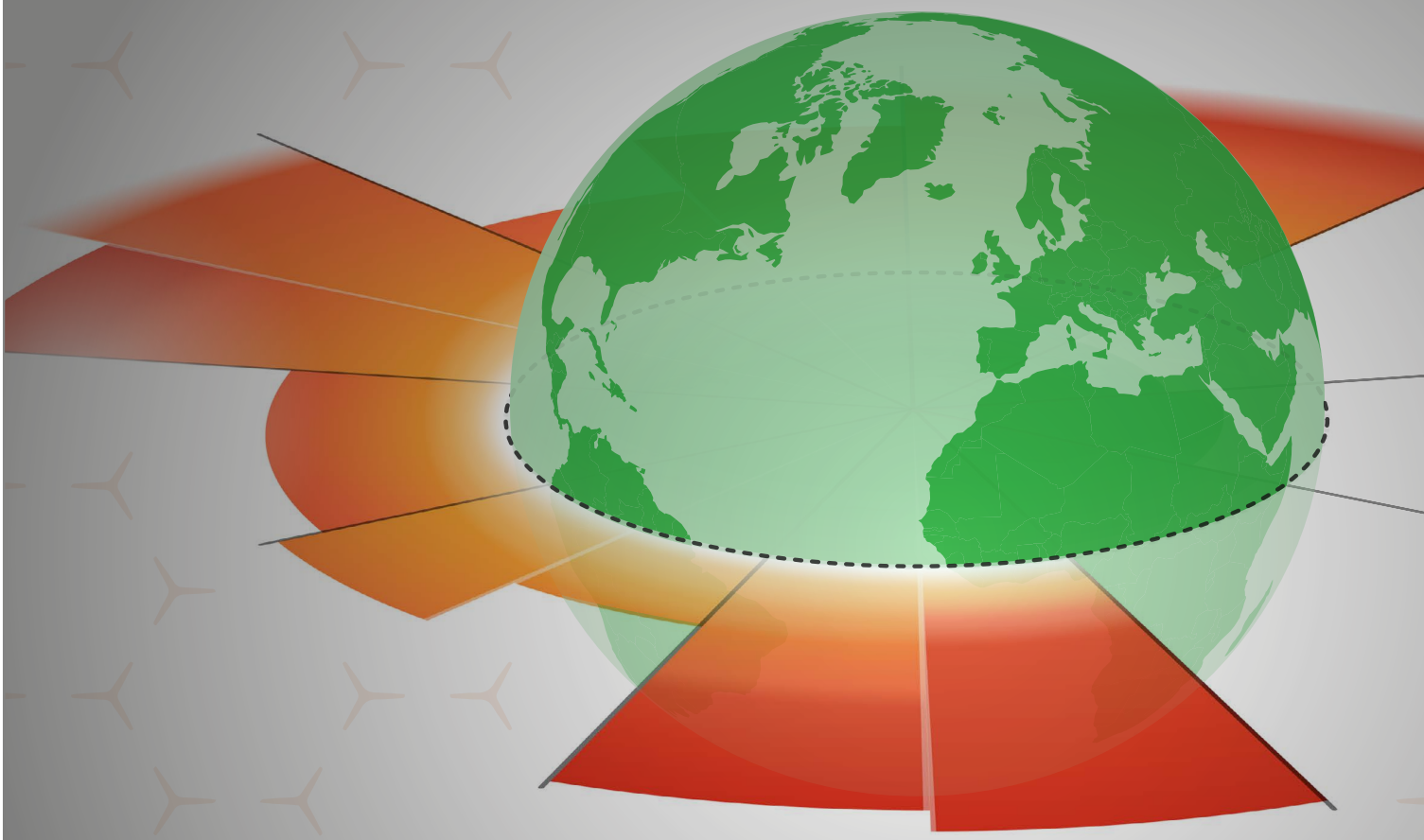
REPORT

# Doing Business Within Planetary Boundaries



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# Why and how to read this report

## Businesses or corporate stakeholders

- Will gain an understanding of why focusing attention on disclosing primarily the most material environmental impacts impedes assessment of cumulative environmental impacts. This undermines our collective ability to gauge where we are in relation to planetary limits, and is likely to lead to unreliable assessments of climate and nature-related risks and inability to set informed targets (Chapter 2).
- Will get an overview of three key features that characterize meaningful environmental disclosures and a science-based guidance for prioritization of data collection and disclosing the most essential environmental impacts, depending on sector (Chapters 3-6).
- Will get insights into a new science-based tool – the Earth System Impact score (ESI) – that provides companies and their stakeholders with information about how a company's local environmental impacts translate into global effects on climate and nature (Chapter 7). The ESI score can help businesses identify key areas for improving environmental performance and facilitating the development of strategic plans to enhance sustainability.

## Investors

- Will gain an understanding of why focusing too narrowly on companies' currently most financially material environmental impacts tends to undermine the reliability of climate and nature-related risks assessments and will likely lead to underestimation of or misinformed decisions about what constitutes relevant risks and opportunities for their investments (Chapter 2).
- Will get an overview of three key features that characterize meaningful environmental disclosures, and science-based guidance for prioritization of which environmental impact disclosures are the most essential in pursuing investments that can help economies stay within planetary boundaries (Chapters 3-6).
- Will get insights into a new science-based tool – the Earth System Impact score (ESI) – that provides investors with information about how a company's local environmental impacts translate into global effects (Chapter 7). This information can aid investors in their company engagements by transparently identifying key areas for improving environmental performance and facilitating the development of strategic plans to enhance sustainability. Understanding the amplified effects of investments on the interactions between climate, land and water resources also improves the understanding of potential systemic risks.

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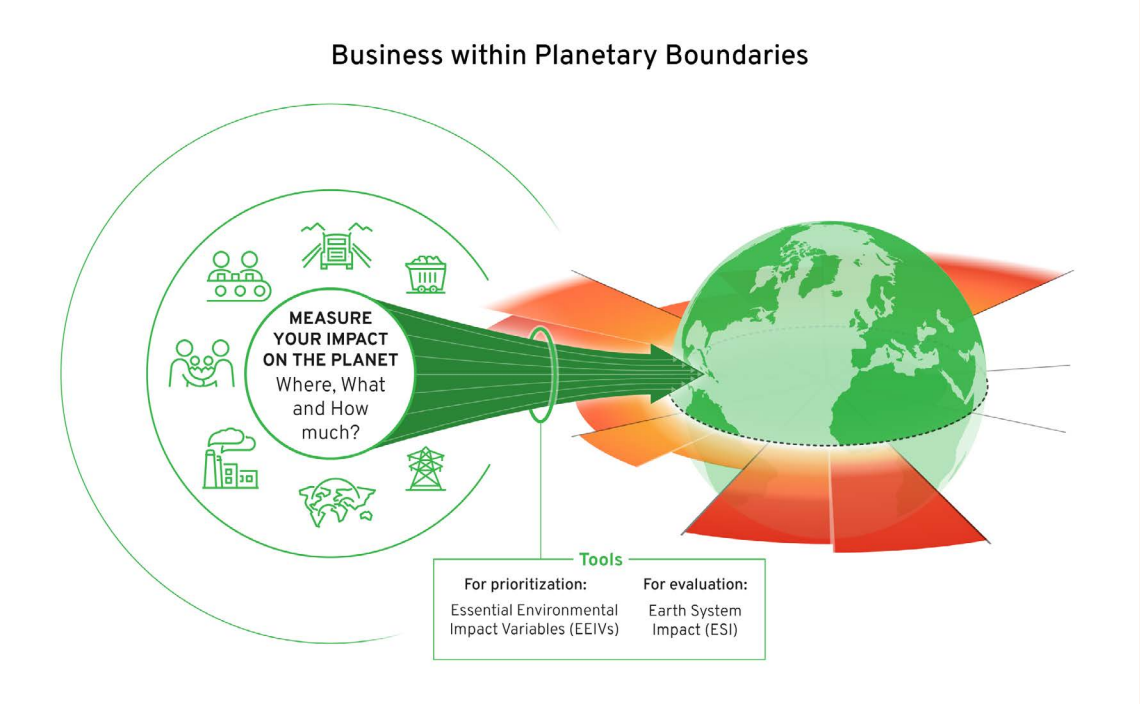
# Executive summary

Over the past decades, humanity has made significant advancements in technology and wellbeing. But these advancements have come at the cost of the world's ecosystems and climate, and have not rectified but rather deepened social inequalities. As a result, six of the nine planetary boundaries, defined by scientists, have already been crossed, pushing our planet well outside the safe operating space for humanity.

In other words, our activities are undermining the biological life-support systems we depend on for our wellbeing. The consequences are dire. Climate change, the loss or change of biodiversity, and aggravating changes to the water cycle could make large parts of the world uninhabitable, and make business impossible or much more costly. We can still achieve a sustainable planet for all, but globally, our economies and investments can and must be a constructive part of changing our current course.

This report deep-dives into specific aspects of corporate reporting, nature-related risk assessments and sustainable investments that need reconsideration if we are to deliver on sustainability ambitions. It focuses on key hurdles and how to address them to turn the emerging new reporting and data landscape into a powerful engine for change and sustainability. By providing concrete examples, it illustrates how impact analyses can be improved and deployed if the disclosed environmental non-financial information – a necessary input for such analyses – adheres to a few scientifically grounded principles.

The first part of the report makes the case for a solid integration of a wider set of environmental dimensions in non-financial reporting, reflecting planetary boundaries and known drivers of nature degradation and biodiversity change (Chapter 1). Such a move beyond carbon is already visible in a growing number of countries and reflected in several recently developed standards and frameworks, like the Taskforce on Nature-related Financial Disclosures, the European



Sustainability Reporting Standards. These reporting recommendations and requirements are a welcome and positive step in the right direction. However, recent scientific insights show that current format risks preventing well-intended reporting efforts from delivering on growing sustainability ambitions.

The report goes on to explain why this is the case by outlining the importance of understanding and acknowledging corporate contributions to cumulative environmental impacts and their direct relevance to nature-related risk assessments (Chapter 2). Such assessments of cumulative aggregate impacts can only be achieved by taking environmental materiality as seriously as financial materiality in corporate disclosures. Certain key features are also necessary to allow accurate assessments of cumulative corporate environmental impacts and risks, namely disclosure of absolute values of environmental pressure (Chapter 3); location-specificity of impacts (Chapter 4); and the combined value of knowing *where*, *what* and *how much* impact occurs (Chapter 5).

Some may argue that corporate reporting should not be the primary data provider for environmental impact assessments. But in a time when widely available environmental monitoring or stringent environmental regulation is lacking in most jurisdictions – this information is essential to assess our joint journey towards or away from planetary limits. Without it, we are all flying blind.

Corporate reporting will always be critical for informing investors of financially material nature-related risks and opportunities. However, by mainstreaming the inclusion of environmentally material information corporate reports will also provide valuable data to a range of other stakeholders, including public agencies and academic institutions. This can support more reliable analyses of global and local environmental impact and status, informing risk analysis of society, business and investors alike (Chapter 6). The good news is that many companies, particularly in extractive sectors and operating in jurisdictions with strong environmental regulations, are already required to disclose much of the information recommended in this report. Such requirements clearly illustrate the feasibility of an environmental materiality approach existing alongside the conventional reporting.

With improved information about *where* environmental impacts occur, *what* the nature of the operations and impact are, and *how much* pressure these activities put on the environment, a range of scientifically grounded analytical methods and tools become meaningful. Together they can enable the estimation of different types of environmental impact, ranging from impacts on species, to effects on ecosystem goods and services, or on the Earth system as a whole.

