth. There are strong norms around meat consumption in many societies today: people prefer, and often even expect, some type of meat with every meal (Chiles & Fitzgerald, 2018; Graça, 2016). Nyborg and colleagues (2016) explore the role of policy interventions to drive a norm shift, and emphasize the potential role of policies as signals, and the reinforcing effect that a small change in acquired taste may have.

These different interventions may be promising, but public opinion is a crucial factor because it may itself limit key actors and policy-makers' ability to make these norm changes happen. In policy, the public can be seen as a "thermostat" signaling what is politically feasible. In general, public opinion is a key determinant of policy change in democratic countries (Anderson et al., 2017; Drews & van den Bergh, 2016). Acceptability - meaning the likelihood that an intervention/policy is accepted (Kyselá et al., 2019) - depends on a number of factors, such as personal values and beliefs about the issue, perception of the actual policy in question, and perceptions of and trust in the policy-maker (Bergquist et al., 2021; Fairbrother et al., 2019). These factors in turn, depend on the current state of the environment and the broader socio-cultural contexts that come with their norms and the shared values on which they rest. This implies that the policies and interventions that can trigger a norm shift, may not translate between cultures.

A viewpoint is needed that acknowledges that interventions and policies may trigger norm changes, and that a policy change often follows shifts in current public opinions. This was illustrated in the case of dueling, where several regulatory attempts were made that failed because the public opinion against these customs was not yet strong enough to challenge them (Axelrod, 1986; Jindani, 2017). Another manifestation of the important role public opinion plays is the "Gilets Jaunes" demonstrations in France where social mobilization blocked fuel price increases (Beiser-McGrath & Bernauer, 2019). Therefore, before exploring what policies could be implemented that trigger norm changes, it is critical to understand the current temperature of public opinion. Is it signaling that we are ready to challenge established norms and accept change? And if not, what can be done?

A 'temperature check' – are people ready to accept change?

In April and May 2021, the Global Commons Survey (Gaffney et al., 2021) was conducted to understand people's awareness about the state of the global commons and attitudes towards the transformation needed to protect them. Global commons are the Earth's resources humans need to survive and flourish: the climate, the oceans and freshwater, the air we breathe, life on Earth, and other processes that keep Earth stable and resilient (Gaffney et



	ARG	AUS	BRA	CAN	CH	FRA	GB	GER	IND	INO	ITA	JAP	KSA	KOR	MEX	RUS	SAF	TUR	USA
Very or extremely **worried about the state of nature today**	68%	46%	74%	52%	46%	57%	46%	57%	70%	68%	69%	44%	26%	64%	77%	57%	66%	79%	45%
Protect environment over economic growth	41%	66%	54%	60%	68%	NA	NA	63%	NA	72%	NA	34%	NA	NA	55%	45%	NA	55%	50%
Economic growth over environmental protection	43%	31%	28%	40%	26%	NA	NA	27%	NA	21%	NA	23%	NA	NA	42%	42%	NA	41%	39%

Figure 16 | A 'temperature check' of environmental concern across the G20 countries. The world map and upper panel shows the percentage of people in each G20 country that are 'very or extremely worried about the state of nature today'. The lower panel shows the percentage of people agreeing with the following two statements: "Protecting the environment should be given priority, even if it causes slower economic growth and some loss of jobs" ('Protect environment over economic growth'); and "Economic growth and creating jobs should be the top priority, even if the environment suffers to some extent" ('Economic growth over environmental protection'). Sources: Global Commons Survey (Gaffney et al. 2021), and 7th wave of the World Values Survey in which 57 countries were surveyed between 2017-2020 (Haerpfer et al., 2022).

al., 2021). In total, 19,735 people across the G20 countries were surveyed. The results suggest that a majority of people show concern about the state of the global commons: 73% of people believe that the planet is close to serious "tipping points" due to human actions, and 58% of people are very or extremely worried about the state of the global commons (see Figure 16). Moreover, 74% of people support the idea that economic priorities should move beyond profit and focus instead more on human wellbeing and ecological protection. There is a general awareness of the need for change, and in particular concerning an energy transition.

In the same time period (March-April 2021), a European survey (European Commission, 2021) addressing attitudes towards climate change was carried out in the 27 Member States of the European Union with 26,669 EU citizens. More than nine in ten Europeans (93%) stated they believe that climate change is a serious problem. Nine in ten respondents (90%) stated that they agree that greenhouse gas emissions should be reduced to a minimum to make the EU economy climate-neutral by 2050. Moreover, 75% of the Europeans thought that economic recovery plans (following the COVID-19 pandemic) should mainly be invested in the new green economy rather than in the traditional fossil-fueled economy.

These two recent surveys, with relatively broad coverage, find indeed that most people are concerned about the state of the environment and believe that action is needed. But what if these stated levels of concern depend strongly on current ecological, social, and political states/landscapes? How robust are these findings? In July 2021, only a few months after these surveys were executed, Western Europe experienced severe flooding due to heavy rain. Would a survey conducted after these floods have shown even stronger concern for climate change? Research has shown that attention to e.g. climate change reliably increases after extreme weather events, at least in the short term (Sisco et al., 2017).

For more than two years, we have been living in the midst of a pandemic and, at the time of writing this report, there is a war in Ukraine. The 'Finite Pool of Worry' hypothesis (Weber, 2006) states that environmental or climate concerns can diminish as other worries rise in importance. This could have serious impacts on environmental policy support. A longitudinal survey of UK residents, surveyed in April 2019 and June 2020, shows however, little support for diminishing climate change concerns during the COVID-19 pandemic. The authors suggest that climate change has become an intransigent concern within UK public consciousness (Evensen et al., 2021). Similarly, preliminary results from a longitudinal study conducted in the USA, Italy, and China show that whereas attention to climate change decreased during the COVID-19 pandemic, people's worry about climate change did not (Sisco et al., 2020). Instead, climate change worries spillover to other worries, which would imply that calls to action about e.g. climate change could achieve greater success in the context of an additional new threat, even one that dominates public attention (Sisco et al., 2020).

