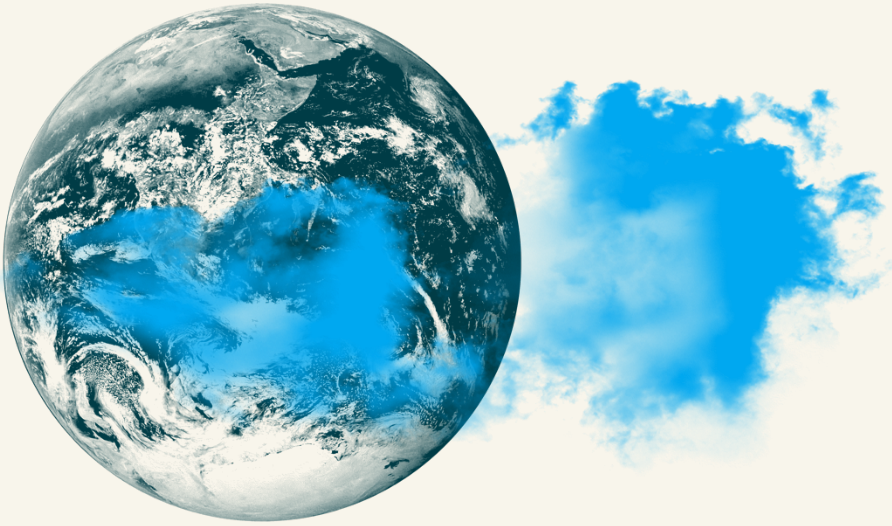
Governance Architecture
for a Safe and Just World

EARTH SYSTEM JUSTICE RESPECTING SAFE AND JUST EARTH SYSTEM BOUNDARIES WHILE MEETING BASIC NEEDS FOR ALL



Authors: Joyeeta Gupta, Diana Liverman, Lauren Gifford, Crelis Rammelt,
Joeri Scholtens, Giuliana Gentile, Paola Fezzigna

Report submitted to the Global Challenges Foundation, 18 January 2024.

This report builds on the work of the Governance Work Stream of the Earth Commission's first phase (2019-2023). It was prepared by members of the Earth Commission – especially the Transformations Working Group co-leads Joyeeta Gupta (University of Amsterdam) and Diana Liverman (University of Arizona), researchers in their teams and members of the working group who met regularly between 2020 and 2023 to discuss justice and transformations and their governance implications

The Earth Commission is hosted by Future Earth and the scientific component of the Global Commons Alliance, and is co-financed by the Global Challenges Foundation

CONTENTS

LIST OF FIGURES

LIST OF TABLES

LIST OF BOXES

1. THE NEED FOR SAFE AND JUST EARTH SYSTEM BOUNDARIES

1.1 Goal and scope of the report

Environmental degradation has reached such a level that multiple planetary boundaries are now crossed posing risks for the Earth system, humans and other species (Richardson et al., 2023). There is growing evidence that the responsibility for, and vulnerability to this degradation, and the capacity to respond, is not shared equitably among different people, communities and countries. Moreover, planetary boundaries are typically formulated in aggregate terms, which obscures contextual differences and inequalities between regions and people at lower levels of scale. In recognition of these challenges, the Earth Commission has established a new Earth system justice (ESJ) framework, and defined boundaries that can guide humanity to live in a safe and just space.

This report proposes that global governance needs to be based on principles of justice, for both intrinsic and instrumental reasons. The Earth Commission develops this through the ESJ framework, and operationalizes ESJ in terms of both the ends, i.e. the goals we strive for, and the means through which those ends are to be achieved, i.e. the transformations required and their implications for governance (Gupta et al., 2023).

In this report we build on published work to summarise key findings that define safe and just Earth system boundaries, Earth system justice, and the Earth system impacts of achieving universal access to basic resources. However, setting these targets and boundaries in itself is not enough. The means and policies through which these targets are achieved need to adhere to justice standards as well. Thus, staying within safe and just boundaries requires a transformation of the global-to-local governance architecture. In this report, we define governance architecture as "the interlocking web of widely shared principles, institutions and practices that shape decisions at all levels in a given area of earth system governance" (Biermann et al., 2009a: 31).

1.2 Target setting and beyond in the Anthropocene

The Anthropocene is often used to refer to the current geological era in which all Earth systems have been irrevocably changed by a “great acceleration” of human activities and impacts on natural systems, such as unprecedented species extinctions and greenhouse gas pollution (Steffen et al. 2015). Some scientists associate the start of the Anthropocene with the rise of the industrial revolution in the 19th century, or the spread of agriculture more than 10,000 years ago and others with nuclear pollution or the age of mass consumption starting in the mid-20th century. Indigenous and global South peoples date it to the spread of settler colonialism and extraction. Whatever its exact start, the Anthropocene has brought about a global ecological polycrisis – including climate change, pollution and biodiversity loss – which affects humanity as a whole. At the same time, it impacts different groups of people in unequal ways, reflecting different geographies and vulnerabilities (Ribot, 2014), increasing levels of inequality (Piketty, 2014), and associated differences in exposure to risk.

Scientific assessments of environmental issues increasingly emphasize the need for just approaches, but these efforts often fall short in terms of operationalisation (Gupta et al., 2023a). To address environmental risks, scientists propose planetary boundaries – biophysical targets such as warming limited to 1.5°C – to prevent tipping points and Earth system degradation. Various stakeholders, including scientists, activists, governments, and corporations, use these targets to convey desired outcomes, seeking simple, measurable ways to guide and assess policy, progress, and environmental conditions (Dahlmann et al., 2020; Morseletto, Biermann, and Pattberg, 2017). Goals and targets communicate social urgency, mobilise support, and set benchmarks. The setting of goals and targets is integral to global governance architecture, exemplified by the 2030 UN Agenda.

At the same time, governance solely based on targets risks oversimplification and inappropriateness (Fukuda-Parr, 2014; Gifford et al., 2023), particularly when set without considering diverse local conditions, distributional, and procedural justice (Gupta et al., 2021). Targets can convey an impression of objectivity, overlooking their social construction and political negotiation (Turnhout, Hisschemöller, & Eijsackers, 2007). For example, proposals to set aside half the Earth for nature face criticism for neglecting land rights and resource consumption issues (Agbor, 2022; Büscher and Fletcher, 2015). Hence, the Earth Commission has identified safe boundaries but also moved beyond to suggest ‘just’ boundaries, and how such ‘safe and just’ boundaries need to be met in a just manner through social and economic transformations.

1.3 Content and structure of the report

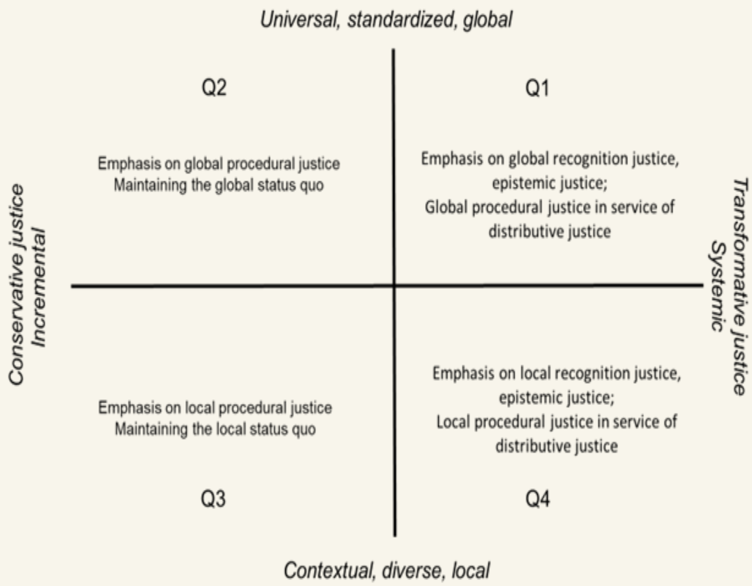
Targets related to Earth system boundaries, the Sustainable Development Goals and other goals must be discussed and debated in global governance systems (section 3). Will such targets protect both nature and the most vulnerable while giving the poor access to the basic resources to escape from poverty? The Earth Commission translates principles of access into quantifiable targets for inclusion in governance systems (section 4). Our analysis reveals that the world has breached most Earth system boundaries, causing significant harm to people and ecosystems (Rockström et al., 2023). These boundaries have been breached, even though the basic needs of those below the minimum have not yet been met. Hence, meeting basic needs for those below the minimum in an unchanged world leads to further boundary breaches (Rammelt et al., 2023) (section 5).