The second part of the report therefore moves on to illustrate how the environmental disclosures discussed above can be used as input for scientifically grounded and transparent impact analysis. The Earth System Impact (ESI) score, highlighted in Chapter 7, offers a way for companies and investors to move beyond impact metrics focused primarily on carbon, and delivers a means to understand and communicate the global effect of their local impacts.

The reliability of environmental impact assessments, such as ESI, hinges on capturing not just the most financially materially impacts, but all the cumulating corporate impacts that in aggregate risk pushing society towards planetary limits. If – or rather when – corporate environmental disclosures begin to embrace the key features outlined in part one of the report (location specificity, absolute measures, and other environmentally material information), ESI and various other impact assessment tools will become much more accurate. This can help businesses, investors, and policymakers to significantly improve the reliability of their assessments of a range of nature-related impacts, risks and opportunities. It will also improve comparability across companies and foster trust among customers, investors, regulatory bodies, and other stakeholders.

While corporate economic activities are a key reason why humanity is crossing planetary boundaries, businesses can also be drivers of positive change and are a fundamental part of transforming societies towards sustainability (Chapter 8). More and more businesses are discovering sustainability as a driver of innovation, competitiveness and value creation. Consequently, there is also a growing interest in, and demand for, more accurate information about companies' environmental performance. This report shows how businesses and investors can play an increasingly large role in these transformations by reconsidering certain aspects of their practices.

This report is the result of decades of collaborative research combining ecological economics, resilience science, and Earth system science with sustainable finance. While the report acknowledges that social impacts are also critically important for a safe and just world within planetary boundaries, the content predominantly reflects the environmental focus of the underlying research. Insights are rooted in the pioneering efforts of the Beijer Institute of Ecological Economics and the Global Economic Dynamics and the Biosphere Program at the Royal Swedish Academy of Sciences, and of the Stockholm Resilience Centre at Stockholm University.

## Key take-home messages:

- Even seemingly financially immaterial environmental impacts contribute to pushing society across planetary boundaries because they accumulate across different regions and over time. In aggregate, these impacts often result in nature-related risks for businesses and society. Their omission directly affects the reliability of current nature-related and climate risk assessments.
- Moving corporate impact assessments beyond greenhouse gas emissions requires a wider array of environmental disclosures and science can help business prioritize which are most essential. Furthermore, these impact disclosures must account for *where*, *what*, and *how much* impact happens.
- Letting environmental science inform prioritization of disclosures would radically improve the capacity of companies, investors and society at large to monitor cumulating environmental impacts, and support improved nature-related risk assessments, transparency and accountability.

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Chapter 1:

# A planet under pressure

**Our living planet is changing at an unprecedented speed. For the past 11,000 years, planet Earth has been in a relatively stable state. But not anymore. Since the middle of the 20th century, human activity and its impact on Earth's natural systems has grown tremendously.**

The human population has increased substantially. On average we have also become healthier and more prosperous. This growth has been enabled by the substantial consumption of resources from the planet's oceans, rivers, forests, grasslands, coastal plains, and other landscapes, which has also resulted in rapidly growing economies in the now globalized world.

However, this progress has also brought about a worsening climate crisis, damage to the planet's ecosystems and increasing social inequality (Figure 1). Human activities are now threatening the biological systems we rely on – to the extent that continued human progress and well-being are in jeopardy. We have directly altered at least 70% of the planet's land surface and over 66% of the ocean. Over 96% of Earth's mammal biomass is now made up of humans (36%) and our livestock (60%) – with less than 4% represented by wild animals.

## Planetary boundaries

Almost 15 years ago, scientists created a framework called "planetary boundaries" to clarify the diverse pressures humanity is putting on Earth. The boundaries represent estimated limits for nine global processes, beyond which our climate and living ecosystems risk becoming destabilized and unpredictable, and could cease to provide the goods and services we rely on.

Three boundaries relate to the materials we take from the system:

- biodiversity loss
- freshwater
- land use

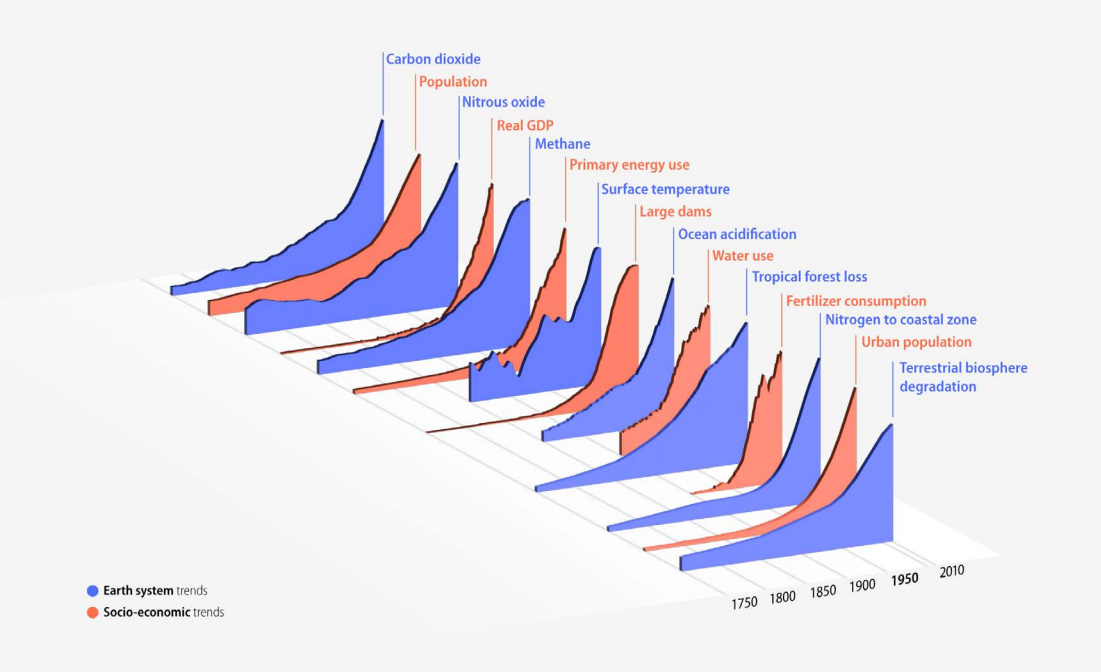
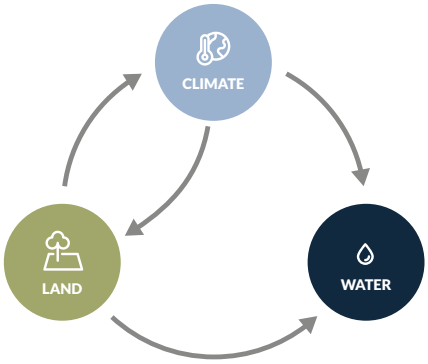



Figure 1

The remaining six relate to substances we release back into the environment:

- greenhouse gases (which cause climate change and ocean acidification)
- ozone-depleting chemicals
- novel entities (plastic, concrete, synthetic chemicals and genetically modified organisms that owe their existence to us)
- aerosols (air particles)
- nutrient overload (reactive nitrogen and phosphorus from e.g., fertilizers)

Most planetary boundaries do not operate in isolation. They interact, and impacts on one often amplify the impacts of another. Below are examples of key interactions between three of the planetary boundaries described here: climate, land use and changes to freshwater.




Climate change affects land cover through changes in rainfall, but also through changing temperatures and so-called 'carbon fertilization effects' which promote more vegetation growth. Land cover change, on the other hand, affects the climate through the release or uptake of carbon in the vegetation. The freshwater cycle is affected both by the type of land use and by climate change, which alters rainfall patterns.

The latest update to the planetary boundaries shows that we live in a fundamentally new reality, where six of the nine boundaries have been transgressed and the effects are already visible. The biosphere, the thin layer of life around the planet that supports humanity, grows ever more fragile and depleted. Changes in the climate system and the biosphere, previously assumed to affect societies in a distant future, are now unfolding with increasing speed and force. This has major implications for all economic activities.

## Going beyond carbon to better assess risks to business and society

Until recently, corporate environmental performance measures focused primarily on global greenhouse gas emissions, often neglecting the vital importance of local environmental impact. But as noted, global temperatures, water flows, land use and biodiversity are tightly linked, and changes in one will ripple through natural systems and affect the others. A narrow focus on greenhouse gases can therefore result in misleading perceptions of progress and inadequate policy development. It will also lead to underestimation of the risks to business and society from ecosystem degradation and loss of access to goods and services on which they depend.

To effectively assess and manage risks to businesses,

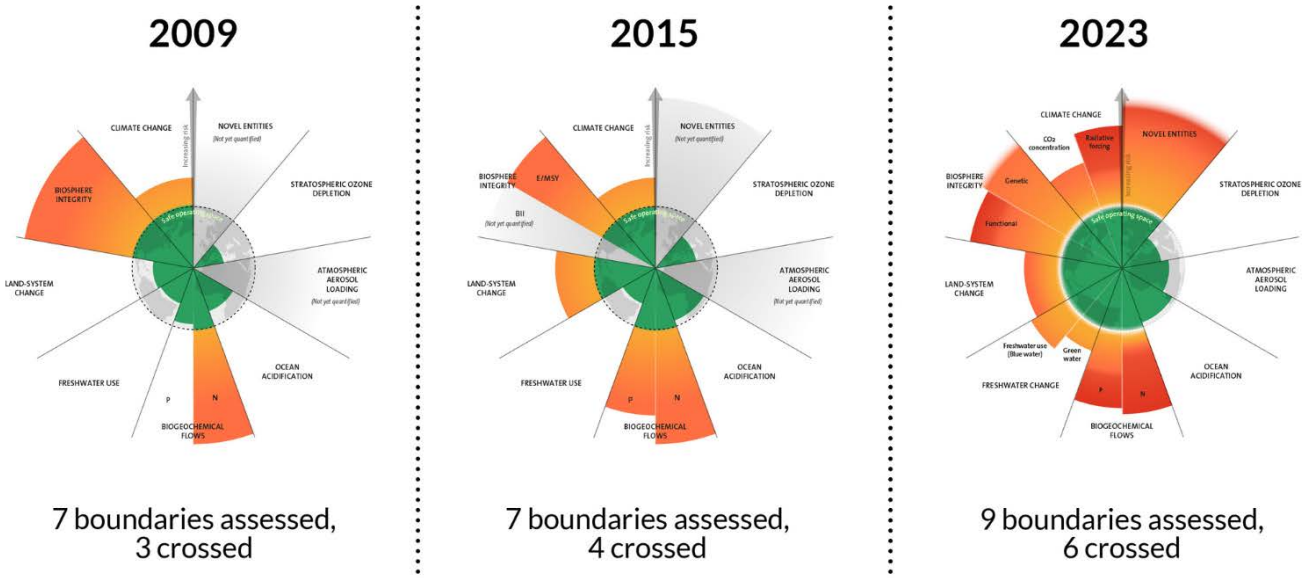



Figure 2. Planetary boundaries

investments, and the planet, corporate environmental disclosures need to encompass a wider set of environmental dimensions that reflect planetary boundaries and known drivers of nature degradation. Such a move beyond greenhouse gas emissions is already visible in a growing number of jurisdictions and recently developed standards and frameworks (notably the European Sustainability Reporting Standards (ESRS), the Global Reporting Initiative (GRI), and the Taskforce on Nature-related Financial Disclosures (TNFD)). These reporting recommendations and standards are a welcome and positive step in the right direction. However, recent scientific research clearly shows that their current format for disclosure risks preventing well-intended reporting efforts from delivering on sustainability ambitions. We elaborate on this in Chapter 2.

## Nature-related risks

Broadly speaking, nature-related financial risks are risks to companies and their investors (e.g. credit, business and liquidity risks) that stem from the loss or degradation of natural capital (the goods and services of nature) and which translate into a financial effect on said organizations due to their dependency on this natural capital.