Results of these fairly recent studies suggest that concerns about the state of the environment and for the global commons may indeed be 'stable'. What people claim to be worried about, however, and what people are willing to accept and do can be very different things (Kollmuss & Agyeman, 2002). Are people willing to make profound changes and to accept personal sacrifices by, for example, embracing policies that are costly to them? One step towards answering this question is to look at surveys measuring peoples' willingness to accept costly environmental policies. In general, a significantly lower percentage of people are willing to accept costly policies (e.g. policies that raise the price of fossil fuel emissions) compared to the percentage expressing a concern for the state of the environment. For example, results from the most recent World Values Survey (2017-2020; Haerpfer et al., 2022) show that, on average, 54% of the population (in 57 surveyed countries) agrees that protecting the environment should be a priority, even if it causes slower economic growth and some loss of jobs (see Figure 16, lower panel). Specific policies that can be costly to the individual, such as carbon taxes, are often supported by less than 50% of the respondents (Beiser-McGrath & Bernauer, 2019; Carattini et al., 2019). These relatively lower numbers of willingness to accept costly policies are also more in line with the de facto relatively low mitigation efforts we have seen so far in many countries (Anderson et al., 2017) as well as the limited investments in climate technologies and biosphere stewardship during the economic crisis following the pandemic (see Chapter 2).

But we also see behaviors and actions pointing to the other direction in different segments of society. The most prominent and visible example is perhaps Fridays For Future, a youth-led and organized global climate strike movement that started in August 2018. This movement led to an increase in activism focused on climate change, particularly among youth (Fisher & Nasrin, 2021), and is today one of the largest youth movements in history (Martiskainen et al., 2020). At the same time, we also observe a willingness to contribute to climate and sustainability ambitions among business leaders, financial institutions, and large transnational corporations (see Chapter 5).

In summary, the expressed concern for the state of the planet could indicate that the temperature of public opinion (and the planet for that matter) is high enough for people to accept change.

Moving ahead

The surveys mentioned above show that people across the world and many cultures strongly endorse values in line with an urgency to protect the environment and our shared global commons, but people do not always act on these values (Bouman et al., 2021). One important factor for such value-action-incongruence is the costliness of behavior: people are less willing to act on such values when the behavior is associated with high economic costs, effort, or inconvenience (Steg, 2016). It is important to keep in mind that not all people have the means or capacity to change and act (Moser & Ekstrom, 2010). For this reason, it is of crucial importance to design policies and interventions that are perceived as fair and just, which also increases the likelihood of policies and interventions being accepted. Moreover, what enables action and what is perceived as fair and just depends in turn on the specific socio-political contexts (Fairbrother et al., 2019; Harring et al., 2019).

Another factor explaining the value-action-incongruence is that people are more likely to act on their values when they are salient (and when competing values are not salient) in the contexts in which choices are made (Hoff & Stiglitz, 2016; Steg, 2016). We must understand, therefore, the landscape of value saliency, and work to support contexts that give more weight to pro-environmental or 'biosphere-based' values. For example, when people underestimate how widespread biosphere-based values are, pro-environmental action may be less likely. If, on the other hand, people recognize their values in others, society-wide action is more likely (Bouman & Steg, 2019). It is often said that 'we value what we can measure,' and given that a new metric for the Anthropocene in which the dependence of a well-functioning biosphere is emphasized (as we argue for in Chapter 4) will also give more weight and inspiration to biosphere-based values and action.

We can also think about how values are formed and potentially can be changed. Once values are formed, they are believed to be relatively stable (Bardi & Goodwin, 2011; Dietz et al., 2005; Maio & Olson, 1998), which suggests that one attempt to strengthen biosphere-based values could be to continue to educate and nurture such values in children (Dasgupta, 2021; Gifford, 2014; Steg, 2016). However, some studies suggest that values may also change later in life if initial values are challenged repeatedly leading to a re-evaluation of the relative importance of certain values (Bardi & Goodwin, 2011). This means that we should also repeatedly challenge values and norms that continue to lead us on a path harmful to sustainability efforts.

So what norms are challenged right now? According to Axelrod (1986) “awareness of a given norm is most intense precisely when it is being challenged.” Today, environmentally damaging behaviors (by individuals, corporations, and states) are clearly being challenged. People are increasingly aware of the norms and behaviors that need to change, which also has bearing on how we, as a society, are beginning to think about how to measure welfare, progress, and success, and about responsibility by actors in both the private and the public spheres, trends which we elaborate upon in several chapters of this report. If we, on a societal level, manage to leverage these trends and support them through new interventions and policies that help to maintain and extend the changed norms, we are much more likely to accelerate change towards sustainability.

Chapter 7. From Systemic Risks to System Opportunities

A changing planetary reality, and the inability to properly grasp its consequences for people and planet, pose immense challenges and risks. Yet, a shift towards a prosperous future for all on a thriving planet is possible. This concluding chapter changes focus from exploring the features of systemic risks in the Anthropocene, to outlining opportunities for transformation. We bring together conclusions from previous chapters and discuss how social norms, supporting economic policies and institutions, the "power of giants," and initiatives to phaseout malfunctioning systems can trigger domino-effects that support opportunities for both people and the planet.