These analyses underscore the need to address the drivers of environmental crises and vulnerability from local to global governance levels (section 6). Current approaches predominantly focus on the symptoms rather than the deeper causes and do not address the deeper needs for transformation of current governance systems (section 7). Our conclusion summarizes key transformations needed to take us to the safe and just space.

2. THE EARTH COMMISSION APPROACH TO EARTH SYSTEM JUSTICE

The Earth Commission considers both safe and just Earth system boundaries (ESBs) by drawing on justice approaches and highlighting the transformations necessary to safely and justly stay within the boundaries (Rockström et al. 2021; Gupta et al. 2023). Safe boundaries have been defined to stabilize the Earth system, such as the protection of biodiversity and the avoidance of climate tipping points. Two important goals, or 'ends', arise from the integration of justice concerns with these safe ESBs: first, minimizing significant harm to vulnerable people and other species through the adoption of safe and just boundaries, and second, ensuring access to the resources for a dignified life or even an escape from poverty for all people. The conceptualisation and operationalisation of harm and access begins with an elaboration of our overall approach to Earth system justice (ESJ).

Figure 1 Matrix presenting a range of justice approaches for environmental governance



Source: Building on Gupta et al. 2021, Earth System Governance, http://creativecommons.org/licenses/by/4.0/

Justice approaches (cf. Tàbara & Chabay, 2013) can range from foregrounding universal values (e.g. human rights) to the protection of contextual values (e.g. justice among and towards local communities); and from reformist incremental justice (based on existing forms of justice, also referred to as conservative justice) to transformative systemic justice (aimed at system change to ensure equitable allocation and redistribution of resources, harm, and responsibilities) (see Figure 1). Resulting from the current breaches of the boundaries (section 5), and the global ambition of the Earth Commission, the ESJ approach is largely positioned on the 'right' side of the Matrix and requires a continuous iteration from local to global. The ESJ framework is informed by a wide range of justice dimensions emerging from research on justice, especially in the legal field and social sciences. ESJ begins by emphasising recognition and epistemic justice which require looking at the world from the perspective of the most marginalized and building upon their knowledge systems. ESJ also focuses on the more transformative concept of ideal justice as opposed to conservative justice which aims to protect the status quo. At the most fundamental level, ESJ recognizes the intrinsic value and plurality of human and non-human nature, and associated knowledges. To reflect that, the ESJ framework is guided by the "3 Is" justice principles, as indicated in the top rows of Figure 2:

- I1: Interspecies justice and Earth system stability: rejecting hierarchies among different species and emphasising the necessity of Earth system stability for life on Earth;
- I2: Intergenerational justice: considering the needs of the past, current and future generations as equally important;
- I3: intragenerational justice: justice among people, communities, and countries.

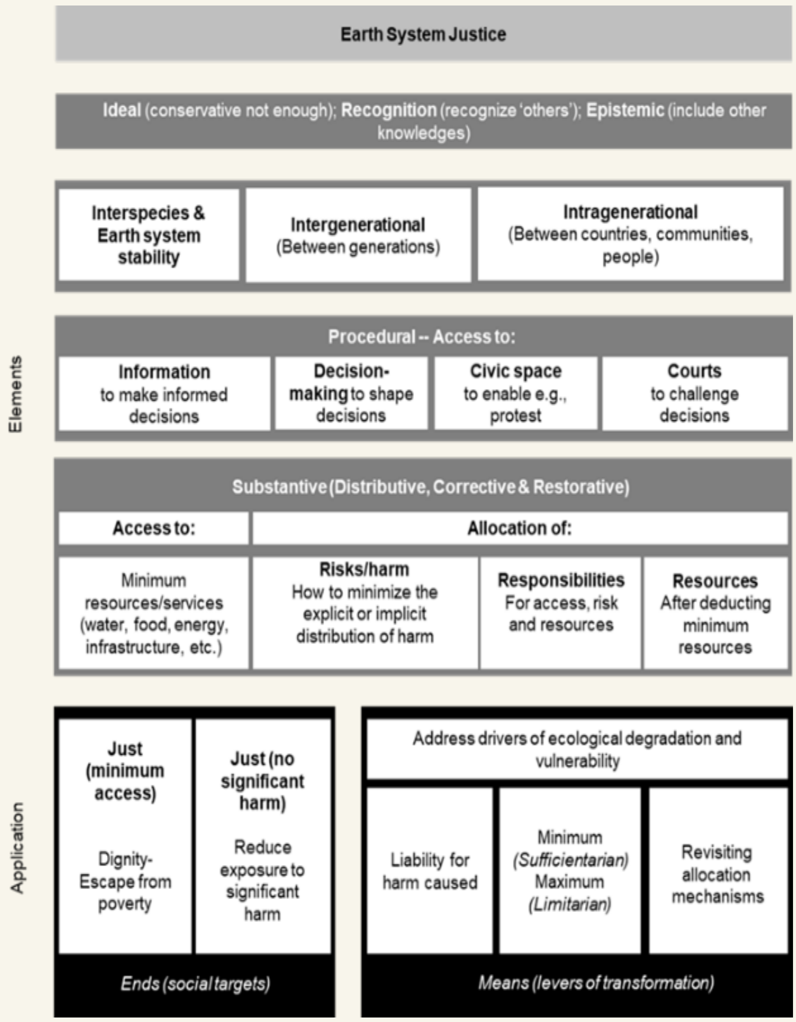


Figure 2. Conceptualizing the multiple dimensions of Earth system justice.

Source: Gupta et al. 2023, Nature Sustainability http://creativecommons.org/licenses/by/4.0/

In terms of substantive justice (the middle and lower rows in Figure 2), we initially focus on two key justice goals (the 'ends'):

1. No Significant Harm: ESBs must be established to prevent significant harm from environmental changes to (vulnerable) human populations and other species, keeping in mind the 3 I's.
2. Minimum Access: All humans should have access to a set of fundamental needs that enable a dignified life and better still escape from poverty.

The attainment of each of these goals independently has posed a considerable challenge for the global community. Simultaneously achieving both goals is even more daunting due to their potential mutual tensions and trade-offs. That is: if the aggregate environmental pressure must be reduced to respect safe and just ESBs while ensuring minimum access for those living below minimum standards this would further increase pressures on the Earth systems, in the absence of other fundamental transformations such as limits to consumption. We argue that both goals must be pursued simultaneously in order to achieve the 2030 Agenda.

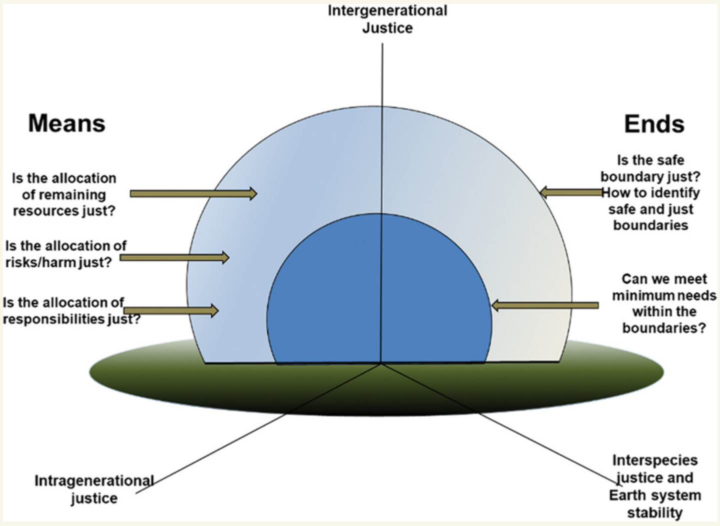


Figure 3. Ends and means of Earth system justice.

Source: Gupta et al. 2023, Environmental Politics. http://creativecommons.org/licenses/by/4.0/

These ambitious but necessary requirements have led to the identification of a set of required transformations each with their own implications for governance. This is what has been termed the 'means' of Earth system justice. These are elaborated on in section 7 and should address:

1. The fundamental drivers of environmental change and vulnerability
2. Access to minimum resources: Ensure that minimum needs are met;
3. Allocation of harm/risks: Promote liability for acts that cause damage and harm to others;
4. Allocation of remaining resources: Identify principles that can ensure the just and effective reallocation of resources, risks/harm, and responsibilities; and
5. Allocation of responsibilities: Identify who is responsible for what action and appropriate effective and just policy instruments that can operationalize the above

3. DEFINING SAFE AND JUST BOUNDARIES

3.1. Introduction

The concept of planetary boundaries (Rockström et al. 2009, Steffen et al. 2015, Richardson et al. 2023) identifies a safe operating space for humanity to maintain a functioning Earth system. The Earth Commission moves beyond the planetary boundary approach with the development of Earth system boundaries (ESB). These refine, and in some cases redefine, the safe boundaries by assessing them in terms of the extent to which these boundaries minimize significant harm while adhering to the principles of interspecies (and Earth system stability), intergenerational and intragenerational justice (the '3-I approach').