This risk thinking is what underpins nature-related financial risk assessment tools such as the ENCORE tool (Natural Capital Finance Alliance 2022) and an increasing range of nature-related financial risk reports (e.g. NGFS 2024, NOU 2024).

Understanding corporate and financial risks as a function of resource dependency is certainly necessary, but not sufficient to capture how risks will materialize to and from companies in the future. Resource dependencies of any given company are vulnerable to environmental impacts created both by the company itself, and by the impacts created by other actors and sectors. It is these cumulating environmental impacts that in aggregate put pressure on the planet's ecological systems and threaten to undermine their capacity to deliver the goods and services we rely on. Chapter 2 elaborates on why a reliable estimate of cumulative environmental impacts is unlikely under current disclosure guidelines and outlines the risks of not addressing this.

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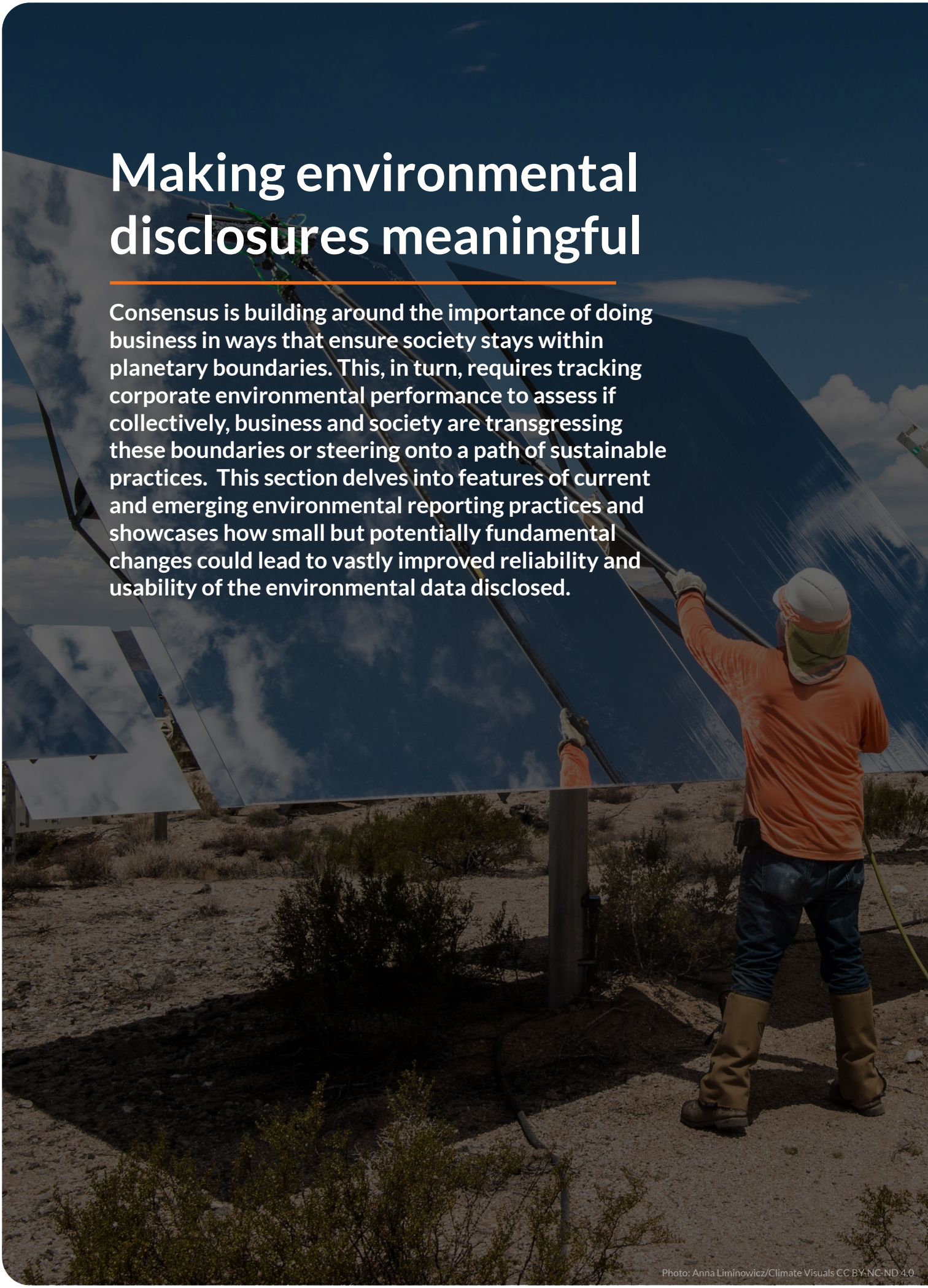
# Making environmental disclosures meaningful

**Consensus is building around the importance of doing business in ways that ensure society stays within planetary boundaries. This, in turn, requires tracking corporate environmental performance to assess if collectively, business and society are transgressing these boundaries or steering onto a path of sustainable practices.  This section delves into features of current and emerging environmental reporting practices and showcases how small but potentially fundamental changes could lead to vastly improved reliability and usability of the environmental data disclosed.**



Chapter 2:

# Every little bit (of impact) counts

## Key takeaways

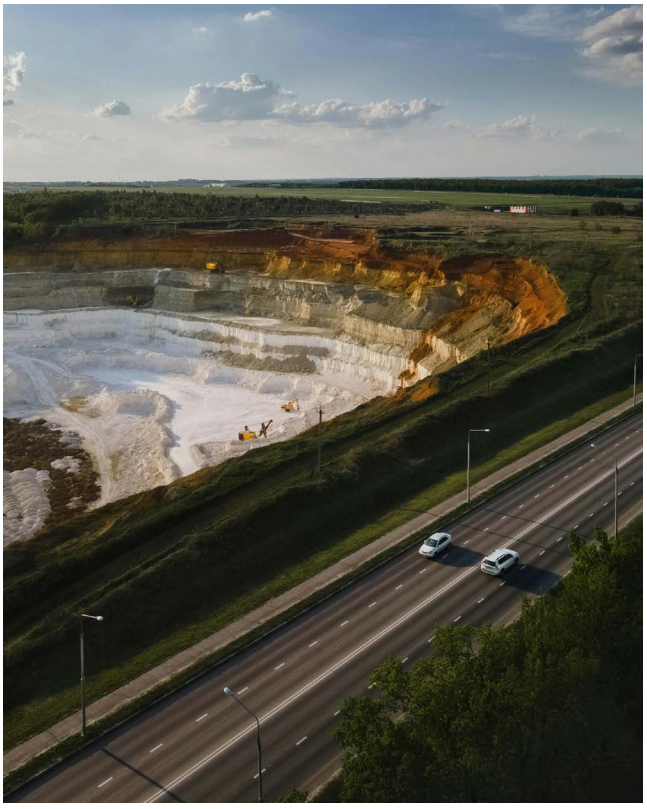
Improving the capacity to understand society's collective trajectory towards or away from dangerous planetary boundaries requires better assessments of corporate contributions to cumulative environmental impacts. It requires taking environmental materiality as seriously as financial materiality in corporate disclosures and decision-making.

As a global society, we are now in an era of increasing risk, where ecosystems are rapidly changing and less and less able to support our societies. Strong scientific evidence indicates that unless we mitigate ongoing impacts on nature, we are likely to witness further ecosystem change and the collapse of essential ecosystem services we depend on. Therefore, as complete an understanding as possible of cumulative and aggregate human environmental pressures is a prerequisite for understanding not just the risks of transgressing planetary limits, but also how remedial actions taken by companies are likely to mitigate these risks.

## Material for companies, for the environment – or both?

Defining what is material is important for our ability to prioritize and act. Financial materiality concerns factors directly affecting a company's financial performance. It is rooted in well-established understandings from finance and related fields. Consequently, it has historically often overlooked environmental impacts that do not appear to affect a company's financial performance. To address this shortcoming, and to also direct attention to the impacts of companies on the environment and society, the 'double materiality' perspective has been introduced.

Double materiality refers to the inclusion of both financial (also referred to as single) materiality and so-called impact materiality, where the latter aims to capture a company's most material environmental impacts. The inclusion of double materiality in the



recent suite of European legislation (CSRD) to guide corporate reporting is an important step in the right direction. However, ambiguities remain as to how the materiality of environmental impacts will be understood and assessed by organizations seeking to comply with rapidly cementing sustainability reporting standards. This brings with it three notable risks.

First, for most auditors non-financial or impact materiality is still a relatively new and complex subject compared to its financial counterpart, there is a clear

risk that impacts that are not perceived as financially material will be deprioritized. This will likely lead to non-disclosure of information that is actually essential for assessing environmental status and our collective trajectory vis-a-vis planetary limits. In other words, information that is 'material for the environment' – but not perceived as immediately financially material to the reporting organization – is likely to be left out. For example, a particular revenue stream might seem so small in relation to total revenues that the environmental impacts caused by those operations are not considered material. However, due to local conditions and vulnerabilities, the environmental impact from these operations in a particular region may still contribute to the loss of biodiversity or critical ecosystem services, such as carbon storage, groundwater recharge, etc. It is currently unclear how double materiality will guide disclosures in such situations, and it is an important risk that both corporate actors and standard developers should be aware of.

A second and related risk is that the level at which standard-setters, businesses and auditors determine the threshold beyond which a given environmental impact should be considered material may not align with what an environmental science assessment would deem relevant and necessary. In fact, even small or seemingly financially immaterial environmental impacts are often important because they accumulate over time and across space. In aggregate, thousands or millions of such impacts tend to add up, becoming severe enough to create nature-related risks for businesses and society, often manifesting as storms, floods, fires, resource shortages, or crop failures. While these events often appear quickly and cause immediate disruptions to corporations, communities, and socio-economic systems, the likelihood of their occurrence is directly affected by the cumulative greenhouse gases in the atmosphere and the gradual loss of biodiversity over time. In other words, all the small environmental impacts that may not be captured by disclosing only what is deemed material can still accumulate and cause significant and large-scale risks. Some other examples of such impacts include the cumulative impacts of pesticides and human encroachment into pristine natural environments. In summary, the second risk is therefore that a lack of information about small but gradually cumulating impacts will lower the ability of decisionmakers to assess and handle resulting risks.

Building from this, the third risk is that by placing so much of the responsibility for assessing the environmental materiality on the companies themselves leaves significant potential for misinformation and unfair accountability outcomes. Different companies may assess materiality differently. While the emerging new reporting formats may appear more comparable, such subjectivity impedes the ability of end users to accurately compare environmental impacts across companies and sectors. This has relevance for market discipline and pricing mechanisms. At the same time, subjectivity in materiality assessments of environmental impact also reduces the capacity of public actors to use disclosed data to assess aggregate and cumulative impacts. This ultimately undermines efforts to set reliable environmental targets (see Chapter 2).

Allowing scientific assessments and analysis to help in the prioritization of what environmental impacts to disclose could reduce these three connected risks. Chapter 6 outlines a scientifically grounded approach to such a prioritization process. It illustrates how sustainability science could play a role in helping to streamline reporting, increase comparability, and potentially reduce the analytical burden for companies in assessing what environmental impacts are material.