The world has entered a time of unusual turbulence with severe planetary, social, and economic consequences. Humanity and societies have truly become a global force of planetary change. Economic decisions by businesses, financial institutions, central banks, governments, and many others result in climatic and ecological impacts, which later feedback to society by threatened livelihoods, food security, loss of resilience in vital ecosystems, and economic harm.

Shifting away from systemic risks to system opportunities requires a new perspective, and new strategies and actions. It is time to move away from theories, world views, and beliefs systems that are blind to planetary change, or that treat the planet and our living biosphere as external to economic and social development. Instead, as this report has clarified, people and planet are now deeply intertwined, directly and indirectly interconnected from the local to the global. This new reality requires actions that build transformative capacities. Building on the insights presented in previous chapters, we develop four avenues for building the transformative capacities needed to shift our common trajectory rapidly: defining a new direction, creating enabling conditions, developing capacities to phase-out, and helping scale up investments for resilience (Figure 17).

Defining a new direction

Building resilience is about enhancing capacities to live and develop with changing circumstances – both predictable or surprising – and, at best, about having the ability to turn crises into system opportunities. Realizing such opportunities however, requires that policy-makers, businesses, and civil society are 1) knowledgeable about our changing planetary reality; 2) can create visions of a safe and just future; and 3) acknowledge the need for not only adaptation, but also transformation.

A new planetary reality

Our planet is changing rapidly. As we discussed in detail in Chapter 1, this new planetary reality creates unprecedented challenges for the financial sector, for economies, for the biosphere, and for us all. Actions by the financial sector and decision-makers that intend to guide a transformation towards a just and safe future, need to acknowledge this new reality, their responsibility in creating it (Chapter 2), and the key role that climate stability and a resilient biosphere plays for both current and future generations. A failure to act on these insights is likely to lead to larger risks and maladaptation with detrimental consequences on the Sustainable Development Goals, the Paris Agreement, and thus, on the world's ability to create a prosperous future for all.

Imagining a safe and just future

A safe and just future is possible. "Seeds" of such a positive and prosperous future can already be identified in the innumerable initiatives that could create a better future for all from the bottom-up (Bennet et al., 2016; Hajer et al., 2015). The operationalization of such a direction is

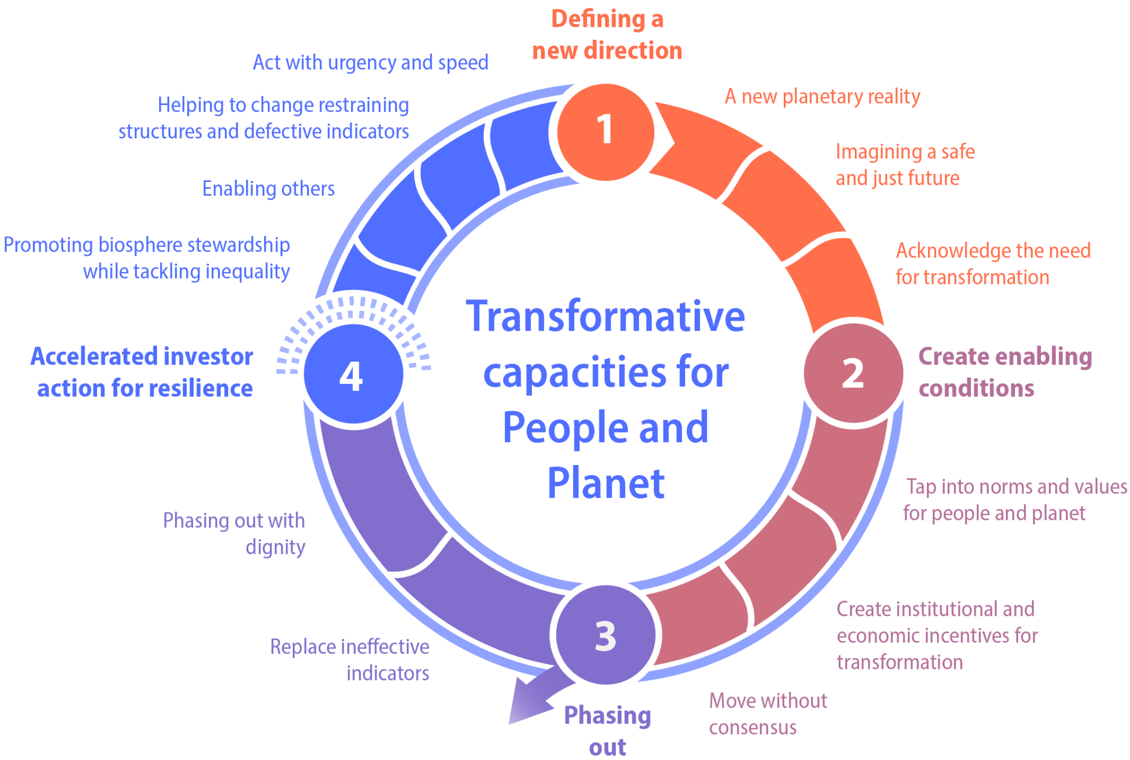


Figure 17 | Building transformative capacities for people and planet.

partially captured by the Sustainable Development Goals (SDGs), but should place strong emphasis on the need to sustain critical earth-system processes in support of the biosphere and human wellbeing (Chapin et al., 2022). Imagining and realizing a safe and just future requires the ability to identify and mobilize co-benefits, and to multiply such benefits through agile global collaborations by experimentation and policy-learning (Kivimaa et al., 2017; Bernstein & Hoffmann 2018).