3.2. Earth system boundaries (ESBs) need to be safe and just

Anthropogenic degradation of the Earth's bio-geophysical systems is destabilizing those very systems that support life on Earth, posing existential challenges for a stable planet threatening ecosystems, and their contributions to people. The Earth Commission has identified and quantified eight ESBs beyond which the risk of critical declines in Earth system functions increases (see 3.3. below). Taken together these ESBs span the major components of the Earth system that are threatened by human activities and have impacts on policy-relevant timescales. Current and further breaching of these ESBs could affect Earth system stability and with that human development on a global scale.

However, these safe ESBs are not necessarily just in terms of supporting and protecting human life today and in the future. Indeed, the justice implications of safe boundaries require systematic investigation (O'Neill et al., 2018; Häyhä et al., 2016). First, a safe boundary may not be just because of its effects. While protecting the functioning of Earth systems, significant harm may still be caused to the lives and environments of vulnerable people and other species. Moreover, safe boundaries may not be scaled to policy relevant levels and may not account for the quality of the system. Second, a safe boundary is indifferent to the question of *who* is using the limited ecospace, i.e., to the tremendous inequalities in resource use and responsibility for degrading the ecospace. Third, the setting of a safe boundary provides no guidance as to *how* human activity might be governed to prevent breaching these boundaries.

Therefore, ESBs have been set at levels that should prevent "significant harm" to humans, as defined in Box 1. The more stringent of the safe and just boundaries was then selected as the "Safe and Just Earth system boundary". Importantly, achieving this boundary is a necessary but not a sufficient condition for justice, since staying within these boundaries can in theory be achieved through unjust means.

Box 1. Defining significant harm.

HARM

Negative impact on humans, communities, and countries from Earth system change ***additional*** to background rates and from changes in vulnerability. This includes harm to human health.

SIGNIFICANT HARM

Existential and/or irreversible negative impact on people, communities, or countries, such as substantial loss of life, deterioration of health, livelihood and income, loss of access to nature's contributions to people, loss of land, chronic disease, injury, malnutrition and displacement.

NO SIGNIFICANT HARM

States and other actors responsible for anthropogenic Earth system change have a duty to refrain from causing significant harm; to prevent, reduce, and control the risk of causing significant harm; and to repair or compensate for the significant harm already inflicted.

JUST (NO SIGNIFICANT HARM) ESB

Earth system state that minimises risk of significant harm to present and future generations, countries, and communities. This can be expanded to minimise risk to species and ecosystems.

Source: Rockström et al., 2023, Nature http://creativecommons.org/licenses/by/4.0/

3.3. Safe boundaries prevent tipping points and Just boundaries minimise significant harm

The Earth Commission has selected five biophysical domains: climate, biosphere, nutrients, water, and aerosols. For these domains a total of eight safe ESBs were defined, since the biosphere, nutrients and water domains each include multiple boundaries reflecting local vs global limits. In the future, the Earth Commission intends to expand this work in the domains of oceans and novel entities, such as microplastics and chemical pollution.

The quantification of these boundaries is based on the assessment of tipping point risks, the decline in Earth system functions at local and global scales, historical variability, and expert judgement (Rockström et al., 2023). Results are summarised in Table 1. As mentioned above, even within safe ESBs, some human and non-human beings might still be exposed to significant harm due to Earth system change, and a safe boundary may therefore still be unjust. Hence, the Earth Commission proposes that:

a) some boundaries be made more stringent to protect present and future generations and ecosystems. That is, for climate the safe and just target has been set at ≈1°C to avoid high exposure to significant harm from climate change instead of 1.5°C as the safe boundary. For nutrients the N Surplus should be kept below 57 TgN/yr which is more stringent than the safe boundary (see Table 1).

b) safe boundaries should be complemented with local level standards, e.g., for aerosols, local concentrations should be kept below 15 µg/m3 PM2.5 (≈ 0.17 AOD) (see Table 1).

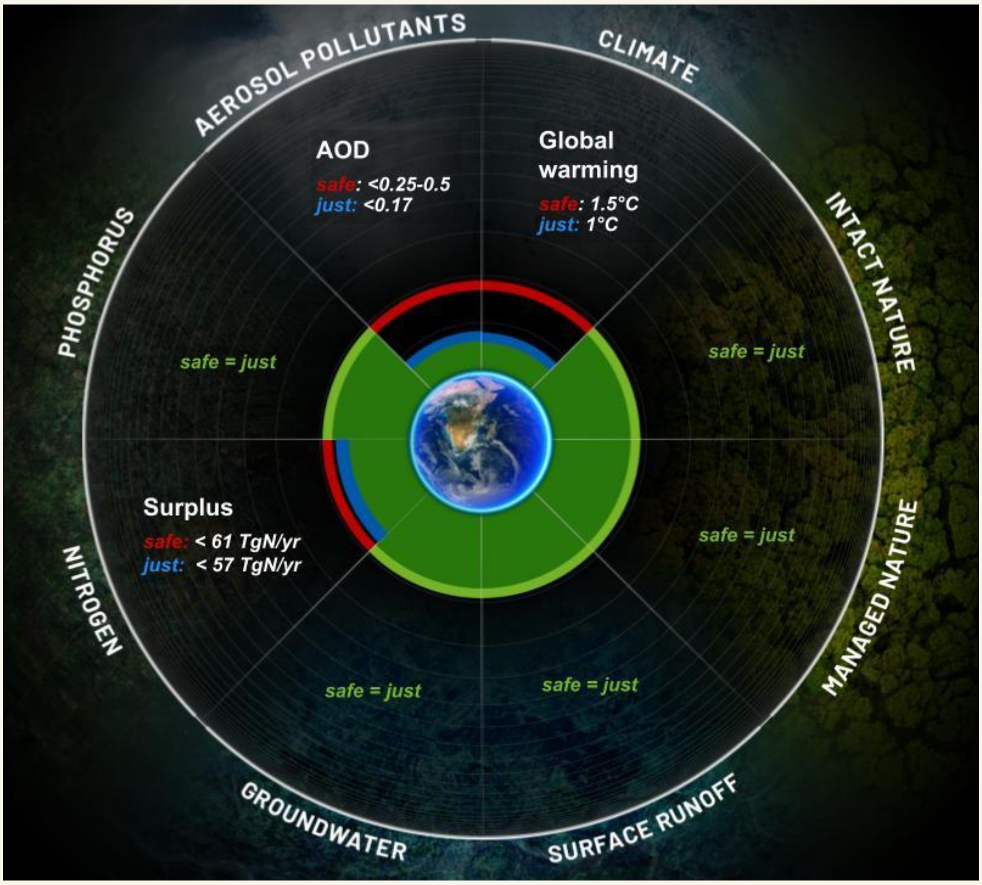
c) if the boundary is likely to cause considerable difficulties for present generations, it should be complemented with policies that account for distributive justice, e.g., for biosphere boundaries (see Table 1).

Table 1. Safe and Just Earth system boundaries and no significant harm (NHS)

	Climate	Biosphere	Water	Nutrients	Aerosol pollutants
SAFE	**Global warming** should not exceed 1.5°C.	**Natural ecosystem area**: At least 50–60% of all land must be natural ecosystems. **Functional integrity**: At least 20–25% of land within every sq km must be semi-natural ecosystems	**Surface water flows**: cannot change by more than 20% monthly (that is, max 7639km^3 globally per year) **Groundwater levels**: Annual drawdown must be less than recharge (i.e., max 15,800 km^3 globally p.a.)	Global **Nitrogen** surplus must not exceed 61 Tg p.a.. Local concentrations should stay below 2.5 mg/liter (surface water) and 5-20kg/ha for terrestrial ecosystems. Global **phosphorus** surplus must not exceed 4.5–9.0 teragrams p.a. Local concentrations should stay below 50-100 mg per m^3.	**Local aerosol optical depth** of 0.25 - 0.5 AOD*. **Global annual mean interhemispheric AOD** difference must not exceed 0.15. **AOD refers to the concentration of particles in the air that will impact monsoon systems (rainfall) and therefore food production*
JUST (NSH)	Global warming should not exceed 1.0°C to avoid high exposure to additional significant harm. Just boundary more stringent. (moderate, 0.5–1 °C; high, 1–1.5 °C; very high, >1.5 °C)	Align with safe boundary plus ensure distributional justice	Both water surface and groundwater align with safe targets. Plus World Health Organization and United Nations Environment Programme quality standards	**Nitrogen**: Global surplus must not exceed 57Tg per year. Local targets align with safe, but add drinking water and air pollution standards. Just boundary more stringent. **Phosphorus**: Global surplus aligns with Safe boundary. Local safe boundary also aligns, to avoid eutrophication	Global just boundaries are more stringent. This is based on local air quality standards: <15 μg per m^3 mean annual PM2.5;

Based on Rockström et al., 2023, Nature http://creativecommons.org/licenses/by/4.0/

Figure 4. Safe and Just targets for the five domains and eight boundaries.