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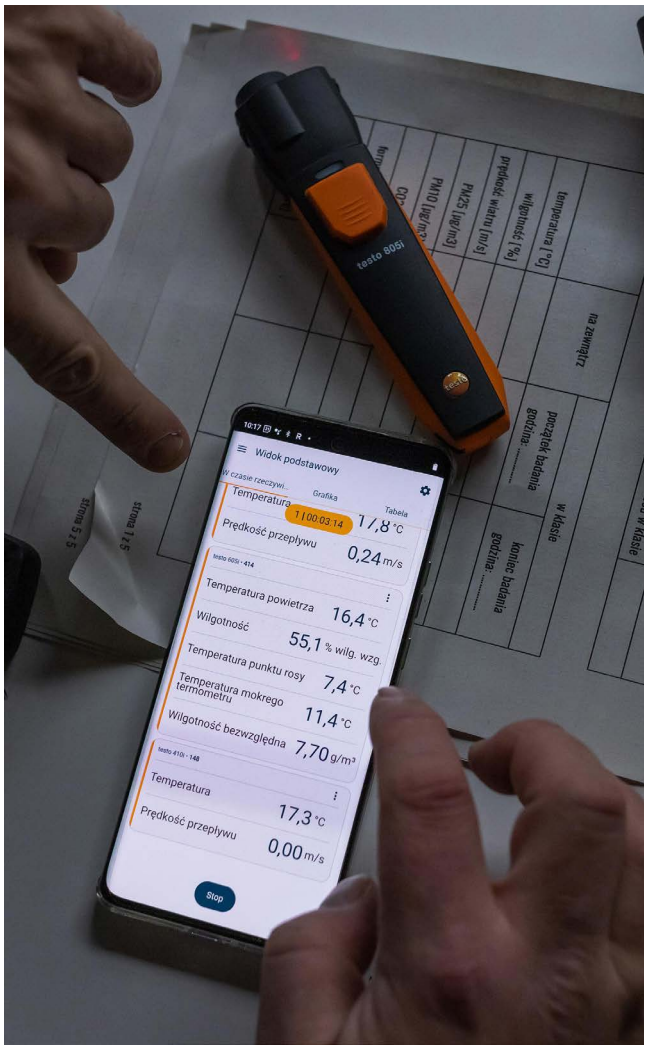
Chapter 3:

# Absolute data is actionable data

## Key takeaways

Grounding company assessments of environmental performance in absolute impact (e.g. total carbon dioxide emissions or water used annually) in addition to relative measures (e.g. carbon intensity measured as $CO_2$ per unit produced) is crucial because absolute measures are what enable the assessment of a company's or investor's actual environmental impacts. Absolute measures support assessments of cumulative environmental pressures and therefore enable improved and more reliable target-setting. They help businesses align with planetary boundaries and reporting such data also reduces the risk of greenwashing and can foster stakeholder trust.

'Absolute measures' refer to quantifications of environmental impacts, such as total carbon dioxide emissions or water usage over a specific period. In contrast, relative measures express this information in relation to other metrics like total revenue, production volume, or assets under management (AUM).




## The insufficiency of relative measures in a world of absolute boundaries

Including 'absolute' information in environmental performance measures is beneficial for two reasons.

First, it reflects the absolute scale of a company's activities and associated impacts, such as the total water used annually or the land required for production. This helps companies better understand their total environmental impact, which in turn allows them to more accurately assess risks that arise as a result of it, and helps them prioritize actions to reduce it and thus seizing opportunities. Efforts to reduce impacts can thus also drive innovation. Absolute data is therefore actionable data.

However, currently, businesses often use relative measures or intensity measures (e.g., $CO_2$ per revenue) to assess or report their environmental performance. While dividing total impact by revenue or production volume allows for valuable comparison of environmental performance across companies

regardless of size, scale, or location, relative measures can be misleading. For example, a company might reduce its carbon intensity, i.e. how much $CO_2$ it emits per produced unit, and thus be more efficient. But if the same company continues to grow and produce more, their total (absolute) emissions will nonetheless increase over time. While relative measures will always have a role to play in comparing across companies and sectors, they are not well suited to estimate how much companies and investments contribute to the crossing of planetary boundaries.

A second reason for Including 'absolute' information is that effective sustainability strategies depend on clear and measurable targets. The reliability of these targets depends on good estimates of total aggregate global environmental impact, which in turn relies on improved assessment of the absolute environmental impact of human activities, to which companies contribute a large share. Making the disclosure of absolute environmental impacts common practice paves the way for more accurate assessments of both impacts and risks – particularly the physical systemic risks that ensue from crossing planetary limits. It also ensures that targets are developed based on reasonably comprehensive impact assessments.

Aiming to further the corporate and financial sustainability agenda without absolute measures will be like flying without instruments, leaving us unable to gauge our proximity to the Earth's surface or to dangerous obstacles.

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Chapter 4:

# Location-specific information is essential

## Key takeaways

Understanding location-specific characteristics and vulnerabilities is crucial for businesses aiming to operate within planetary boundaries.

## Effective mitigation needs consideration of local conditions

When considering environmental impacts beyond greenhouse gas emissions, the importance of location-specific data becomes evident. A carbon atom has the same effect on the climate, no matter where it is released into the atmosphere. However, for most other environmental concerns, such as water stress, land use change, and impacts on biodiversity and ecosystem services, this is not the case. For example, the same volume of groundwater extraction may be sustainable in one area but catastrophic in another. To understand their environmental impact and develop effective sustainability strategies, businesses must consider the specific conditions and ecological limits of each location they operate in. Adopting location-specific assessments will allow businesses to tailor sustainability efforts to local conditions, ensuring that impact mitigation strategies are meaningful and effective.

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Chapter 5:

# *Where*, *What*, and *How Much* - environmental disclosures that enable radically improved assessment of impacts and risks

## Key takeaways

To meaningfully estimate impacts from most human-induced environmental pressures, detailed information is needed, summarized as *where*, *what*, and *how much*. *Where* identifies the location of the environmental pressure, *what* specifies the type of pressure (impact) generated by the economic activity, and *how much* quantifies the absolute amount of the pressure (impact) at that specific location. With this information, a range of scientifically grounded analytical methods and tools becomes available for meaningfully estimating various types of environmental impact.

## Where, what and how much?

Measuring actual environmental outcomes from corporate activity, such as changes in biodiversity over time, would require data collection on-site in many different places along increasingly complex value chains. Currently, this is unfeasible due to limited resources, underdeveloped assessment tools, and a lack of consensus on which aspects of biodiversity or environmental change to prioritize. As a result, corporate impact is typically estimated based on the known environmental pressures that corporate activities have on local environments - here referred to as environmental impacts.

As noted in Chapter 4, the impact of a carbon atom on our climate is the same regardless of where it is released in the atmosphere. However, to meaningfully estimating impacts from practically all other human-induced environmental pressures – such as water and land use, pollution, invasive species, resource use and removal – requires detailed information that can be summarized simply as *where*, *what* and *how much*.

*Where* represents location (as discussed in Chapter 3). Shifting to asset-level data collection and reporting will

have to become the norm if companies and investors are serious about monitoring progress toward environmental targets. Some jurisdictions with strong environmental regulations require that companies disclose this data already, and firms in some, particularly extractive, sectors have already begun the journey of detailed asset level reporting of multiple environmental impacts. But globally this is far from the norm.

*What* represents an identification of the environmental pressure caused by a particular economic activity, for example water extraction, pollutants emitted, tec.

*How much* requires quantifying the absolute amount of a particular environmental impact associated with operations at a specific location. Examples include cubic meters of water used, land area covered, and volumes of fertilizers or chemicals used. In cases where direct quantification is not feasible, information on management practices, introduced species, and disease outbreaks can still provide valuable information for impact estimation.

Armed with information on where, what and how much, there is suddenly a variety of scientifically grounded analytical methods and tools available to estimate various types of environmental impact. These range from geospatial models to lifecycle analysis (LCA) and footprinting tools. When deployed with company-wide revenue or sales data as the primary input, these tools can generally not provide meaningful information about nature impact in specific sites of operations (unless characterization factors for that specific site or habitat type are used). However, location-specific information on environmental pressures opens opportunities for a range of relatively sophisticated impact assessments, including radically improved footprinting analysis. Therefore, in the next two chapters, we introduce a scientifically grounded way to prioritize the most essential environmental impacts to disclose (capturing the where, what and how much) called Essential Environmental Impact Variables (EEIVs), as well as a novel tool that is uniquely capable of estimating global effects from local impacts: the Earth System Impact (ESI) score. Both grounded in the science of the nine planetary boundaries.

## Background references

Wassénius, E., Crona, B., & Quahe, S. (2024). Essential environmental impact variables: A means for transparent corporate sustainability reporting aligned with planetary boundaries. *One Earth*, *7*(2), 211-225. doi.org/10.1016/j.oneear.2024.01.014

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Chapter 6:

# Letting environmental science inform prioritization of disclosures

## Key takeaways

Essential Environmental Impact Variables (EEIVs) represent a limited set of environmental disclosures grounded in the science of the nine planetary boundaries. They capture complex system dynamics and provide a scientifically grounded and transparent prioritization for disclosing environmental impacts, based on what is most environmentally relevant, without adding to the burden of non-financial environmental reporting. Letting environmental science inform prioritization of disclosures can radically improve the capacity of companies, investors and society to monitor cumulating environmental impacts and would support improved nature-related risk assessments.

## The planet is a real and tangible stakeholder

Recent frameworks, such as the Taskforce for Nature-related Financial Disclosures (TNFD), and newly adopted standards, such as the European Sustainability Reporting Standards, are a big step in the right direction as they guide companies to think more thoroughly about their environmental impact. Yet, as noted in Chapter 2, ambiguities remain as to how the materiality of environmental impacts will be understood, assessed, and reported (in TNFD, ESRS and GRI). Furthermore, financial materiality still guides which environmental impacts companies are asked to focus attention on.

However, with six of nine planetary boundaries breached, the planet and the environment need to be considered as a real and tangible stakeholder, whose interests are also material if we want to avoid significant nature-related risks. Recent scientific research suggests a new structured way of capturing what is 'environmentally material' by identifying *the most essential or relevant impact data* needing to be disclosed at the level of individual operations or assets. These Essential Environmental Impact Variables (EEIVs) represent a limited set of proposed environmental disclosures grounded in the nine planetary boundaries.

The environmental dimensions covered by EEIVs are called 'variables' to emphasize that they build on a deep scholarly field of environmental monitoring and assessment. The environmental impact disclosures proposed by the EEIVs framework generally overlap substantially with the information already needed for companies to comply with reporting standards such as the European Sustainability Reporting Standards, the Global Reporting Initiative or the TNFD recommendations. Abiding by EEIVs would therefore not add to the existing reporting burden, *but EEIVs offer a transparent and objective means to prioritize the most essential environmental dimensions to consider for specific sectors.*

In doing so they provide a means to shift the burden of determining environmental priorities from companies to a scientifically grounded and transparent framework. They could also empower companies by guiding the collection and organization of precise, quantifiable, and actionable data that is ultimately needed for evaluating and addressing sustainability performance and environmental risks.

## Essential Impact Variables are Material for the Environment

The concept of 'Essential Variables' is well-established in environmental science and has emerged from the

need to streamline and standardize environmental monitoring by focusing on *the most essential elements* needed to describe complex environmental systems. Climate monitoring was one of the first fields to adopt this approach. Greenhouse gases represent an essential climate variable and this is a key reason why these emissions are now a standard measure for assessing climate impact. Essential Environmental Impact Variables (EEIVs) were developed to allow the systematic collection and reporting of data on the activities that drive *the most essential environmental impacts* – in other words the impacts of a given sector that are most material to the planet and the environment.

EEIVs encompass 15 disclosures grouped into three hierarchical levels, with varying needs for location-specificity (see Figure 3). Not all EEIVs are deemed relevant for all sectors. For more details of which EEIVs are relevant for a particular primary sector, see Table S1 in Supplemental Information of Wassénius et al 2024.

**Level 1 represents information reported at the aggregate company level**. Greenhouse gas emissions is the only information that can be reported at the headquarter level.

**Level 2 represents information about the location and specific nature of operations at each site.** This is reported for each location of operations.