Examples of such co-benefits are manifold. Tackling climate change and the loss of ecosystems and species for example, offers considerable benefits to human health (Watts et al., 2015; UNEP & ILRI, 2020). Actions that halt or reverse biodiversity loss also have substantial climate advantages (Shin et al., 2022). A sustainable and just blue economy could be made possible through the mobilization of new forms of finance and regulations that empower local people, and that support responsible business and long-term societal goals (Sumaila et al., 2020). A transformation of food systems towards healthy and sustainable food for all is attainable with the right economic incentives (Béné et al., 2020; Queiroz et al., 2021). Financial and economic incentives and regulation can, and should, align with such visions and system opportunities.

Acknowledge the need for transformation

The first years of the 2020s have, in many ways, illustrated the ability of the global community to act collectively to help mitigate global shocks, and to respond to unfolding emergencies. The COVID-19 pandemic, for example, led to an unprecedented mobilization from the scientific community and governments to create new vaccines at record speed. The organization by individuals, civil society, and neighboring countries to support Ukrainian families fleeing from the Russian invasion of Ukraine, is another notable example. However, the first years of this new decade also show the vast fragilities and lock-ins that characterize our world today. Despite the rhetoric about the need to "build back better," and the window-of-opportunity opened by the economic stimulus packages created to support economies around the world to recover from the COVID-19 pandemic (Andreijvic et al., 2020; Walker et al., 2020), recent evidence that significant fragilities remain and are even being sustained. Both private and public investments have continued to flow into sectors and industries that are known to undermine climate stability and the resilience of our living planet (Nahm et al., 2022).

This is why resilience research makes a clear distinction between adaptation and transformation. Adaptation is about adjusting responses to changing circumstances in order to remain on the current pathway of development. For example, a business, community, city, or economy can revise their activity plans for the coming years to cope better with expected market changes. Transformation, on the other hand, involves the creation of a fundamentally new system when ecological, economic, or social conditions make the continuation of the existing system untenable (Walker et al., 2004; Folke et al., 2010).

Transformations towards sustainable and just futures are defined as fundamental shifts in the way authority, power, and resources are structured and flow in a particular social system. This also includes the practices and processes that reflect and reproduce those structures, norms, and values (Moore & Milkoreit 2020; Leach et al., 2012). Transformations are complex social processes that unfold over time and across different levels of organization in society. They involve innumerable interactions among actors and institutions. Often, such deeper system changes unfold following crises that dislodge vested interests and conventional ways of looking at the world. These disruptions can allow innovative ideas and practices to be seeds for a new direction (Olsson et al., 2004; Olsson et al., 2006; Loorbach, 2010; Geels et al., 2017; Herrfahrt-Phäle et al., 2020). Transformations raise important questions about values ('what do we want to achieve, and why?'), democracy ('who gets to decide?') and legitimacy ('how are decisions to be made in ways that are viewed as legitimate?') (Pickering et al., 2022).

Transition management and resilience theory scholars studying transformations argue that they happen by the upscaling of innovation unfolding in parallel with the dismantling of older paradigms, institutional infrastructures, and incentives. This is often illustrated as an X-shaped curve (Box 7, based on Loorbach, 2014; Hebinck et al., 2022), where the changes evolve in different phases, and at several levels in society at the same time. As we elaborate below, economic and financial incentives, policies, and indicators, need to tackle all parts of this X-curve to be able to be viewed as contributing to transformative change.

Creating enabling conditions

Existing institutions, political interests, and economic incentives can all hinder the emergence of sustainable alternatives to malfunctioning arrangements. This is why creating conditions that enable transformations has proven important. Below, we elaborate on three key actions that contribute to the creation of such conditions.

Tap into norms and values for people and planet

Social norms and the shared values on which they rest can be an important enabling condition to accelerate change towards sustainability. As described in Chapter 6, norms and values extend durable influences on human behavior

Box 7. How transformative change happens

Transition and resilience theory scholars who have studied transformations argue that they unfold through changes that evolve during different phases, and at several levels in society at the same time. Each phase requires different types of actions from decision-makers. For example, in the preparation phase, a crisis or anticipated risks can trigger initiatives by policy-makers, businesses, or members of civil society to experiment with new practices and modes of governing.

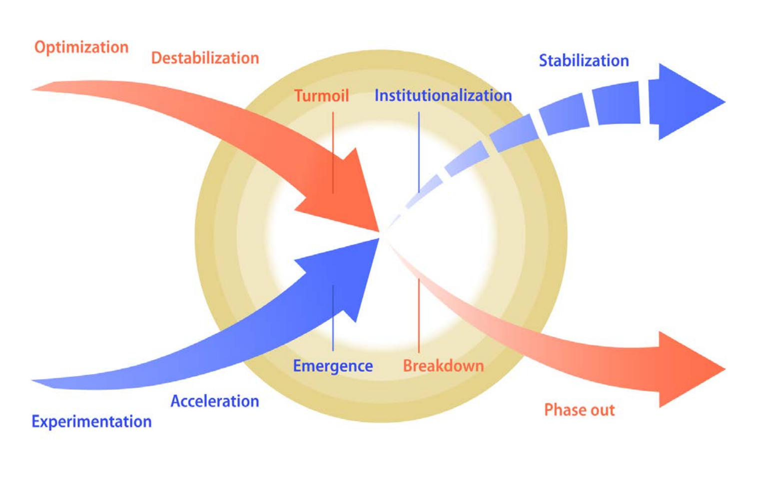


Figure 18 | The X-curve of transformative change. The X-curve portrays the parallel processes of build-up and breakdown. Based on Hebinck et al., 2022.