In this visualization of Earth system boundaries, the safe boundaries are in red, the just (NSH) boundaries are in blue, and the cases where safe and just (NSH) boundaries coincide are in green.

Source: Gupta & Rockström plenary presentation at World Economic Forum, Davos. Credit: Globaïa for the Earth Commission (2023, January).

4. DEFINING MINIMUM ACCESS TO RESOURCES FOR ALL

4.1 Introduction

Safe and just Earth system boundaries (ESBs) impose restrictions on the amounts and types of wastes and pollution generated (e.g. greenhouse gases, nutrients, air pollution), and on the amounts and types of resources that can be extracted (e.g. water, fossil fuel) or altered (e.g. land use change). In other words, ESBs reduce the total environmental utilisation space, or 'ecospace', available for sharing between humans and nature.

The transgression of ESBs goes hand in hand with tremendous inequalities in the responsibility for transgressing those boundaries and in the harm resulting from those transgressions (Gupta et al. 2020). A privileged minority has historically benefitted from the utilization of a much greater share of the planet's ecospace, and developed consumption and trade patterns that perpetuate such exploitation. Meanwhile, half of the world's population lives on less than $5.50 per day, which heavily limits their access to resources and disproportionately exposes them to environmental degradation (Rammelt & Gupta 2021; Gupta et al. 2023). An Earth system justice (ESJ) approach is therefore not only needed to guide how humans are to live within the ESBs, but also to formulate guidelines for a just distribution of the limited ecospace.

4.2 Earth system justice (ESJ) requires meeting the minimum access needs of people urgently

The UN 2030 Agenda calls for urgent action to eradicate poverty in different forms (e.g. SDG 1), meet the basic needs of people (e.g. SDG 2, 3, 6, 7), reduce inequalities (SDG 5, 10) and protect the environment (SDG 13, 15) (UN 2015). In line with the 2030 Agenda, justice in access to minimum resources is assumed to support human rights, reduce vulnerabilities, and enable healthy and productive lives (Derek et al. 2015). Going beyond the 2030 Agenda, the ESJ framework has developed a biophysical and material conceptualization and operationalization of minimum access, focusing on the key resources of energy, water, food and infrastructure, in line with a number of SDG goals and targets as shown in Table 2.

Table 2. Selection of SDG targets related to minimum access.

	SDG	SDG Target	SD
Water	#6: Ensure availability and sustainable management of water and sanitation for all	**6.1** Access to universal and equitable safe and affordable drinking water for all	6.1.1 Proportion of population using safely managed drinking water services
		6.2 By 2030, achieve access to adequate and equitable sanitation and hygiene for all and end open defecation, paying special attention to the needs of women and girls and those in vulnerable situations	6.2.1 Proportion of population using (a) safely managed sanitation services and (b) a hand-washing facility with soap and water
Food	#2: End hunger, achieve food security and improved nutrition and promote sustainable agriculture	**2.1** By 2030, end hunger and ensure access by all people, in particular the poor and people in vulnerable situations, including infants, to safe, nutritious, and sufficient food all year round	2.1.1 Prevalence of undernourishment
			2.1.2 Prevalence of moderate or severe food insecurity in the population, based on the Food Insecurity Experience Scale (FIES)
Energy	# 7: Ensure access to affordable, reliable, sustainable and modern energy for all	**7.1** - By 2030, ensure universal access to affordable, reliable and modern energy services	7.1.1 Proportion of population with access to electricity
			7.1.2 Proportion of population with primary reliance on clean fuels and technology
Infrastructure-housing	# 11. Make cities and human settlements inclusive, safe, resilient and sustainable	**11.1** - By 2030, ensure access for all to adequate, safe and affordable housing and basic services and upgrade slums	11.1.1 Proportion of urban population living in slums, informal settlements or inadequate housing
Infrastructure-transport	#9 - Build resilient infrastructure, promote inclusive and sustainable industrialization and foster innovation	**9.1** - Develop quality, reliable, sustainable and resilient infrastructure, including regional and transborder infrastructure, to support economic development and human well-being, with a focus on affordable and equitable access for all	9.1.1 Proportion of the rural population who live within 2 km of an all-season road
			9.1.2 Passenger and freight volumes, by mode of transport
	Goal 11. Make cities and human settlements inclusive, safe, resilient and sustainable	**Target 11.2** - By 2030, provide access to safe, affordable, accessible and sustainable transport systems for all, improving road safety, notably by expanding public transport, with special attention to the needs of those in vulnerable situations, women, children, persons with disabilities and older persons	11.2.1 Proportion of population that has convenient access to public transport, by sex, age and persons with disabilities

Access domain	Access level	Value	Unit
Energy	1	74.5	Kilowatt-hours per capita per year (kWh cap^{-1} yr^{-1})
	2	255	
Water	1	50	Litres per capita per day (l cap^{-1} d^{-1})
	2	100	
Food	1	2,100	Kilocalories per capita per day (kcal cap^{-1} d^{-1})
	2	2,500	
Infrastructure—housing	1	7	Square metres per capita (m^2 cap^{-1})
	2	15	
Infrastructure—transport	1	3,500	Passenger kilometres per capita per year (pkm cap^{-1} yr^{-1})
	2	4,500	

Table 3. Quantifying minimum levels of access to water, food, energy and infrastructure.

Source: Rammelt et al. 2023, Nature Sustainability http://creativecommons.org/licenses/by/4.0/

Our starting point is that there is not a single cut-off level for what constitutes 'minimum' access, but a range between two levels of 'just access'. These levels represent minimum per capita requirements that would enable a dignified life beyond survival (level 1— dignity) and a somewhat higher level that would enable escape from poverty and vulnerability (level 2—capability).

Table 3 shows the quantification of those levels for four key resources that all humans rely on: food, energy, water, and infrastructure (in terms of housing and transport). Achieving level 2 can be interpreted as the preferred goal, with level 1 representing the absolute lowest threshold, although it is higher than the international poverty line. We take 2018 as the base year for these calculations where we can assume that all other factors (e.g. technology use/distribution) remain constant.

Table 3 summarises our assumptions about access needs for energy, water, food and infrastructure for these two levels on the basis of scientific and grey literature and expert judgement within the Earth Commission (see Rammelt et al. 2023). These values do not reveal the full range of resource uses that have been accounted for. For example, the minimum access to water refers only to direct household consumption. Access to irrigation water is accounted for under food. Similarly, access to energy refers only to electricity. Energy use for cooking, heating and mobility are accounted for under food and infrastructure. Finally, access to food is shown in kilocalories, but a healthy diet has been taken into account, not just dietary energy.

This conceptualisation of minimum access forms the basis to examine the hypothetical additional impacts of achieving just access (at both levels) on critical Earth systems, that is, on top of existing total impacts. In the next section, we show the calculations of these further impacts, and how this should be interpreted in the light of the current unequal patterns of responsibility for transgressing the ESBs.

5. THE CURRENT SITUATION: BREACHING THE BOUNDARIES

5.1 Introduction

Sections 3 and 4 have articulated the two 'ends' of the Earth system justice framework: 'no significant harm' and 'minimum access'. In short, these ends would ensure that all people have a minimum level of access to the resources needed to fulfil basic needs, *and* that they would not be exposed to significant harm caused by anthropogenic environmental degradation. These two ends can compromise each other as the environmental pressure resulting from all people acquiring access to basic needs puts additional pressure on the boundaries and can cause significant harm. However, this additional pressure must be seen in the context of existing unequal patterns of responsibility.

We must also recognise that harm is already being done at current levels of environmental pressure, even in the absence of additional pressures from hypothetically achieving minimum access.

The goal of this section is therefore to demonstrate the extent to which currently ESBs are breached, and outline how these two ends can be brought together. We will then define what is required to ensure that the global community meets both goals simultaneously.

5.2 ESBs have been breached

At the global level, 7 of the 8 ESBs have been breached (see Table 4 and Figure 4). The global aerosol boundary is the only one that has not been breached yet; however, locally aerosol boundaries have been breached in many parts of the world.

In terms of global spatial distribution, the areas where at least two ESBs have been breached add up to more than 50% of the Earth's land surface and are in regions where 86% of the world population lives (see Figure 6).