**Level 3 represents sector-specific information to be reported for each location.** Level 3 variables are grouped into four general categories (inputs, resources, management, and events).

**Four novel contributions of the Essential Environmental Impact Variables are:**

1. They represent a structured way of disclosing the most environmentally relevant impact data from specific operations or asset locations.
2. By focusing on the most essential impacts for a given sector, resulting in a total of only 15 variables, they can substantially reduce the current and emerging burden of non-financial environmental disclosures.
3. They capture data that is necessary to assess human pressures on planetary boundaries – thus capturing what is material for the environment and the planet.
4. They are based on absolute information allowing for aggregation across locations, companies and sectors and thus allowing assessment of the cumulative impact of activities.

## Essential environmental impacts align with existing disclosures but add transparent prioritization

Essential Environmental Impact Variables (EEIVs) align to various degrees with existing reporting requirements, such as the European Sustainability Reporting Standards (under the Corporate Sustainability Reporting Directive (CSRD)), but also the Global Reporting Initiative (GRI) and the Taskforce for Nature-related Financial Disclosures, making it

# Fifteen Essential Environmental Impact Variables (EEIVs)

## Level 1: Company level

**1 Total company climate emissions**

Greenhouse gas emissions (GHG Protocol). Scope 1,2 and 3 emissions are key for understanding impact on climate, and contributors to climate change.

## Level 2: Location and Use Level

A set of variables for *each location* where the company has operations

**2 Operations location/ contextualization**

GPS location of each part of operations e.g. extraction or processing facilities. All impacts apart from climate are context and location dependent.

**3 Area of use**

Area under use at each location. Area is important for understanding the extent of habitat impact for EEIVs 4 and 5.

**4 Purpose of use**

Purpose of the area of use. Locations can be used for many different purposes like resource extraction, production and processing. Different facilities have different impacts.

**5 Start year**

The year at which this location was taken into use or acquired. Helps assess the cumulative impact over time. If fully controlled by the company, it also acknowledges the year in which responsibility for impacts began.

## Level 3: Operations

A set of variables for *each resource* used at *each location* where the company has operations

**6 Input amount by type of input**

Amount of input by type, for instance freshwater, manure, fertilizers, novel entities, feed, and seed. Added inputs change biogeochemical and hydrological flows and add novel entities to a location, connecting to multiple impact pathways.

**7 Input use purpose/ method**

Use purpose for inputs and method of administration The use purpose of inputs provides context to the weights/volumes of EEIV6. Inputs like freshwater can for instance be used for many different purposes. Method provides key information on efficiency of input uptake and thus likely dispersal of excess/not absorbed inputs.

**8 Input sourcing**

Either internal or external. For internal provide operations identifier, for external provide company (and operations identifier if available). Sourcing location of inputs provides information on associated impacts from production of inputs. If internal sourcing, this can be linked to all other impact data.

**9 Resource extraction/ production method**

Method of extraction or production provides context to impacts on habitats, and thus associated ecosystems and biodiversity, at extraction/production site.

**10 Resource amount**

Amount of resource extracted/produced by type (species/element, and associated breed/variety/strain). Amount of resource extracted or produced provides information on impacts on wild stocks/reservoirs (if extracted) or impact on regeneration capacity (if produced).

**11 Amount of end product**

Amount of end product by type. End product provides some information on the end usages of product, and thus downstream impacts. Amount of end product is needed in order to calculate intensity metrics of impact per unit of end product.

**12 Management practice**

Description of management/operations practices that either influence input use or that are necessary during production process (prior to extraction/harvesting). Activities and practices during operations (such as weeding, thinning, water quality management, planned fires, fishing practices) will influence impacts of the operations. Information on management practices also allows for disclosure on where management practices reduce input use.

**13 Frequency/extent of disturbance event**

Frequency and/or extent by type of disturbance event. Impact is created by disturbance events (such as fishing nets lost at sea, fires, escaped species, oil spills), even if outside of company control. Disclosure provides information on the cumulative and potential spill-over impacts from operations locations.

**14 Non-purposefully introduced species/ varieties**

Number/extent by type of non-purposefully introduced species, varieties or strains (if planned introduction of non-native species/varieties, should be provided in EEIV10) in operations location. Information on non-purposefully introduced species or varieties/strains highlights impact on biodiversity (including genetic diversity) as well as the spill-over of these impacts to non-company locations.

**15 Disease/pest outbreaks**

Number or extent of detected cases of disease or pest outbreaks by type of disease or pest. Disclosure provides information on the cumulative and potential spill-over impacts from operations locations. Impacts from disease and pest outbreaks primarily affect biodiversity.

**Figure 3.** Essential Environmental Impact Variables (EEIVs)

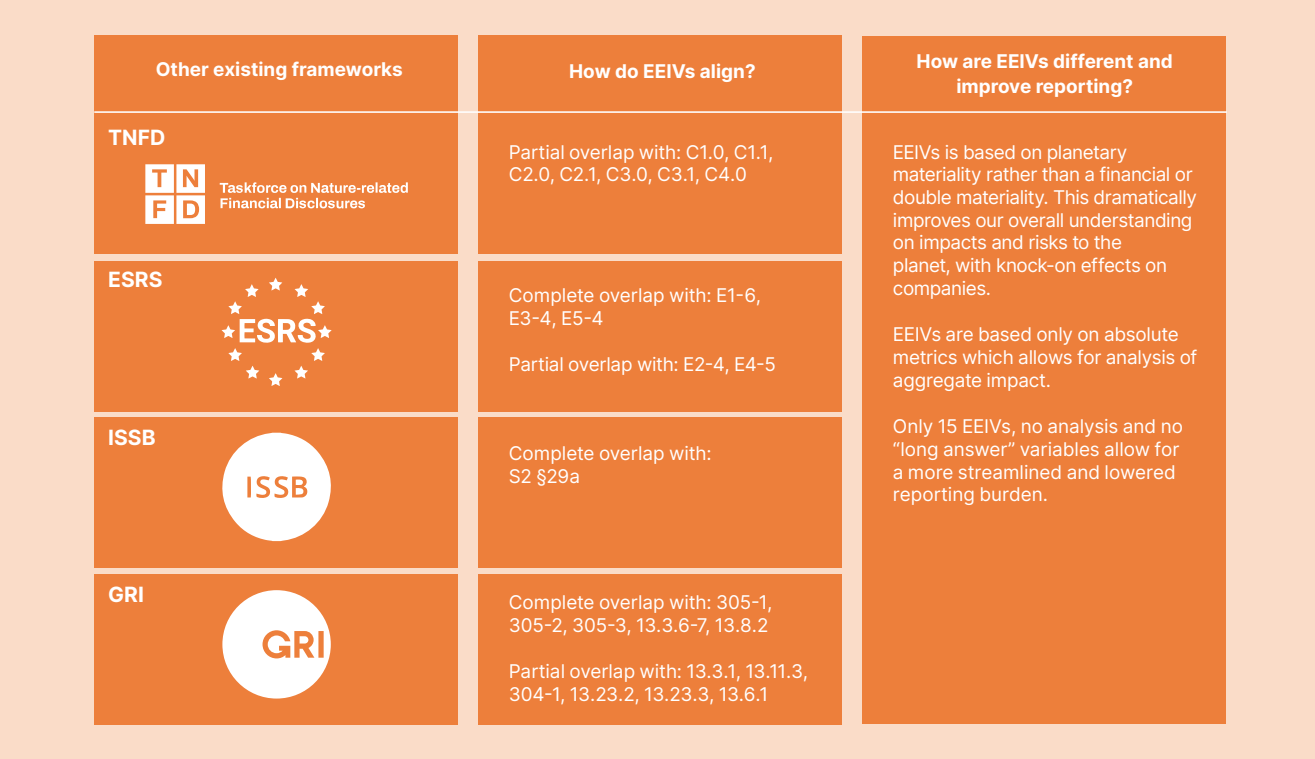


**Figure 4** EEIVs align with current frameworks.

relatively easy for companies to adopt these metrics without significant additional burden.

As mentioned above, many companies, particularly in extractive sectors with strong environmental regulations, are already required to disclose much of the data recommended by the EEIVs, thereby illustrating the feasibility of an environmental materiality approach existing alongside the conventional reporting.

## Additional benefits provided by disclosing in line with what is environmentally material

Essential Environmental Impact Variables (EEIVs) offer a practical, transparent and science-backed way for companies and investors to understand and act on their most essential and absolute environmental impacts. By capturing complex system dynamics and providing a scientifically grounded prioritization of reporting, EEIVs offer a streamlined set of essential disclosures that capture what is most relevant from the perspective of the environment yet without adding to the burden of non-financial environmental reporting.

The prioritization support offered by the EEIVs is particularly useful for companies with supply chain links to primary production such as agriculture, mining, and forestry. For example, mapping supply networks using Level 2 EEIVs can highlight areas of impact for a company's entire portfolio and can also identify key dependencies and associated risks. This supports decision-making that aligns with finite planetary boundaries.

The transparency afforded by large-scale implementation of EEIV reporting across the corporate universe would also improve the reporting of upstream scope 3-impacts – that is indirect impacts from operations not directly owned or controlled by the reporting organization. For example, if a company that sources from primary sector suppliers required its upstream supply chain to report using EEIVs, it would be able to assess how substituting suppliers (or demanding higher compliance from existing ones) might affect its scope 3 performance. Changing sourcing and improving scope 3 performance is a means for companies to differentiate themselves from competitors in a time where demands for climate and nature-related transition plans are growing. The current practice of using industry averages to assess scope 3 severely limits this ability for companies within a sector, with similar supply chains.

## Background references

Wassenius, E., Crona, B., & Quahe, S. (2024). Essential environmental impact variables: A means for transparent corporate sustainability reporting aligned with planetary boundaries. *One Earth*, *7*(2), 211-225. doi.org/10.1016/j.oneear.2024.01.014


# Assessing real impact and the risks that arise

**As shown in Chapter 5, information about where environmental impacts occur, what the nature of the operations and impact are, and how much pressure these activities put on the environment, makes a range of scientifically grounded analytical methods and tools more meaningful and available. Chapter 6 outlined a science-backed approach to guide the prioritization of necessary and sector-relevant environmental disclosures that aligns with existing reporting requirements. These disclosures represent key inputs into all modelling efforts aiming to reliably estimate environmental impacts, but also the risks that may arise. Building on this, Chapter 7 showcases a novel impact assessment tool that assesses the global Earth system impact of local corporate activities by using four of the suggested environmental disclosures.**

Chapter 7:

# Earth System Impact analysis – estimating global effects from local impacts

## Key takeaways

The Earth System Impact (ESI) score is a systemic, science-based and context-sensitive tool that helps users assess the global environmental impact of their local activities, including carbon emissions, water, and land use. It evaluates pressures on three planetary boundaries simultaneously and uniquely captures their interactions. This nuanced approach helps companies and investors assess systemic impacts and identify key contributing factors. ESI supports strategic planning, enhances transparency, and facilitates benchmarking, benefiting companies, investors, and lending institutions.

## The Earth System Impact (ESI) score in a nutshell

The Earth System Impact (ESI) score offers a way to assess the global environmental impact of local business activities. It extends beyond carbon emissions to also include the effects of water and land use. By acknowledging the varying effects of water and land use across different regions and types of vegetation, the ESI tool ensures a nuanced and detailed impact assessment. A key novelty of the tool is its ability to evaluate pressures on three planetary boundaries simultaneously and capture the amplified effects resulting from the interactions between them (see Chapter 1). ESI therefore provides a means to assess the systemic impact of any economic activity, helping companies and investors to consider both cumulative and cross-scale effects of their operations.