Socio-political and environmental shocks can open up opportunities for new solutions to diffuse and become institutionalized. Decision-makers in both the private and public sector can support a sustainability transformation if they are skillful enough to evaluate, support sensemaking, and combine a range of available and sometimes competing ideas and approaches into new creative solutions to garner support. There is a risk however, that legacies and proponents of the previous regime mobilize to either actively reject, or to outcompete alternatives. Novel ideas can also be coopted by dominant interests as a means to preserve the status quo. The capacity to consolidate new values, implement and enforce new rules and regulations and support the routinization of new practices are key in the stabilization phase. Promising alternatives will remain vulnerable to changing circumstances if policy-makers, business, and civil society fail to manage the need for stabilization. Capacities to accelerate breakdown and a phaseout of unwanted activities are also key as a complement (see below).

Sources: Olsson et al., 2004; Olsson et al., 2006; Herrfahrt-Phäle et al., 2020.

(Hoff and Stiglitz, 2016; Schill et al., 2019), and are a key determinant for how economies and financial systems operate (Elster, 1989; North, 1990; Young, 1998). Norms, and the way they change, thus have a key role to play for instigating necessary transformation in the economic and financial systems. Policies can trigger shifts in norms by altering the behaviors of key actors, changing expectations, and thus, potentially activating large-scale behavioral shifts as actions trigger additional actions (Nyborg et al., 2016). For example, the introduction of strict climate regulations could change the expectations of institutional and private investors about the return of carbon-based investments. A resulting change in investment behavior and norms would then create enabling conditions for a more rapid evolution of a non-fossil-fuel-based economy (Ewers et al., 2019).

Recent large-scale surveys show that people in general endorse climate action and planetary stewardship (e.g. European Commission, 2021; Gaffney et al., 2021). As we argued in Chapter 6, policy-makers and intervention designers have a key role to play in bridging the gap between sustainability rhetoric and action by leveraging existing support and values.

Create institutional and economic incentives for transformation

Enabling legislation and constitutional revisions have historically played an important role for transformation (Olsson et al., 2022). Recent discussions about climate change and law have emphasized the transformative potential of efforts around the world to ensure that constitutions reflect the need for climate action (Setzer & Winter de Carvalho 2021). Such initiatives could support the acceleration of additional climate and sustainability policies and norm shifts. So far, eleven countries have included a climate constitutional provision or 'climate clause' in their constitutional reforms, including Algeria, Ecuador, Vietnam and Zambia (Ghaleigh et al., 2022).

Temporary institutional arrangements and step-by-step experimentation have been key to the major and purposeful economic transformations experienced in China and Vietnam (Schmitz & Scoones 2019). An important challenge will be to make sure that these initiatives not only are continuously adapted to changing circumstances, but also that they manage to result in changes to the structures that shape economic incentives and outcomes (see Chapter 4, Loorbach, 2010; Schmitz & Scoones, 2019). The proposed changes in the architecture and incentives for the financial sector (e.g., the European Union taxonomy, and United States' Securities and Exchange Commission proposal for climate change disclosure for publicly traded companies) will require similar experimentation and adjustments in its institutional architecture and standards as new knowledge becomes available.

Economic incentives also play a key role in enabling economic conditions for transformations. A new planetary reality (Chapter 1) drastically changes the context of markets due to increased risks of surprising abrupt changes that can cascade across societal or economic sectors, regions, and scales, resulting in systemic risks. Significant externalities created by planetary change can be impossible to anticipate due to long chains of causation, emergent properties, and critical thresholds (Crépin and Folke 2015, see also Chapter 2).

This increasingly complex and unpredictable context requires economic policies, which are based on a systems perspective with the ability to identify both risks as well as potential benevolent synergistic effects on people and planet (Levin et al., 2013; Biggs et al., 2015; Preiser et al., 2018; Sterner et al., 2019). Economic policies therefore need to not only help mitigate the impacts of such risks (which is merely a short-term solution), but also support actions that reduce their emergence (Polasky et al., 2020; Crépin et al., 2017; Chapin et al., 2022; Pedercini et al., 2019; Collste et al., 2017). Avoiding the transgression of threshold also requires economic policies specifically designed to help create safe standards, and traditional policies to be implemented within those boundaries (Li et al. 2018, see also Margolis & Nævdal, 2008; Polasky et al., 2011).

Transformative changes can be supported by a wide range of well-known economic policies. The policy's objectives (transforming rather than maintaining), scalability (large), and durability (one time intervention) will determine if it contributes to a transformation or not. Theoretical models indicate that transformational economic policies might need to be rolled out in multiple steps. Heijdra & Heijnen (2013, 2014) consider the more limited problems of transforming an ecosystem with thresholds such as a lake. With the goal of moving from a turbid to a clear water lake, one first step requires the policy to administer the largest possible necessary shock to the system for the shortest possible period of time to push the lake into a clear regime i.e., trigger the transformation. A second step is then to make sure that the system remains in the new transformed regime, for example by limiting the nutrient inputs to the lake (ibid, 2013, 2014).

The choice of policy instruments and their long-run effects can be substantial, and require careful consideration during and after a transformation. Policy instruments may influence the size of an industry (Perman et al., 2011), its incentives for innovation (Jaffe & Stavins 1994), and the lock-in to particular technologies (Kalkuhl et al., 2012), which all have bearing on the long-term success of the policy and of the intended tramsformation.

Move without consensus

Broad agreements – including those that cross ideological silos – have proven important as enabling conditions for transformations (Westley et al., 2017). However, a major challenge with transformations is that steps taken towards change often cause disagreement about ends and means, and result in lock-ins and polarization (Levin et al., 2021). Finding means to move forward under such conditions is nonetheless essential for moving away from business as usual.