Table 4. Safe and Just ESBs have been breached

Climate	Biosphere	Water	Nutrients	Aerosol pollutants
Global warming Breached: Current warming is 1.2°C.	Natural ecosystem intactness Breached at just under half of all land	Flow of rivers Breached for 34% of global area.	Nitrogen surplus Breached: Current nitrogen surplus is 119 Tg/y.	Local aerosol optical depths (AOD) Not breached at global level, but breached at local level.
	Functional ecosystem integrity within every sq km. Breached across about two thirds of human-settled land.	Annual drawdown of groundwater Breached: for 47% of global area.	Phosphorus surplus Breached: current phosphorus surplus is 10 Tg/y.	Global annual mean interhemi-spheric AOD Not breached.

Based on Rockström et al., 2023, Nature http://creativecommons.org/licenses/by/4.0/

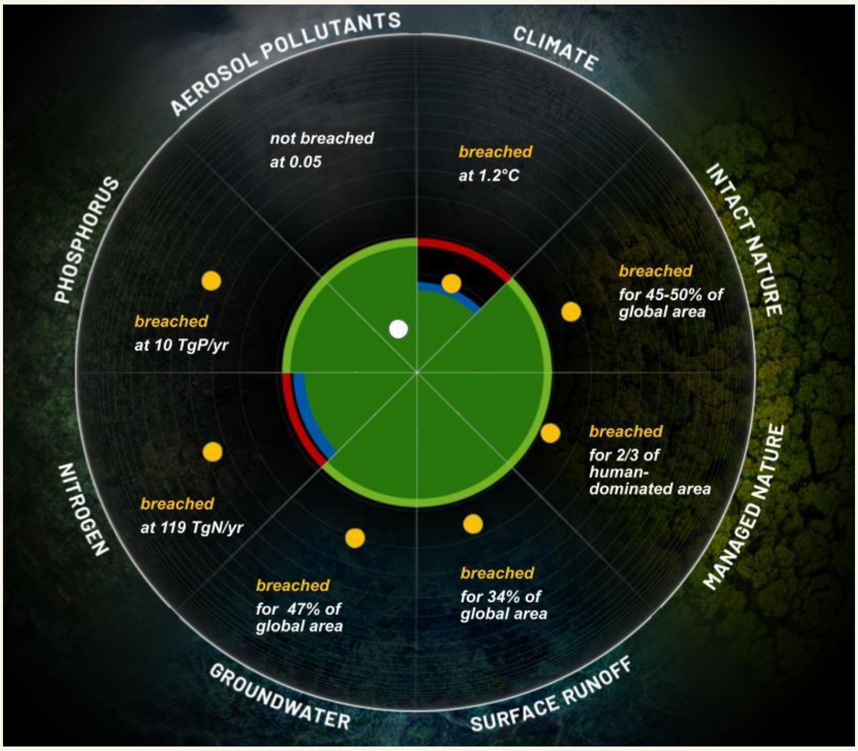
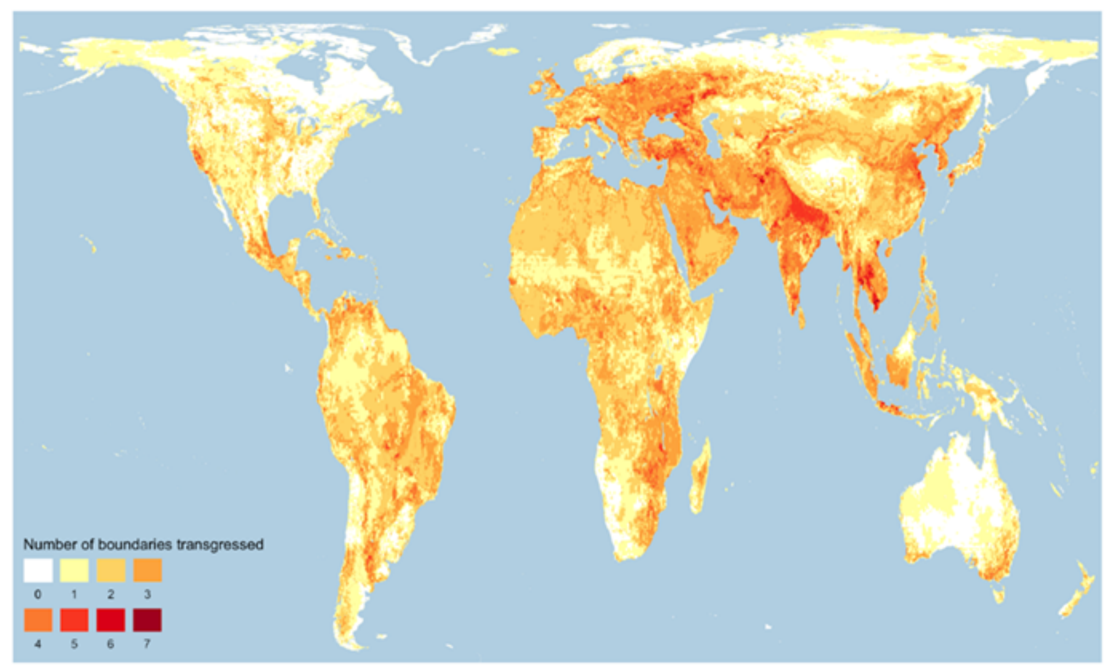


Figure 5. Breached Earth system boundaries.

In this visualization of the ESBs, the safe boundaries are in red, the just (NSH) boundaries are in blue, and the cases where safe and just (NSH) boundaries coincide are in green; the current global states are represented by the yellow and white dots.

Credit: Globaia for the Earth Commission Source: Gupta & Rockström (2023, January). Plenary session at World Economic Forum, Davos.

Figure 6. Hotspots of current ESB transgressions.



Source: Rockström et al. 2023, Nature http://creativecommons.org/licenses/by/4.0/

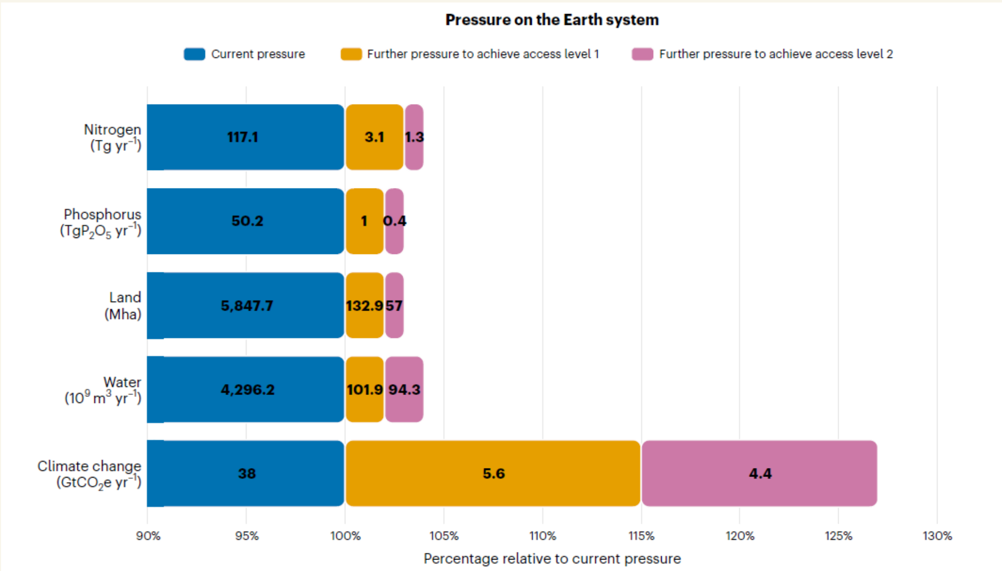
5.3 Meeting minimum access could lead to further crossing boundaries

Based on our definition of minimum access requirements (section 4), we estimated the additional impacts on the five Earth system domains. We used the scenario in which minimum access to food, water, energy and infrastructure would have been achieved for those without such access in 2018, and then determined the impact of this additional resource use on Earth Systems. 2018 was chosen as a reference year because it was a pre-covid year and because it allows us to avoid making contested assumptions about future changes in technology, demography and resource distribution. Importantly, consumption levels for all those consuming above the 'minimum level' remained unchanged; so in this scenario we lifted up those below the minimum, but did not 'restrict' those above the minimum.

We translated per capita access requirements for food, energy, water, and infrastructure to pressures on each of the Earth systems. The different Earth systems are influenced by multiple access domains. For instance, climate pressure results from access to both energy (emissions from household electricity consumption) and food (emissions from agricultural production). Conversely, each access domain impacts multiple Earth systems; for instance, access to food influences climate change, land use, water use, and fertilizer use. We drew from case-specific estimations for these causal links, such as CO_2 emissions per kcal, water use per kcal, or land use per kcal.