## How to use the ESI Tool to calculate environmental impact

Using the ESI tool requires four types of input data, covering three environmental pressures and the geo-coordinates of each asset or facility:

1. Location
2. Carbon dioxide equivalent ($CO_2e$) emissions (at the asset level)
3. Land use (at the asset level)
4. Water consumption (at the asset level)

**Four novel contributions of the Earth System Impact score are:**

1. It accounts for pressures on three critical planetary boundaries: climate, water and land use, and uses as inputs four environmental disclosures; asset location, carbon emissions, water use and land use.
2. It also considers how corporate activities impact the interactions between these planetary boundaries.
3. It distinguishes impacts on land and water based on region and vegetation type – *for example, a land clearing in the Amazon has different impacts than a clearing of similar areas in a Mediterranean forest.*
4. It accounts for total resource availability. *For example, it recognizes that water extraction has a greater impact in arid regions, such as the North American plains, compared to tropical rainforests.*

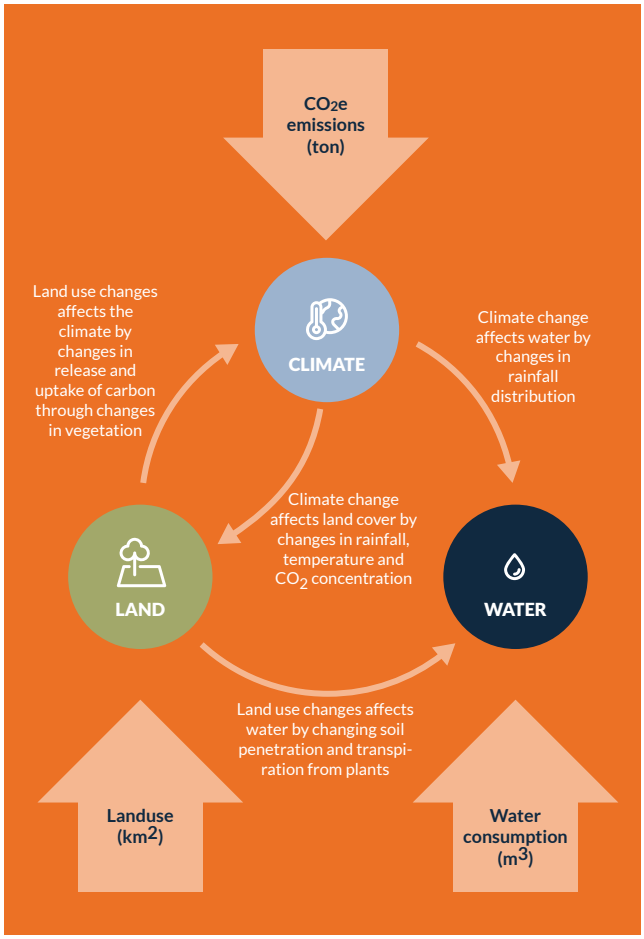


**Figure 5**. Earth system interactions asessed by the ESI prototype score. Big arrows represent the anthropogenic pressures that impact Climate, Land and Water. Small arrows represent the interactions between Earth system components.

Together, these data are used to estimate the global Earth System Impact of economic activities at specific sites. The ESI score is calculated for each individual pressure—Carbon ESI, Water ESI, and Land ESI—and can be combined to provide a total ESI score for any asset. Furthermore, asset-level impacts can be aggregated to assess the overall company-level impact (see Table 1).

## Potential uses of the ESI Score

Outputs of an ESI analysis can be plotted to easily identify assets with large impacts, and determine which of the three ESI components contributes most to this impact. Figure 6, shows the assets of the five largest precious and non-precious metal mining companies in the world, ranked according to their ESI intensity (ESI per revenue, top panel) and according to their carbon intensity (bottom panel, emissions per revenue). When comparing the two plots, it becomes clear that some assets have a high ESI, despite having a fairly low carbon footprint. These are assets that would have been overlooked with assessment tools only focused on carbon. This illustrates the added value of the ESI tool in identifying these high-impact assets.

### Interpreting the ESI outputs

The ESI score captures a complex set of Earth System processes. In essence, the ESI score expresses an activity's environmental impact in relation to regional boundaries (also referred to as guardrails), while also accounting for the current state of the Earth system and key interactions between climate, vegetation cover, and water.

The unit of measure represents the impact on all three planetary boundaries, considered together because the ESI captures interactions between different Earth system components (e.g., the impact that land use has on climate change and water runoff), and the amplifications of environmental impact that results from this,

The ESI is normalized to account for contributions towards planetary boundaries. An ESI value of 1M therefore means that an activity moves the value of one of the three planetary boundaries from its boundary level to twice beyond it.

Since any single company or asset contributes a relatively small fraction of the total regional or global impact relative to these boundaries, ESI numerical values are usually much smaller than 1M. However, this does not imply that their impact is negligible.

Finally, the ESI score can be broken down into its three components – carbon emissions, land use, and water use – to show each pressure's contribution to the total score of an asset or company. These contributions depend on both the volume of the pressures and the specific location of the asset (e.g., assets in water-scarce locations tend to have a higher contribution from water use to their total ESI). This detailed breakdown helps companies prioritize their mitigation decisions effectively.

## Who can use ESI and for what?

**Companies** wanting to reduce negative environmental impact across their operations could employ the ESI score to identify which localities have the biggest integrated Earth system impact. Additionally, the ESI score helps identify the specific environmental pressure most concerning in each region.

**Institutional investors** could use ESI in a similar way as companies by assessing portfolio companies' own operations to inform and sharpen their engagement with the board. This can help in developing targeted impact mitigation plans tailored to specific regions.

**Table 1.** Illustration of ESI results for a large mining company. Results are provided as total ESI, but also broken down to show the contribution to total ESI by climate, water and land use. Colours of the cells in the individual ESI contributions columns are formatted horizontally, to show which components (Carbon, Land, Water) contributes the most and least to the total of each specific mine. The rightmost column (Total ESI) is conditionally formatted to show the mines with the highest total impact in red, and those with the least in green.

| Mine | Vegetation | Region | Primary commodity | Total Emissions ($tCO_2e$) | Total Water Consumption ($103m^3$) | Total Landuse ($km^2$) | Climate ESI | Water ESI | Land Use ESI | Total ESI |
|---|---|---|---|---|---|---|---|---|---|---|
| Mine 1 | Cool climate grassland | Africa | PGMs | 2 107 135 | 28 831 | 42 | 5,90 | 12,60 | 4,72 | 23,20 |
| Mine 2 | Cool climate grassland | Africa | Iron | 720 000 | 7 259 | 139 | 2,02 | 3,17 | 15,70 | 20,90 |
| Mine 3 | Warm climate grassland | Australia | Coal | 1 850 164 | 3 773 | 309 | 5,18 | 0,09 | 8,29 | 13,60 |
| Mine 4 | Cool climate grassland | Australia | Coal | 1 955 625 | 3 988 | 36 | 5,48 | 0,41 | 4,23 | 10,10 |
| Mine 5 | Tropical forest | Australia | Coal | 3 115 868 | 6 355 | 92 | 8,72 | 0,02 | 0,00 | 8,74 |
| Mine 6 | Cool climate grassland | South America | Copper | 877 953 | 20 011 | 33 | 2,46 | 3,50 | 1,47 | 7,43 |
| Mine 7 | Temperate forest | Africa | Coal | 169 903 | 4 898 | 53 | 0,48 | 0,39 | 5,81 | 6,67 |
| Mine 8 | Tropical forest | South America | Nickel | 1 033 168 | 6 988 | 14 | 2,89 | 0,00 | 0,90 | 3,79 |
| Mine 9 | Warm climate grassland | Africa | PGMs | 1 084 418 | 14 838 | 23 | 3,04 | 0,47 | 0,26 | 3,77 |
| Mine 10 | Tropical forest | South America | Iron | 210 000 | 17 441 | 47 | 0,59 | 0,00 | 3,09 | 3,68 |

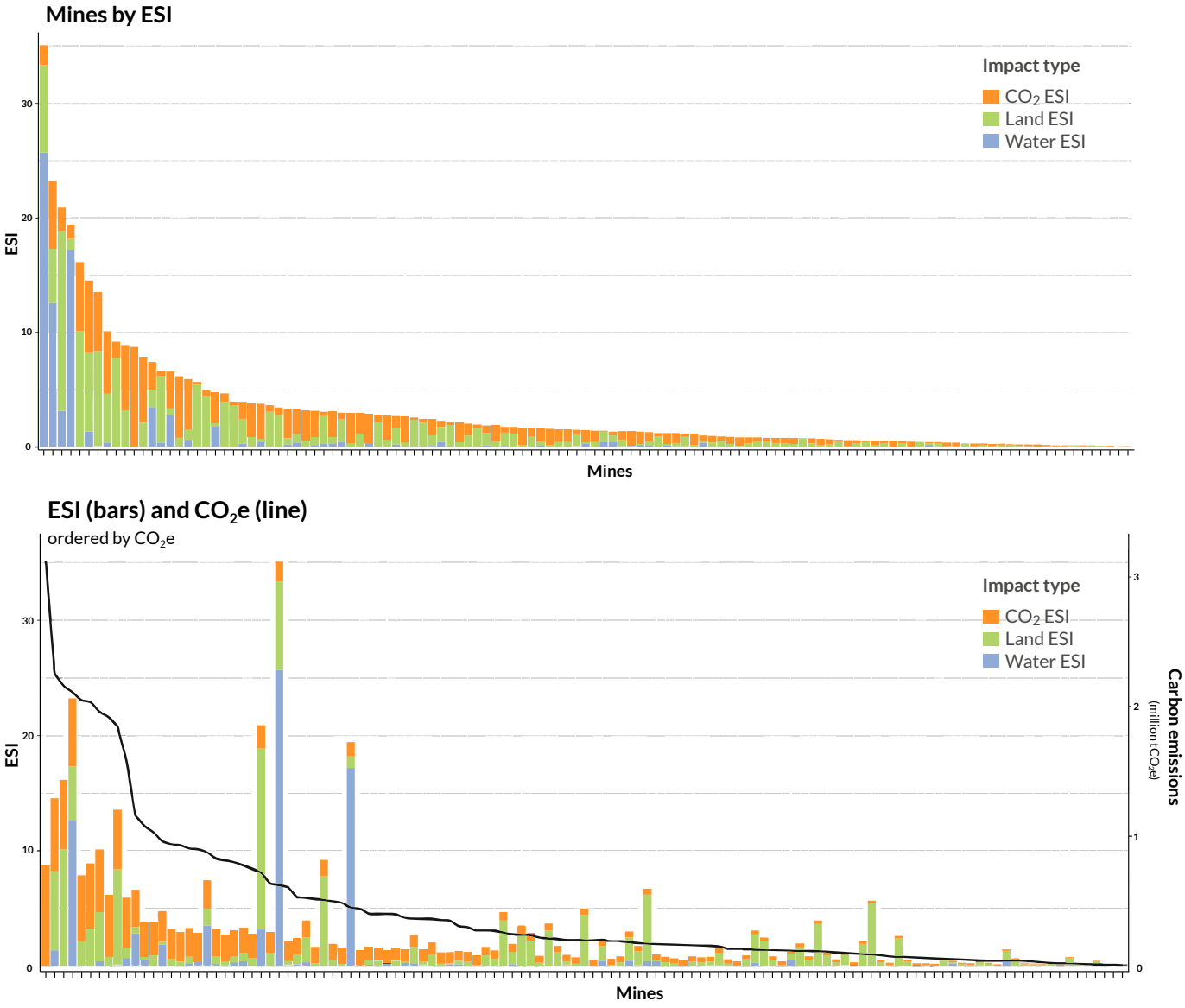


**Figure 6.** Comparing ESI and carbon intensity measures. This graph shows the assets of the five largest precious and non-precious metal mining companies in the world, ranked according to their ESI intensity (ESI/revenue, top panel) and according to their carbon intensity (bottom panel, emissions per revenue). When ordering assets according to the carbon intensity it becomes very clear that some assets have a high ESI, despite having a fairly low carbon footprint. These impacts would not be captured by measures focused only on carbon emissions.