A common response to these polarized situations is to try to establish consensus. However, it is often not possible, nor desirable, to achieve consensus, especially when windows-of-opportunity present themselves, for example after a crisis. There is then, a need to move, even without consensus. "Stretch collaboration" (Kahane, 2017) is a method developed for situations where actors are far from each other (with regards to values, worldviews, preferences, approaches, or ideologies), but nonetheless need to agree on important decisions. It has been used to navigate the transition from apartheid to democracy in South Africa, and from conflict to peace in Colombia. Stretch collaboration is one of many methods designed to support the navigation of transformations in contexts of high uncertainty and high levels of agency (Drimie et al., 2021). Other methods for such contexts include Three Horizons for foresight (Sharpe et al., 2016), and Developmental Evaluation for monitoring and evaluation (Patton, 2010).

Stretch collaborations have proved to be key for deep societal and economic transformations that support sustainability. A range of societal actors need to support such sustainability transformations, and generating change often requires the ability to identify co-benefits, and depends on building alliances with those whose primary priorities differ from the issue at hand. Countries with capacities to support such alliances, also tend to be able to achieve more ambitious climate policies (Finnegan, 2022). For example, identifying co-benefits between reducing fossil fuel combustion and reliance, while increasing energy security, health benefits, and job creation can encourage otherwise combative policy-makers to ally (Schmitz & Scoones, 2019). The growth of the solar industry in India (Chaudry et al., 2014) is a good example where identification of co-benefits proved to be an important prerequisite.

Chapter 5 highlighted a number of 'giants' that could be engaged in smaller yet powerful alliances to help accelerate action for transformations. 'Keystone actor' companies, financial giants, central banks, and index providers are all in a position where their actions both can help change underlying financial and economic structures, incentives and norms, as well as induce domino-effects of actions on other economic actors through their influence. As we explored in Chapter 5, some of these shifts are already underway to certain extent. A key challenge will be for policy-makers and others to leverage this shift, and hold such giants accountable for their actions as well as inactions.

Phasing out

Transformative change is as much about the scaling of innovation as it is about letting go of older defective structures that reproduce inequities and unsustainability (Loorbach 2014; Olsson et al., 2014; Novalia et al., 2022). Policy-makers, financial institutions, and others can act in ways to support the destabilization and phaseout of unsustainable systems, and ensure that people are not left behind during such a change (Rinscheid et al., 2021; Turnheim & Geels 2012).

Replace ineffective indicators

One key aspect of such a shift as also noted by the Dasgupta review (2021: p. 488), is the need to replace flawed indicators of development and sustainability with indicators that are better suited for our rapidly changing planet. Current indicators do not effectively account for the dependence between economic and human development on one hand, and a stable climate system and resilient biosphere on the other. Indicators for human well-being must acknowledge human pressures causing the transgression of planetary boundaries and other possible thresholds in important ecosystems (see Chapter 2). Only then will the indicators meaningfully capture the viability of human well-being. Current indicators for macroeconomic performance which have proven ineffective in monitoring a livable planet, must be replaced. New indicators have to integrate the value of different forms of capital, including different forms of natural capital, which tends to be neglected in national accounting. Natural assets, including a livable biosphere, may not be relevantly nor meaningfully translated into monetary values, but these assets must still be the basis for decision-making by the use of dashboards of indicators that focus on monitoring slow changes, unexpected connections, and identifying possible thresholds that may trigger abrupt changes if crossed (Chapter 4). Financial actors must replace current ineffective ESG indicators with multidimensional risk measures to act as active stewards of the commons, recognize a wider set of Earth system processes, and develop impact accounting systems that will become core part of capital allocation decisions.

Phasing out with dignity

Sometimes, "things have to die" in order for new solutions to emerge as part of systems change. This down-sloping and unmaking part of the X-curve is central in evolving theories about transformative change (Feola et al., 2021). The concept of "hospice" (*sensu* Andreotti et al., 2018) has been used to describe the capacities involved in the process of dismantling old and dysfunctional infrastructure and institutions in ways that do not leave people and communities behind. Ignoring the distributional aspects of transformative change could have detrimental effects, and eventually effectively block transformations towards sustainability. For example, workers in polluting and fossil-based industries (such as coal powerplants or in the mining sector) risk to not only lose their jobs and incomes as economies transition to a low-carbon economy, but also to see phaseouts of these industries as a threat to their identity (Olson-Hazboun, 2018; Abraham 2017; Hultman & Pulé, 2018). Identifying work opportunities and securing private and public investments that help these materialize in parallel to "phaseout" processes hence will be key. Several initiatives around the world are already creating such solutions in collaboration with governments and the financial sector. The Partnership for Action on Green Economy (PAGE) has recently supported the Mongolian banking sector to develop green and inclusive financial products and services in partnership with the UN Environment Programme Finance Initiative. In October 2017, the Mongolian government established a Green Development Fund with the aim to apply sustainability to development financing and large-scale public investment projects. Since 2019, the Green Finance Corporation has started to provide green credits through three commercial banks.

Table 1 below offers a few examples of recent such phaseout initiatives. These examples also illustrate the government engagement needed, and the ability to involve many different sectors in the economy (including the financial sector) to create greater multiplier effects (*sensu* Deleide & Mazzucato, 2021). Most of the included examples are recent, and thus still debated. Some of these might even fail to reach their declared ambitions due to changing circumstances, or economic and political inertia. They do however, offer examples of phaseout initiatives that will be needed to complement ambitions to "scale up" financial innovations for sustainability.

Largely, all issues we have elaborated in this report – such as deforestation, land use change, the depletion of marine systems, the loss of biodiversity – illustrate the need for the phaseout of harmful activities. Such phaseouts include the private and public investments that undermine the resilience of people and planet (Chapter 2); unresponsive

Table 1 | Recent examples of phase-out, including financial, economic and governance.