Results show that ensuring minimum access to those lacking it – in an unequal world (so without redistributing resources) – would lead to marginally increased pressures on the Earth's natural systems, except for the climate system where the impact would be significant. The said scenario for 2018 would have raised greenhouse gas emissions by 26%, compared to a 2-5% rise for water, land use, and biogeochemical flows (Rammelt et al. 2023) (Figure 7).

Figure 7. Pressure on the Earth system of meeting basic needs of those below that level in 2018



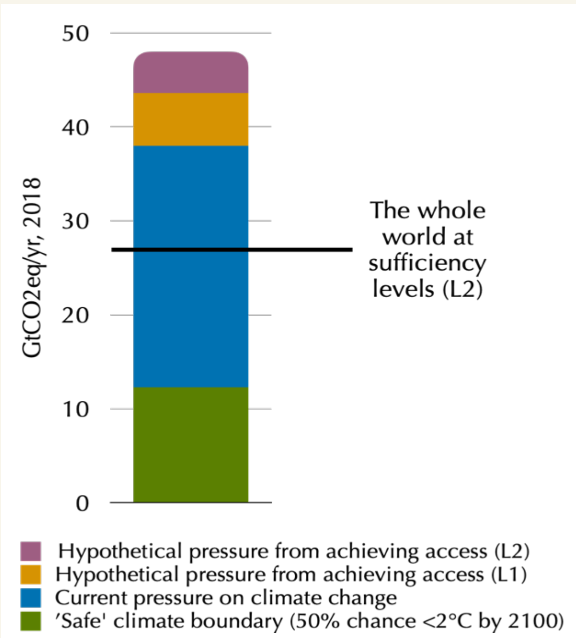


Figure 8. Impacts on greenhouse gas emissions of meeting access.

Source: Based on Rammelt et al. 2023, Nature Sustainability. http://creativecommons.org/licenses/by/4.

5.4 Meeting minimum needs requires redistribution and transformation

On average, the access-related impacts mentioned above are caused by an estimated 30% of the world population at level 1, and by 37% at level 2. It is important to compare these estimates with existing patterns of distribution of resources and responsibility. Pressures arising from roughly the poorest third of humans consuming at the level of 'minimum access' equals the pressures caused by the wealthiest 1-4% (Rammelt et al. 2023). This implies that in order to achieve societal and environmental goals, transformative change must redistribute resources from 'over-consumers' to 'under-consumers'. The impacts of achieving minimum access must therefore be assessed in the context of existing inequalities in the distribution of resources, i.e., in what we call "the Great Inequality" (see 8).

However, redistribution alone will not resolve the contradiction between achieving minimum access while respecting safe ESBs. Take climate: if the emissions of the entire world population had been equalised at minimum access level 2 in 2018 (a highly unlikely scenario, but a useful thought experiment), the annual emissions would still have exceeded the safe limits for climate under current circumstances. Redistribution is therefore not enough; it must go hand in hand with broader transformations including changes in technological systems (particularly fossil-fuel based energy and food systems) and in economic and trade systems.

.

6. WHY BOUNDARIES ARE BREACHED – UNDERSTANDING THE DRIVERS

6.1 What are the drivers of Earth system change?

Achieving a safe and just future for people and the planet will not occur unless the fundamental drivers of environmental change and injustice are addressed through effective governance and other transformations. Various assessments and publications that examine the fundamental drivers most often highlight population, consumption, technology, values, information, and political and economic systems. While natural variability and processes such as orbital changes or evolution may have driven Earth system changes for millennia, in the Anthropocene human activities are becoming the dominant drivers (Steffen et al. 2007).

Although some researchers and policy makers still see population growth and high fertility rates as a major driver of Earth system change, others have demonstrated that increasing per capita consumption is becoming a far more important driver, especially as fertility rates have declined rapidly and population growth is slowing (Kallis 2019; Bongaarts 2006). Demographic drivers also include urbanisation and migration. Per capita consumption is highly unequal ranging from the resources needed for survival to a dignified life, escape from poverty to a high consumption luxury lifestyle (World Inequality Report 2022; Rammelt et al. 2023). The impact of consumption also depends on the type of activity or technologies used and their environmental impacts.

Technological drivers and choices drive Earth system change when they produce high levels of greenhouse gases, accelerate land use change, or are associated with pollution but can also reduce pressures when they increase efficiency or provide substitutes with lower environmental impacts (Horback et al. 2012). Technology can embrace a wide range of activities including manufacturing, types of energy generation, indigenous agriculture, artisanal production, communications, and different infrastructures. Negative impacts include pollution and land degradation but more positive impacts include innovations in efficiency, and moves towards renewability, and reuse and restoration within socio-technical systems (O'Brien 2012).

Value drivers include ethical, cultural, political and other beliefs that affect behaviour and action by individuals and organisations including governments, business and environmental groups. They are often influenced by information and education, religion, media and increasingly social media. Problematic values include the pursuit of economic growth at the expense of environmental degradation and social exclusion/ marginalisation, and the rejection of government regulation (Rammelt & Gupta 2021).

Other scholars argue that political and economic systems are the most important drivers of environmental problems and suffering especially when they exploit people and nature and focus on profit and accumulation such as under capitalism (Hickel 2020; Schmelzer et al. 2022). A long term political and economic driver is colonialism which dispossessed local and indigenous peoples, changed land use and exacerbated North-South inequality. Neoliberal political economies of reduced government, free trade, and privatisation of the commons are blamed for dispossessing access, undermining public services, and removing environmental protection (Liverman and Vilas 2006).

In both democracies and autocracies powerful elites may oppose transformative policies that redistribute wealth and protect the environment (Scoones and Stirling 2020). However, state authorities may intervene against elite interests in response to growing knowledge of the impacts of such dispossession, social protest and when environmental crises or health emergencies undermine profits.

Governance is an overarching driver of Earth system change and inequality and can be both positive and negative. Governance includes the goals and actions of the state (national and local government) as well as private actors (business, NGOs), the courts, and international organisations. For example, government and private actors have promoted consumption (and associated environmental and social impacts) through colonialism, property rights, trade, marketing, subsidies, and other incentives (Barber 2021). However, government recognition of women's rights and provision of healthcare has contributed to lower fertility. Government and private investment in technology innovation is associated with both harm (such as from polluting technologies) and sustainability (efficiency, low carbon alternatives) (Lamb et al, 2014). Poor governance also allows for corruption and loss of inclusive politics.

7. TRANSFORMATIONS IN GOVERNANCE AND SOCIETY

7.1 Introduction

Slowing and reversing the speed and intensity of unsafe Earth system changes must go beyond conventional solutions. Fundamental system-wide transformations are needed to stay within safe and just boundaries and to ensure wellbeing. Transformations are profound processes of change involving systemic, structural, political, practical and individual changes across scales that can address the drivers of Earth system change. Past transformations of the human-environment relationship have been both positive and negative for the Earth system and wellbeing and include the domestication of plants and animals, the use of fire, colonialism, the industrial revolution and the great acceleration in human pressures and pollution after 1950.

Widespread environmental degradation led to some transformations in values and governance in the 19th and 20th centuries including the environmental movement, UN environmental action, stronger NGOs, environmental education, and international health and environmental regulations. Other transformations in the last 50 years include rapid global urbanisation, a halving of fertility rates and slowing population growth, and the expansion of democracy and recognition of human rights.

Many international environmental assessments and agreements have proposed just and systemic transformations such as reducing poverty and inequality, more sustainable energy, food, health, and urban systems; limiting consumption, adjusting values and lifestyles; and changing political and economic systems to be more inclusive, ensuring decent work, protecting the vulnerable and incentivising sustainability (Gupta et al., 2024).

The 2030 Agenda with its 17 Sustainable Development Goals calls for meeting minimum needs and addressing inequality, while solving the major environmental crises (UN, 2015). Our work on the Earth system boundaries propose quantifications of the boundaries within which humans need to live to avoid significant harm. The Earth Commission has shown that seven out of eight boundaries have been crossed at global level and more than 80% of the global population lives in areas that have crossed at least 2 of the local boundaries (Rockström et al., 2023). Business-as-usual and incremental solutions will not address the problem. Living within these Earth system boundaries while meeting minimum needs of all requires just transformations. Such transformations go beyond reformative or conservative justice to ensure transformative justice. In fact, reformative or conservative justice is unlikely to achieve the transformations needed to live within the boundaries.

7.2 Key transformations in consumption, economy and technology

In our discussions and publications, the Earth Commission has identified a few key areas of transformation to achieve a future that is both safe and just, and which minimises harm from exceeding Earth system boundaries while allowing access to wellbeing for all. These proposals are consistent with many of the Sustainable Development Goals (SDGs) and international agreements.