**Lending institutions** could use the ESI score to assess the potential environmental impact of portfolio companies and to identify clients with specific needs to transition to less impactful operations in certain regions. ESI could also be used to assess the potential impacts of new projects or to assess the pre- and post-issuance impact of bonds.

**Venture capital investors and their portfolio companies** can use the ESI score as a pre-screening tool to identify regions with the least environmental impact for developing production sites. It can also be employed to assess and compare the ESI scores across different planned or potential production sites. Additionally, ESI can be used to evaluate sourcing locations or sourcing scenarios, allowing start-ups to evaluate their future potential impact as they scale and make informed decisions to mitigate and minimize these impacts.

## Benefits of the ESI Score

**Strategic planning and improvement:** The ESI score provides stakeholders with information about how a company's local environmental impacts translate into global effects. By using the ESI score, businesses can identify key areas for environmental performance improvement, facilitating the development of strategic plans to enhance sustainability.

**Transparency and accountability:** The ESI score is open-source, scientifically based, and thoroughly documented. This transparency promotes accountability in environmental reporting, fosters trust, and supports informed decision-making.

**Benchmarking and communication:** The ESI score can be used to develop industry standards, allowing companies to benchmark their performance. This highlights areas of excellence, identifies opportunities for improvement, and supports continuous improvement. Additionally, it facilitates effective communication of sustainability achievements to stakeholders.

## Limitations

In its current format, the ESI tool does not, in itself, include full supply chain considerations. For this, one would have to model (as is often done) the generic impact of products or services and use this as input. However, sourcing location for inputs is critical. This is not technically a limitation, per se, but rather a necessary input requirement to unleash of the tool's capability of assessing Earth system impact based on where on the planet the land or water impact occurs.

## Background references

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To access and explore the tool go to:
https://gedb.shinyapps.io/ESI_showcase/

Chapter 8:

# From follower to forerunner - Business as changemakers

## Key takeaways

Change is brewing across multiple levels, from companies experimenting with novel solutions to new and emerging corporate reporting frameworks and standards. But widespread environmental impact monitoring or stringent environmental regulation is unlikely to emerge in many nations in the foreseeable future. Corporate environmental disclosures can and should therefore contribute to filling the vast information gap about our collective trajectory vis-à-vis planetary boundaries. Businesses and investors play a key role in the transformation towards sustainability and can become ambassadors for change, leading the way forward. Engaging with the ideas, guidelines and tools presented in this report can help catalyse this development.

Today, change is brewing across multiple levels, from companies experimenting with novel solutions to grand challenges, to new corporate reporting frameworks and standards (e.g. ISSB, ESRS, TNFD, GRI, and the EU taxonomy). Some of this change is the concrete outcome of a shift in the broader policy debate represented by the EU strategy for financing the transition to a sustainable economy. At even higher levels, novel narratives are emerging that challenge traditional ways of "doing business" and measuring progress, while also outlining new economic paradigms. A prime example is the Earth4All report, which highlights the need for economic models that prioritize ecological sustainability, social equity, and long-term resilience over short-term gains, and suggests a fundamental rethinking of how societies define and pursue prosperity. These evolving narratives are helping to pave the way for large-scale transformations that can facilitate doing business within planetary boundaries and align economic practices with the urgent need for sustainability and equity.

The content of this report speaks to each of these scales of practice and levels of ambition. It encourages all corporate and financial actors with a desire to be credible ambassadors for change to engage with the ideas, guidelines and tools presented here.

## All businesses can contribute to stewardship of nature and the planet

At a time when society and business are transgressing critical limits, beyond which the planet may no longer deliver a stable and predictable flow of the goods and services we depend on, businesses must accelerate their sustainability efforts, and begin to align their operations with planetary boundaries. This requires companies to redefine their relationship with the planet, from merely extracting the resources of the natural world to becoming active stewards of them. While no single business can make this happen alone, all businesses can contribute to such stewardship, and choose to become active change agents for a larger transformation towards sustainability.

The good news is that already today much can be done (and in some sectors and jurisdictions is done). Companies and investors can improve the accuracy, simplicity and transparency of reporting, while future-proofing investments. A key insight from this report is that corporate environmental disclosures can and should contribute to filling the currently vast information gap about our collective trajectory vis-à-vis planetary boundaries. Widespread environmental impact monitoring or stringent environmental regulation is unlikely to emerge in many nations in the

foreseeable future. Corporate reporting therefore still has the critical role of informing investors of financially material nature-related risks and opportunities. Moreover, by mainstreaming the inclusion of environmentally material information corporate reports will also provide valuable data to a range of other stakeholders, including public agencies and academic institutions seeking to provide reliable analyses of global and local environmental impact and status that can inform risk analysis of society, business and investors alike.

This report has outlined critical realizations and steps necessary to embark on this path, emphasizing the importance of absolute data, location-specific assessments, and the integration of environmental materiality into decision-making processes.

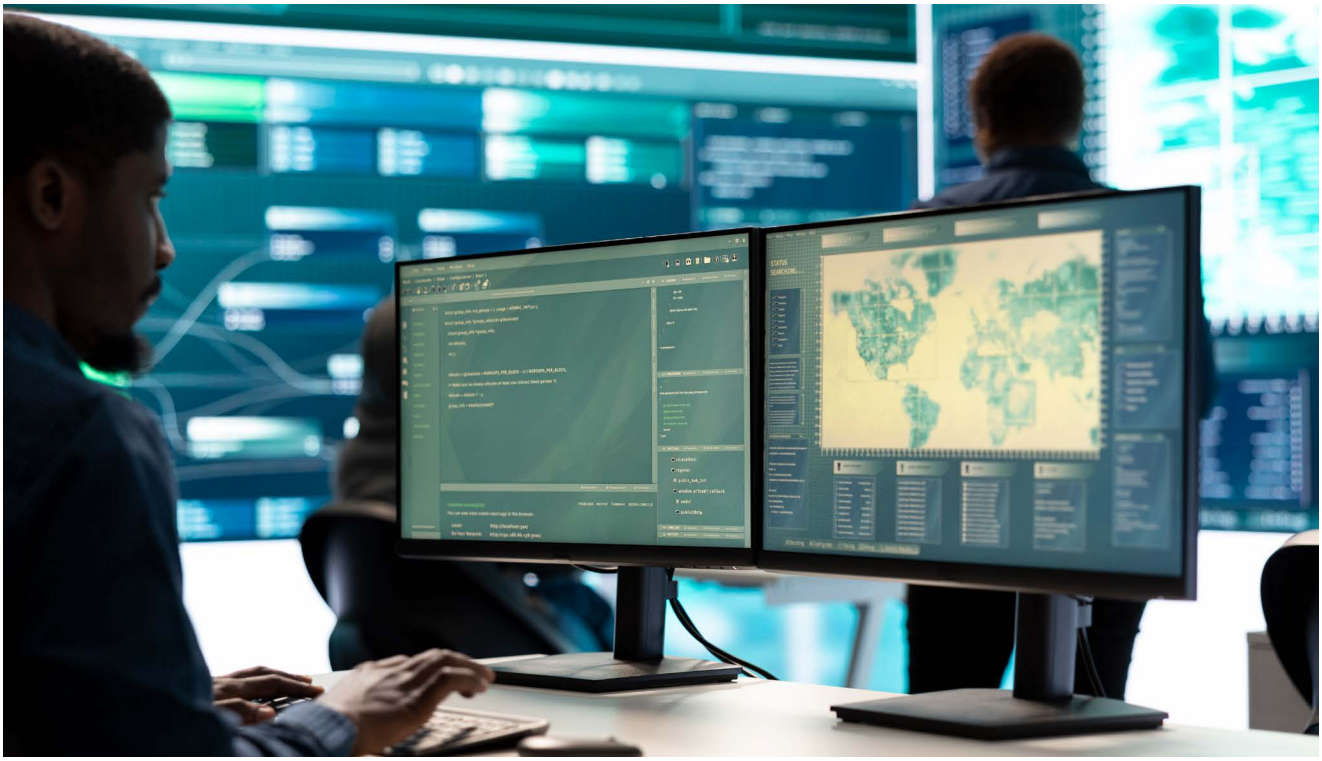
Our ambition is to contribute to the momentum seen in sustainable business practices, reporting and sustainable investments while highlighting that without changing certain fundamental departure points – such as taking what is material for the planet as seriously as financial materiality – our efforts are likely to become misguided.

Needless to say, accurate analysis, accounting and disclosure of environmental impact is a necessary, but not sufficient step towards sustainability. Acting on the improved analyses of risk and opportunities that can emerge from revised practices put forth in this report, by adjusting operations and investments to minimize negative impact and maximize positive impact – that is what really matters. But such adjustments will only be effective with more accurate assessments of actual impacts.

## Transformation to sustainability demands a fundamental rethink

The changes to how we measure and "do business", proposed here, must be understood within the broader context of societal transformations that extend beyond individual corporations, and encompass shifts in rules, regulations, values, and paradigms. Such large-scale transformations are urgently required to address the global systemic risks and the threat of multiple compounding crises facing humanity. In sustainability science, transformations are defined as deliberate change processes that are initiated when prevailing ecological, economic, or social conditions make the existing systems and ways of "doing business" untenable. In essence, a transformation to sustainability necessitates a fundamental rethink of key relationships that govern the distribution and flow of authority, power, and resources, as well as fundamental shifts in underlying norms, values, and beliefs. Additionally, transformations require redefining the relationship between humans and nature.

This report shows how businesses and investors can contribute to and play a key role in these transformations. Research on societal transformation



shows that such change often begins with a few dedicated actors that recognize the problems, question traditional practices, and start experimenting with novel solutions or practices on the fringes. As interest in, and acceptance of, these potentially disruptive innovations grow they can lead to transformative impacts. Over time, these new practices may spread, challenge and eventually replace existing norms, resulting in the emergence of new and different institutional settings. An example of this is the shift from fossil fuel-based electricity to renewable electricity technologies.

Changing one's own practices is a first and important step. This report outlines how companies can begin to do this by collecting and disclosing information about absolute environmental pressures from their operations guided by the prioritization suggested by the Essential Environmental Impact Variables (EEIVs) (Chapter 6), and also take stock of, and understand, their global Earth system impact through the ESI tool (Chapter 7).

As a growing number of actors change practices this can itself create a critical mass and a momentum that begins to challenge existing norms. However, change is often accelerated and amplified as actors look beyond their own operations to contribute to a change of the wider playing field, including other actors such as policy-makers. Becoming a change-maker does not have to be difficult but entails taking every opportunity to challenge the norms that guide current practices. This can include helping suppliers to adopt new practices and urging them to follow suit and embrace sector-specific disclosures proposed by EEIVs or applying the ESI tool, thus gradually facilitating the achievement of shifts in reporting that can pave the way for radical transparency and a hope for credible scope 3 assessments.

It can also include engaging with investors, showing the hands-on value of changing reporting practices and the transparency and enhanced credibility of ESG that it provides, and urging them to demand such disclosure across their portfolios. This, in turn, can put pressure on and provide support for policymakers to shape the playing field and governance schemes that enable new science-based reporting standards.