Example of phase-out		Financial, economic and governance dimensions
Just Energy Transition Partnership, 2021- (JETP, South Africa)	JETP is one of many outcomes of COP26 in Glasgow (2021) and is designed to help achieve the lower bound of South Africa's emissions targets under the Paris Agreement.	JETP includes the early retirement of coal plants, support for coal-dependent regions, and investments in cleaner energy sources. The phaseout of coal is estimated to put 120,000 jobs at risk. However, the energy transition will also require new energy sources and thus new jobs. The United States, Britain, France, Germany, and the European Union has promised to provide $8.5 billion in grants and cheap loans over the next five years support the phaseout and job creation (Ray, 2021). There are tensions currently, however, about how to distribute these funds. Governments will need to be able to manage these evolving distributional conflicts (Kumleben, 2021).
Amazon Soy Moratorium, 2004-2012 (Brazil)	The so-called "Amazon soy Moratorium" in Brazil during the years 2004-2012 led to the rapid and 84% decrease in the rate of deforestation.	The combined effects of more stringent national legislation, increased government capacities, international partnerships, and consumer pressure led to visible improvements on deforestation risks in the Brazilian Amazon. Restrictions to access to credit, and new rules for municipal subsidies to economic sectors with high deforestation-risk played a key role. A phase-out of deforestation-prone economic activities, to new and socially inclusive business models that support regenerative farming practices, reforestation and job opportunities, will require investments (based on Nepstad et al., 2014; Heilmayr et al., 2020; Nobre & Nobre, 2020).
Pandemic prevention in the meat industry, 2022-	Emerging infectious diseases pose a major threat to human and animal health all over the world. Investor engagements (such as those led by the FAIRR Initiative) that focus on industries where such risks may be amplified, offer important lessons for the future.	Climate and environmental changes, and the way animal agriculture is conducted in many parts of the world, amplify the risks of novel emerging infectious diseases to evolve. Reducing such risks will require the disassembling of agricultural practices associated with deforestation and intensive animal production such as crowded conditions and the overuse of antibiotics. Improved transparency and disclosure, together with active investor engagement could help companies change their practices and reduce such disease risks (based on FAIRR, 2022; Galaz et al., 2022).

policies that increase inequality (Chapter 3); defective indicators of human development, macroeconomic performance, and "sustainable" investments (Chapter 4); the inability of key players in our globalized economies to properly account for and act on systemic risks created by a new planetary reality (Chapter 5); and norms and behavioral patterns that result in the amplification of social and planetary damage (Chapter 6). Hence, the examples presented here should be viewed as an important component of policies aiming to stimulate transformations.

Accelerated investor action for resilience

Phasing out needs to be matched with investments towards a new direction. As mentioned in Chapter 1, the growing interest for climate-friendly and sustainable investments has grown considerably over time in the last years. However, accelerating investments for resilience for both people and planet also need to be directed towards activities that help both people, ecosystems and the biosphere as a whole to cope with a changing planetary reality. Additionally, the gap between investment needs and actual investments, is considerable. Recent assessments show that yearly total investments need to increase by 10 to 29 times in sectors like agriculture, forestry, and other land use by the year 2030 to be able to achieve the climate mitigation goals of the Paris Agreement (Kreibiehl et al., 2022). Securing financing for resilience of communities and important ecosystems has also proven particularly challenging in many parts of the world since such investments require a longer-term time horizon (i.e. decades) than investors normally operate on (Kreibiehl et al., 2022).

As the World Bank notes, these financing needs can be delivered through private capital toward commercially viable projects, but some will require public finance support, especially in low-income countries (Voegele & Puliti, 2022). Those laying the groundwork for such accelerated investments in resilience need to consider not only total volumes of investments, however, but also the need for investors and financial actors to 1) integrate biosphere stewardship with equity, 2) to act in ways that enable others, and 3) to help change constraining structures.

Promoting biosphere stewardship while tackling inequality

Inequality is a central aspect of planetary change. Not only is the creation of such changes on our living planet a result of inequalities, but their risks and damaging impacts will disproportionally affect the most vulnerable (see Chapter 3). The rise in global inequality, the effects of the pandemic, and growing stresses on public finances and debt in poor countries makes the need to tackle growing inequalities even more important. The financial sector therefore, has a responsibility to make sure that investments and actions integrate biosphere stewardship with equity concerns. As an example, while climate finance plays a critical role in enabling a transition to a climate-resilient economy in climate vulnerable regions like Africa, using green debt to mobilize funds can also exacerbate the African debt crisis. Climate induced disasters and macro-economic volatility could, for example, result in growing sovereign debt and growing inequalities as countries struggle to repay their debts (Dube, 2022: p. 33-35). Box 8 expands on how this principle to combine biosphere stewardship ambitions with equity dimensions applies to a growing ocean economy. The recommendations provided here illustrate the need to promote investments for biosphere stewardship in all sectors of the economy through cross-sectoral collaboration, local engagements, and financial innovation.

Enabling others

As explored in several parts of this report (e.g. Chapter 2, Chapter 5), pension funds, private equity firms, commercial banks, multilateral development banks, insurance companies, financial regulators, and central banks all have agency, and hence a responsibility to contribute to a shift towards a safe and just future for all. Furthermore, many of these actors have the ability to enable others to act as biosphere stewards. Chapter 5 elaborated the influence of large institutional investors. Government, private and civil society collaborations with such influential financial actors could lead to benign domino-effects as investments and policies upscale and diffuse across sectors and regions. As noted in Chapter 2, investors can use their influence as owners in multiple ways to contribute to systemic changes. Investors can help others reconceptualize financial risk and corporate performance in ways that are more apt for a new planetary reality (Chapter 4). Investors can also use their influence to change company policies in ways that help eliminate harm to people and planet (e.g. through stricter corporate human rights and deforestation policies).