The transformations we propose include (Gupta et al, 2024):

- Reducing and reallocating consumption while ensuring access
- Transforming economic systems for sustainability and justice
- Expanding affordable and sustainable technologies

All of these require urgent transformations of values and governance systems.

7.2.1 Reducing and reallocating consumption while ensuring access

As we argue in previous sections on access and distributive justice, reductions in excess consumption, and reallocation to those without can provide everyone with a decent life within safe Earth system boundaries. Individual decision-makers within households, companies, and governments possess the capacity to change values, structures, and behaviours in order to reduce consumption. Consumption is a key driver of Earth system change and as fertility rates decline and population growth slows, per capita consumption, far beyond sufficientarian principles and especially among the rich world, is becoming the key driver (IRP, 2019). Fertility rates have declined with improving gender equality, education and work access for women, better health care and rising incomes, urbanisation, education and are projected to slow and reverse population growth (Bongaarts, 2006). Per capita global average consumption of energy and food increased by more than 25% since 1970, partly associated with declining poverty for some, but also as wealthier countries and individuals consume more as social norms, media and advertising encourage larger homes, automobiles and air transport, and turnover of material goods such as electronics and clothing (Otto et al., 2019; Nielsen et al., 2021). Decreases in consumption are associated with environmental values, price increases, and government policies that reduce overconsumption, promote limitarian justice or support sustainable choices. Limiting overconsumption by some people allows access for others and well as more equitable use of resource.

Values are an underlying driver of consumption decisions of individuals, policymakers and corporate leadership, with values changing with education, public awareness, cultural visions, incentives, and genuinely green advertising (Tàbara & Chabay, 2013). Although communicating alternative worldviews and norms can trigger consumption change, the media and interest groups can promote false information or excess luxury consumption that influences the public.

There are many accepted and effective governance and other mechanisms for reducing and reallocating consumption including interventions such as environmental information, sustainable actions of peers, progressive and enforceable taxation, graduated resource pricing, land use planning, green technologies, and subsidies for more sustainable options (IPCC, 2023). Information includes standards, certifications and labels, and campaigns to change household behaviour. However, reducing and reallocating environmentally significant consumption faces challenges in growth oriented political and economic systems, in the lack of more affordable sustainable choices for consumers, and the continued aggressive advertising of excess or luxury consumer products. Decisions made by consumers worldwide, if changed in a sustainable direction, can have a major impact on addressing global change (Millward-Hopkins and Oswald, 2021). Elite lifestyles projected in advertising and media discourses drives emulative responses from others further exacerbating the problem (Stuart, Gunderson & Petersen, 2020).

7.2.2 Transforming economic systems for sustainability and justice

Economic systems can drive inequality, excess resource use, and high per capita consumption and waste generation, especially when they have a strong focus on accumulation of assets such as land, resources, and investments and capital, when progress is measured primarily through measures such as GDP, or where the economic costs of pollution are viewed as externalities. For example, trillions of dollars are invested in fossil fuels, minerals, and agricultural land, often speculating on future profits, rather than production for current use.

The transition to lower-carbon energy systems, cessation of fossil fuel usage, and efforts towards conservation and sustainability face challenges associated with the potential risk of stranded assets and the influence of investors (Ansar et al., 2013; Watts et al., 2018). Several countries and corporations rely on the revenues and employment generated by the fossil fuel sector and have lobbies preventing a fossil fuel phase out – despite a growing social movement advocating for disinvestment and a fossil fuel non-proliferation treaty. In many countries, the prevalent economic system for allocating resources is the market, where prices may limit access by the poor, non-market values are overlooked, and the commodification of nature frequently falls short of meeting social and environmental objectives (Green, 2021).

The business and finance sector can use governance through self-regulation such as disclosure, benchmarking, divestment, engagement, investment, and environment and social commitments; but this has not yet resulted in significant reductions in inequality or environmental degradation at a large scale (Yu et al. 2020). Insurance is increasingly used by businesses and individuals to manage risk, including from climate and pollution disasters. But insurance can allow societies and governments to postpone difficult decisions or shift the responsibility to those harmed, and away from those driving harm. The projected damages from Earth system changes may crash the insurance markets which in any case are not available to the poor.

The current economic and political systems in many countries that focus on (GDP) growth, high consumption and reducing government intervention that protects nature and the less well off, needs to transform (Park, 2015; Acheampong & Opoku, 2023).

The environmental impacts of economic growth and growing inequality can be addressed through policies that require that external costs be included in prices, measure progress through alternative indicators, require decent working conditions and pay, and monitor and control investment, subsidies, and trade. The transformation of the financial system can be achieved by reporting environmental risks, increasing both private and public funding for environmental protection, granting access to resources and credit for impoverished individuals and nations, and refraining from detrimental subsidies and investments. Initiatives such as debt cancellation, restricting structural adjustment prerequisites, opting for payments over loans, and offering low-interest rates for sustainable activities have the potential to bring about a positive transformation in the global South, addressing historical inequalities linked to unequal exchange (Gupta et al., 2024).

Economic transformations can offer effective means to alleviate pressures on the Earth system while ensuring just access. Taxation has the potential to redistribute wealth and profits, generating revenue for government initiatives for environment and social protection, yet its effectiveness is often compromised by inadequacies, weaknesses, or insufficient enforcement in both developed and developing nations. Tax justice suggest policies aimed at tackling extreme inequality while generating resources for governments to provide public goods. This involves addressing issues such as tax havens, tax evasion, avoidance, abuse, criminal activities, and financial secrecy (Alm, 2021) (Cottrell & Falcão, 2018). Financial globalization has facilitated the rapid movement of money across jurisdictions, prompting suggestions to tax trade or currency exchange to fund green policies (Baker & Murphy, 2019). A well-functioning tax system ensures revenue for funding public services, redistribution to mitigate inequalities, repricing to address public and environmental harms, and representation to uphold state accountability (The state of Tax Justice, 2021). In contrast, tax injustice results in diminished resources for states to finance essential public and merit goods, environmental protection, and perpetuates inequalities (Cottrell & Falcão, 2018).

To replace perverse fossil fuel subsidies and unsustainable food systems, governance can include policies to implement time-limited subsidies and incentives for sustainable alternatives (Loboguerrero et al, 2019). Initiatives to internalize external production costs, such as pollution and waste, can be expedited through legal means, regulatory frameworks, and corporate self-regulation (ESG). However, it is essential to ensure that these efforts do not lead to unjust consequences, such as price increases, restricted access for the economically disadvantaged, and undermining governments' capacities to ensure affordable basic services.

7.2.3 Expanding sustainable and affordable technologies

Technology – such as the tools, machines, electronics, manufacturing, biotech, and infrastructure used in production, consumption and transport – can have significant impacts on the Earth system. New technologies include taking capturing greenhouse gases from the atmosphere. Such innovations may be helpful, if they are cost and energy effective and do not cause new problems. Technology has supported the expansion of agriculture and manufacturing, including the use of polluting fossil fuels and agricultural chemicals. However, technological innovation also provides solutions such as increases in efficiency and renewable energy for decarbonization including solar and wind energy, battery storage, electric vehicles, efficiency advances, building retrofits, digitalization, and alternatives to cement. Some call for solutions to environmental change that include investment and implementation of bioenergy with carbon capture, advanced plant breeding, or geoengineering through solar radiation management. But these technological developments can bring new risks such as rebound if geoengineering stops suddenly or alters rainfall and also faces limits in the capacity to resolve the polycrisis, especially in the context of economic growth (United Nations Environmental Programme 2019, Rammelt & Gupta 2021). Technology transformation often involves trade-offs such as the environmental and human rights impacts of mining rare minerals used in some low carbon options.

Technology is a double-edged sword, providing access to goods and services that improve well-being but, in combination with market forces, can accelerate the exploitative behaviour of the extractive industries and create a whole new range of pollutants that are difficult to deal with (Dieste et al., 2023). Technological and behavioural changes, while important, have not succeeded in realizing the needs of the poorest while respecting safe planetary and Earth system boundaries (Rammelt et al., 2020). Additionally, unconditional faith in future technology can serve as an excuse to continue unsustainable behaviour, and therefore delay climate action (Lamb et al., 2020). There is urgent need for governance that encourages the beneficial aspects of technology while controlling its negative impacts. The precautionary principle can minimise the introduction and use of new harmful technologies and protect health. Subsidies for sustainable and adaptation technologies can make them affordable for all.