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# Key takeaways by stakeholder type

## Business consideration

- Corporate environmental impact disclosed only based on what is perceived as financially material runs the risk of overlooking an unknown portion of a company's impacts. These impacts will, however, contribute to cumulating and aggregate environmental harm that increases the likelihood of systemic risks, such as large-scale loss of ecosystem goods and services. Not capturing cumulative impacts increases the likelihood of underestimating systemic risks (see Chapter 2).
- Collecting information about the absolute environmental impacts of operations helps businesses align with planetary boundaries. It also improves a company's ability to set meaningful targets and assess progress against these targets (see Chapter 3).
- Adopting place-based approaches to data collection and establishing internal systems of information coordination is advised since this type of information is necessary for the assessment of most environmental impacts other than carbon emissions. This is also already becoming a requirement in emerging reporting standards. (see Chapter 4).
- Corporate environmental disclosures should reflect scientifically established priorities, such as those represented by the Planetary Boundaries. The Essential Environmental Impact Variables (EEIV) provide a science-based, sector-specific framework to guide and prioritize data collection of information on corporate activities that drive *the most essential environmental impacts* for each sector (see Chapter 6).
- Collecting data according to Essential Environmental Impact Variables (EEIV) will improve the ability of companies to set meaningful targets and assess progress against these targets, but also to make more accurate assessments of nature-related risks and opportunities (see Chapter 2 and 6).
- The Earth System Impact score (ESI) provides companies and stakeholders with information about how a company's local environmental impacts translate into global effects. The ESI score can help businesses identify key areas for improving environmental performance and facilitate the development of strategic plans to enhance sustainability. It can also ensure that the business accounts for the cumulative and cross-scale effects of its operations (see Chapter 7).

## Investor consideration

- Institutional investors should be aware that disclosures of corporate impact based on materiality assessments (i.e. what is material to a company) run the risk of overlooking an unknown portion of corporate impacts. These impacts will, however, contribute to cumulating and aggregate environmental harm that increases the likelihood of systemic risks materializing, such as large-scale loss of ecosystem goods and services. Not capturing them, increases the likelihood of underestimating systemic risks (see Chapter 2).
- Institutional investors should therefore, whenever possible, encourage companies to
  - » collect and disclose information about their absolute environmental performance (Chapter 3), and complement relative performance measures with such information.
  - » collect and disclose the location of all operations/assets (see Chapter 4).

- Institutional investors should support the consideration of environmental materiality as a complement to conventional materiality assessments, with the knowledge that 'environmentally material' information will significantly improve the capacity to estimate the full scope of environmental risks and opportunities (see Chapter 2 and 5).
- Institutional investors should be aware that corporate disclosures of absolute impacts across a wider scope of environmental dimensions (e.g., guided by EEIVs) will offer unprecedented opportunities to assess a range of nature-related impacts, risks and opportunities. It will also improve comparability, transparency and accountability and is therefore important for fostering trust among stakeholders, including customers, investors and regulatory bodies (see Chapter 5).
- One way to consider environmental materiality is by promoting corporate disclosures that mirror scientifically established priorities, such as those represented by the Planetary Boundaries. The Essential Environmental Impact Variables (EEIVs) provide a science-based, sector-specific framework to do so by helping companies prioritize data collection of information on corporate activities that drive the most essential environmental impacts for each sector (see Chapter 6).
- The Earth System Impact score (ESI) is one example of a science-based tool to assess the environmental impact and sustainability of assets and investments, based on carbon, water use and land use (see Chapter 7).
- The Earth System Impact score (ESI) provides investors with information about how a company's local environmental impacts translate into global effects. The ESI score could aid investors in their company engagement, by helping businesses and their investors transparently identify key areas for improving environmental performance and facilitating the development of strategic plans to enhance sustainability (see Chapter 7).
- By promoting impact measures, such as the Earth System Impact score (ESI), and supporting businesses that integrate such measures into their practices, investors can ensure that investee companies account for the cumulative and cross-scale effects of their operations (see Chapter 7).

## Policy and framework developer consideration

- Location-specific information about absolute environmental impacts from corporate activities is a necessary ingredient to any meaningful assessment of the current or potential environmental performance of companies and the sustainability of investments. Developers of policy, frameworks or regulation therefore should:
  - » Ensure that policy, guidelines and frameworks developed for corporate reporting encourage the collection and disclosure of absolute environmental performance information (see Chapter 2).
  - » Ensure that policy, guidelines and frameworks developed for corporate reporting encourage or demand disclosure of the location of all operations/assets (see Chapter 3).
  - » Recognize that disclosures of corporate impact that are based on materiality assessments – focusing on what a company itself defines as material – run the risk of overlooking an unknown portion of corporate impacts. These impacts will, however, contribute to cumulating and aggregate environmental harm that increases the likelihood of systemic risks materializing, such as large-scale loss of ecosystem goods and services. Failing to capture these impacts increases the likelihood of underestimating systemic risks (see Chapter 4).
- Encouraging companies to disclose absolute impacts across a wider scope of environmental dimensions (e.g., guided by EEIVs) will offer unprecedented opportunities to assess a range of nature-related impacts, risks and opportunities. It will also improve comparability, transparency and accountability and is therefore important for fostering trust among stakeholders, including customers, investors and regulatory bodies (see Chapter 6).

- Policies aimed at improving corporate environmental performance to align with globally set climate and nature-related targets must go beyond carbon and ensure that a wider set of environmental impacts are disclosed. These disclosures should mirror scientifically established priorities, such as those represented by the Planetary Boundaries (see Chapter 5).
- Policies aimed at improving corporate environmental performance to align with globally set climate and nature-related targets must move away from disclosures based on self-determined environmental priorities. Instead, they should promote science-based evaluation of corporate activities that drive the most essential environmental impacts for each sector. The Essential Environmental Impact Variables (EEIVs) provide such a framework (see Chapter 5).
- By promoting impact measures, such as the Earth System Impact Score (ESI), policymakers and regulators can ensure that businesses account for the cumulative and cross-scale effects of their operations (see Chapter 7).

# Glossary

**Absolute Data:** Unmodified, exact figures that quantify environmental impacts, such as total carbon dioxide ($CO_2$) emissions, as opposed to relative data which is normalized by revenues or volumes of production, for ease of comparison across companies or investments.

**Biodiversity:** The diversity of all living organisms. Can be measured on various levels, from genetic diversity to species diversity, ecosystem diversity or functional diversity.

**Carbon Metrics:** Measurements and indicators that quantify the amount of carbon dioxide ($CO_2$) emissions associated with activities, products, or services.

**Earth System Impact (ESI) Score:** A comprehensive analytical tool that assesses the global Earth system impact of local environmental impact of business activities by considering interactions between climate, water, and land use.

**Ecological Economics:** A transdisciplinary field that addresses the relationships between ecosystems and economic systems, aiming to promote sustainability and well-being.

**Ecological Footprints:** A measure of human demand on Earth's ecosystems, quantifying the amount of natural resources consumed and the amount of waste produced.

**Ecosystem Services:** The various benefits humans derive from healthy ecosystems; ranging from e.g. provision of food, natural pollination of crops, and clean air and water, to decomposition of wastes, or flood control.

**Environmental Materiality:** Issues that are of critical importance to understand human impact on the environment and should be accounted for in corporate disclosures, regardless of their financial materiality.

**Essential Environmental Impact Variables (EEIVs):** A set of proposed environmental disclosures grounded in the science of the nine planetary boundaries that capture complex system dynamics and provide a transparent prioritization for disclosing corporate environmental impacts. EEIVs encompass 15 variables across three levels: emissions, location and use, and sector-specific operations.

**Financial Materiality:** The significance of factors that directly affect a company's financial performance, often focusing on short-term impacts.

**Greenwashing:** The practice of making misleading claims about the environmental benefits of a product, service, or company's practices to appear more environmentally friendly than they are.

**Natural Capital:** The world's stocks of natural resources, including geology, soil, air, water, and all living organisms, which provide ecosystem services essential for human survival and economic activity.

**Planetary Boundaries:** Thresholds or limits within which humanity can safely operate, preventing large-scale and potentially irreversible environmental changes.

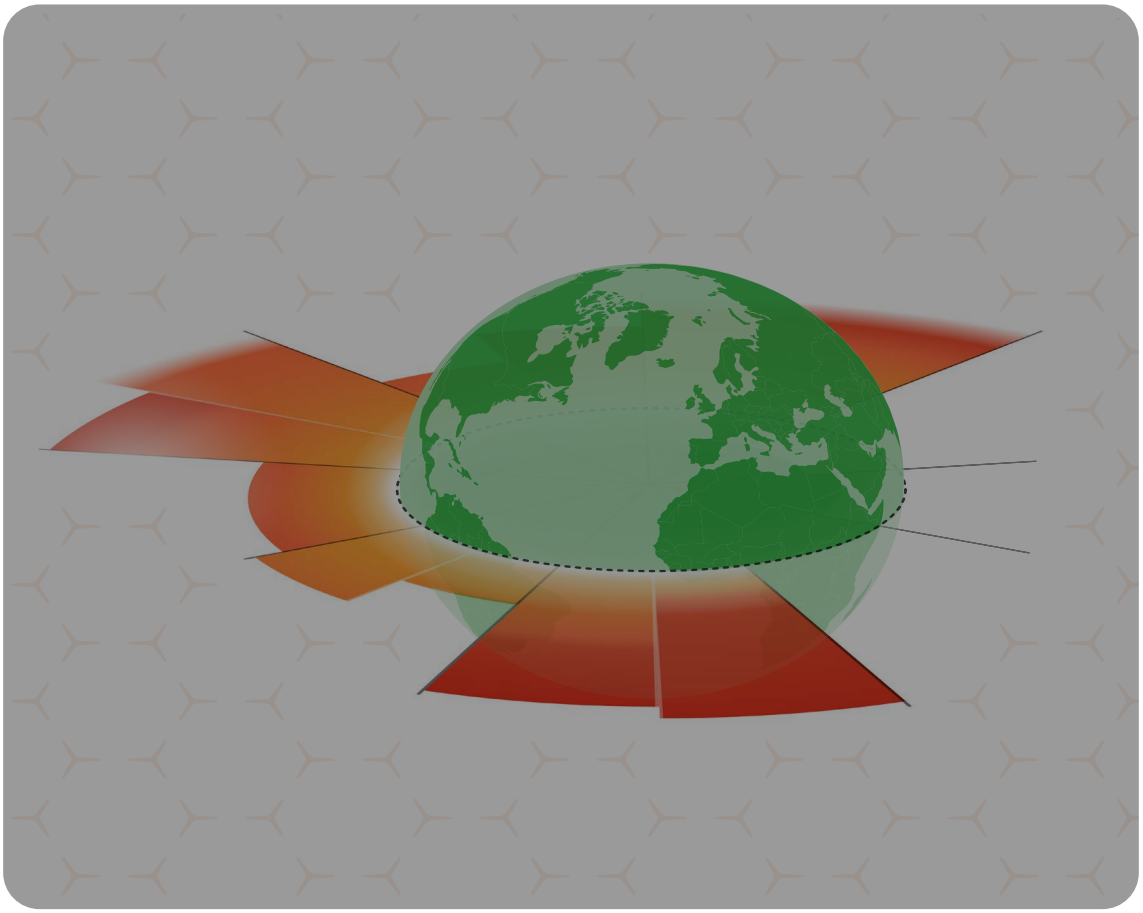
**Relative Data:** Comparative metrics that measure environmental impacts in relation to another variable, such as $CO_2$ emissions per unit of production, which can sometimes obscure the total impact.

**Resilience Science:** A field of study focused on the ability of systems, particularly ecological and social systems, to withstand and recover from disturbances and changes.

**Resource Depletion:** The exhaustion of natural resources due to overuse or unsustainable management, leading to a decline in the availability of these resources.

**Sustainability Science:** An interdisciplinary field that seeks to understand the interactions between natural and social systems and develop solutions to complex environmental challenges.

**Systemic Risks:** Risks that affect an entire system or sector, often resulting from interconnected and interdependent factors, and potentially causing widespread impact.



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