Globalization and connectivity can also support networks of innovators and financial change-makers to share insights faster, and mobilize collectively to push for changes in malfunctioning institutions (Brodie Rudolph et al., 2020). Technological advances (in for example satellite technologies, mobile technologies, and sensors), growing access to fine-grained ecological and climate data, and increasingly sophisticated analytical models based on artificial intelligence could drastically improve the financial sectors' access to actionable information about natural capital (e.g. SEEA Explorer, n.d.) and evolving material financial risks (Spatial Finance Initiative, 2021). Combining such improved tools with an explicit ambition to promote sustainable economies could increase the abilities of financial institutions and investors to be a powerful force of change.

Box 8. Creating an Equitable and Sustainable Ocean Economy

A new oceanic investment paradigm is needed, which clearly acknowledges that investing in marine and coastal natural capital is vital for long-term social and economic well-being and development. Achieving widespread adoption of this new paradigm requires policies and financial mechanisms tailored to catalyze action at scale, and government and businesses to adopt full costing of environmental externalities and natural capital accounting (Dasgupta, 2021). Emerging tools are already enabling investors to measure coastal risk and investment opportunities where nature-based solutions (such as mangrove restoration) provide resilience benefits.

Investors need clear guidelines

Investors also need clear guidelines on how to redirect investments towards sustainable blue economy projects and activities. General principles like 'The Sustainable Blue Economy Finance Principles' provide broad guardrails. Ongoing work to develop taxonomies for blue investments will equip financial institutions with more comprehensive classification systems that can guide what ocean economy investments are sustainable and which are not. The finance sector also needs to adopt better approaches to assessing complex and long-term risks across the global blue economy, using science-based methods. For example, recent assessments suggest that a business-as-usual trajectory will entail great risks to ocean economy sectors, with a cost potentially reaching up to US$8.4 trillion over the next 15 years.

Emerging financial tools

"Blue bonds", that is financial instruments that are designed to support marine protection and stewardship, have emerged in recent years. While they represent only a small portion of financial flows, they are beginning to show promise at scale. For example, the recently announced Belize Blue Bond involves a US$364 million financial transaction with the Government of Belize that will enable the country to reduce its debt burden and generate an estimated US$180 million for marine conservation, strengthening fisheries governance, and establishing a regulatory framework for coastal blue carbon projects. It has also increased Belize's credit rating. Critically, however, such investments need to be infused with the active engagement of local communities, and incorporate clear social-ecological monitoring and evaluation programs. There is also great promise and inspiration to be drawn from a growing number of novel social enterprises that are promoting financial inclusion, and which are underpinned by co-designed traceability and data platforms, fair and transparent supply chains, and community cohesion and entrepreneurship.

Alliances for transformation

Clearly, a shift towards a sustainable and equitable ocean economy requires long-term commitments of coalitions for change that include local actors, grassroots organizations, national and international non-governmental organizations, national governments, private finance and insurance sectors as well as asset managers, and international financial institutions.

This is a contribution from the webinar "An Equitable and Sustainable Ocean Economy: The role of finance in mitigating risk and building resilience" organized on 16th of March, 2022, by the Global Resilience Partnership, and The Ocean Risk and Resilience Action Alliance.

Helping to change restraining structures and defective indicators

Enabling others is only one part of the solution as investors, corporations, policy-makers, and civil society strive to accelerate investments for resilience. Such investments can also be designed in ways that not only increase access to capital, but also contribute to deeper structural changes in norms, institutions, and indicators that have proved unfit for a changing planetary reality (Chapter 3).

Insurance companies, investors, and local governments have for example, taken important steps in mobilizing investments to help build the resilience of climate fragile cities. This includes the restoration of ecosystems (such as mangroves that provide high flood reduction benefits), contributing to enhanced resilience planning, improving credit ratings for the cities involved, and combined ecological and social co-benefits (Sasson et al., 2021: p. 13-15).

The recent rise in food insecurity in many parts of the world brings to light the need to transform food systems, especially in the world's most vulnerable and fragile regions. Investments, financial innovation (such as agricultural resilience bonds), and loan covenants can all play an important role in mobilizing resources and help shift economies away from unsound corporate practices (Queiroz et al., 2021).

The Belize Blue Fund mentioned in Box 8 for example, not only leads to increased funds for marine conservation, but also helps reduce the Belize's debt burden and increase its credit rating. Investors can engage in various ways to help address the lack of transparency and structural inequalities created by the extensive use of tax havens and secrecy jurisdictions by corporations in sectors that erode natural capital and the biosphere (Chapter 3). The use of new indicators such as Gross Ecosystem Product (GEP) by investors could not only attract public and private investments in the protection and stewardship of natural capital, but also help shift investors and policy-makers away from simplistic economic metrics that have proven damaging for the resilience of both people and planet (Chapter 4, see also Daily, 2021). Accelerated investments hence can do more than just increase sustainable finance flows. They can, and should, also help replace structures and indicators that restrain the emergence of better alternatives.

Act with urgency and speed

Our planet has changed profoundly in the last 50 years since the Stockholm Conference 1972 (Chapter 1). The prospects for a just and safe future for all look bleaker today in many ways. But the science, innovation, and action-based experience in trying to tackle these challenges have improved in astounding ways as well. Powerful partnerships, experimentation, and strategic initiatives between investors, financial regulators, governments, the private sector and civil society, need to address all dimensions of the identified transformative capacities.

The science is overwhelmingly clear: we need to act with urgency and speed to secure a safe and just future for all on a thriving planet. It is – as the slogan for Stockholm+50 notes – both our opportunity, and our responsibility.

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