7.3 Sharing Our Ecospace

This report explored the interlocking issues affecting our societies and our planet, which perpetuate ecological degradation and inequality. We have demonstrated that safe Earth system boundaries (ESBs) are needed to maintain the resilience and stability of the Earth system. We have argued that these safe boundaries in and of themselves are not just, because often long before the safe boundaries are crossed, humans (and other species) are subjected to significant harm. The Earth Commission has therefore set both safe and just boundaries, some of which have been sharpened by the justice perspective (Rockström et al., 2023). This implies that there is limited ecospace that has to be shared between humans.

Building on human rights agreements and the Sustainable Development Goals, we argue that some of this space must be prioritized for meeting the human rights to water, food, energy and infrastructure. Our calculations show that if these rights were met in 2018, this would, not surprisingly, increase the pressure on the Earth system. However, this pressure of the poorest on the Earth system would be equivalent to the damage caused by the top 1-4% of the world (Rammelt et al. 2023). This calls for transformation of the ways in which we all live.

The Earth Commission's research shows that we have already crossed seven of eight ESBs. The only ESB we have not crossed at the global level is aerosol pollution. However, the aerosol boundary has been crossed at local levels all over the world. The areas where at least two ESBs have been breached add up to more than 50% of the Earth's land surface and affect 86% of the world population (Rockström et al. 2023; section 5). The costs of inaction at global level are huge.

We have crossed the ESBs – and yet, the minimum needs of the poorest have not been met. This begs the question – how do we define a safe and just corridor within which we can all live? We take the safe and just ESB as the roof of the corridor. To define the floor, we have undertaken a thought experiment to see what would be the pressure on the Earth system if all people on Earth would have access to minimum resources. The remaining space provides the ecospace that we have to share with each other (Gupta et al. 2024, in review).

All this implies that we have to radically transform our global system to ensure that we can return to the corridor in a world where everyone has access to basic needs. This is a major challenge.

REFERENCES

Acheampong, A. O., & Opoku, E. E. O. (2023). Environmental degradation and economic growth: Investigating linkages and potential pathways. Energy Economics, 123. https://doi.org/10.1016/j.eneco.2023.106734

Acosta, A. (2013). Extractivism and neoextractivism: two sides of the same curse. Beyond development: alternative visions from Latin America, 1, 61-86.

Agbor, D. T. (2022). Convention on Biological Diversity Post 2020 Target: A Critical Analyses of the Threat Posed by 30 X 30 Target, Devoid of a Human Rights Approach Towards Conservation to Land Rights in Developing Countries: Case Study Cameroon. American Journal of Environment and Climate, 1(2), 92-99.

Alm, J. (2021). Tax evasion, technology, and inequality. Economics of Governance. Dec1;22(4):321–43.

Ansar, A., Caldecott, B., Tilbury, J. (2013). Stranded assets and the fossil fuel divestment campaign: what does divestment mean for the valuation of fossil fuel assets? Oct. Report No.: 635365.

Armstrong, C., & McLaren, D. (2022). Which net zero? climate justice and net zero emissions. Ethics & International Affairs, 36(4), 505-526.

Arts, B., & Tatenhove, J. V. (2005). Policy and power: A conceptual framework between the 'old 'and 'new' policy idioms. Policy sciences, 37, 339-356.

Asher, M., & Bhandari, P. (2021). Mitigation or Myth? Impacts of Hydropower Development and Compensatory Afforestation on forest ecosystems in the high Himalayas. Land use policy, 100, 105041.

Baker, A., Murphy, R. (2019). The political economy of "tax spillover": A new multilateral framework. Glob Policy. May;10(2):178–92.

Barber, A. (2021). Consumed: the need for collective change: colonialism, climate change, and consumerism. Balance.

Bengtsson, et al. (2010). "The Four Main Types of Policy Instruments." Policy Tools for Sustainable Materials Management: Applications in Asia. Institute for Global Environmental Strategies. http://www.jstor.org/stable/resrep00758.4.

Biermann, F., & Kim, R. E. (2020). The boundaries of the planetary boundary framework: a critical appraisal of approaches to define a "safe operating space" for humanity. Annual Review of Environment and Resources, 45(1), 497-521.

Biermann, F., et al (2012). Navigating the Anthropocene: improving earth system governance. Science, 335(6074), 1306-1307.

Biermann, F., Pattberg, P., Van Asselt, H., & Zelli, F. (2009). The fragmentation of global governance architectures: A framework for analysis. Global environmental politics, 9(4), 14-40.

Bongaarts J. (2006). The causes of stalling fertility transitions. Stud Fam Plann. Mar;37(1):1–16.

Bongaarts, J. (2006). The causes of stalling fertility transitions. Studies in family planning, 37(1), 1-16.

Buck, H. J. (2021). Ending fossil fuels: Why net zero is not enough. Verso Books.

Büscher, B., & Fletcher, R. (2015). Accumulation by conservation. New political economy, 20(2), 273-298.

Caney, S., & Hepburn, C. (2011). Carbon trading: unethical, unjust and ineffective? Royal Institute of Philosophy Supplements, 69, 201-234.

Costanza, R., et al (2014). Changes in the global value of ecosystem services. Global Environmental Change, 26, 152–158.

Cottrell, J., Falcão, T. (2018). A Climate of Fairness: Environmental taxation and tax justice in developing countries.

Dafnomilis, I., den Elzen, M., & van Vuuren, D. P. (2023). Achieving net-zero emissions targets: An analysis of long-term scenarios using an integrated assessment model. Annals of the New York Academy of Sciences.

Daugbjerg, C., Smed, S., Andersen, L. M., & Schvartzman, Y. (2014). Improving eco-labelling as an environmental policy instrument: Knowledge, trust and organic consumption. Journal of Environmental Policy & Planning, 16(4), 559-575.

Dehm, J. (2016). Carbon colonialism or climate justice: Interrogating the international climate regime from a TWAIL perspective. Windsor YB Access Just., 33, 129.

Dellink, R., et al (2009). Common-but-differentiated-Responsibilities for adaptation financing: an assessment of the contributions of countries. Institute for Environmental Studies (IVM) Working Paper (Amsterdam: Institute for Environmental Studies).

Delmas, M. A., & Gergaud, O. (2021). Sustainable practices and product quality: Is there value in eco-label certification? The case of wine. Ecological Economics, 183, 106953.

Derek, O., Amy, C., & Farook, U. (2015). Universal Sustainable Development Goals. sustainabledevelopment.un.org. https://sustainabledevelopment.un.org/content/documents/1684SF_-_SDG_Universality_Report_-_May_2015.pdf

Deutch, J. (2020). Is net zero carbon 2050 possible? Joule, 4(11), 2237-2240.

Dieste, M., et al (2023). The "Dark Side" of industry 4.0: How can technology be made more sustainable? International Journal of Operations & Production Management. https://doi.org/10.1108/ijopm-11-2022-0754

Dorninger, et al. (2021). Global patterns of ecologically unequal exchange: Implications for sustainability in the 21st century. Ecological economics, 179, 106824.

Erickson, P., Lazarus, M., & Piggot, G. (2018). Limiting fossil fuel production as the next big step in climate policy. Nature Climate Change, 8(12), 1037-1043.

Ervine, K., (2013). Carbon Markets, Debt and Uneven Development. Third World Quarterly, 34 (4), 653–670.

European Environment Agency. (2019, December 7). Paving the way for a circular economy: Insights on status and potentials. https://www.eea.europa.eu/publications/circular-economy-in-europe-insights

Fankhauser, S., Smith, S. M., Allen, M., Axelsson, K., Hale, T., Hepburn, C., ... & Wetzer, T. (2022). The meaning of net zero and how to get it right. Nature Climate Change, 12(1), 15-21.

Fanning, A., & O'Neill, D. (2018). A Good Life For All Within Planetary Boundaries| An Interactive Website.

FAO (2020) Cost and affordability of healthy diets across and within countries. Background paper for The State of Food Security and Nutrition in the World 2020. FAO Agricultural Development Economics Technical Study No. 9. https://doi.org/10.4060/cb2431en

Fuchs, D., et al (2021). Consumption corridors as a vehicle to pursue the good life. Consumption Corridors, 33–54. https://doi.org/10.4324/9780367748746-3

Fukuda-Parr, S. (2014). Global goals as a policy tool: intended and unintended consequences. Journal of Human Development and Capabilities, 15(2-3), 118-131.

Grasso, M., & Heede, R. (2023). Time to pay the piper: Fossil fuel companies' reparations for climate damages. One Earth, 6(5), 459-463.

Green, J.F. (2021). Does carbon pricing reduce emissions? A review of ex-post analyses. EnvironRes Lett. Mar 24;16(4):043004.

Gupta, J. (2015). Normative issues in global environmental governance: Connecting climate change, water and forests. Journal of Agricultural and Environmental Ethics, 28, 413-433.

Gupta, J. et al. (2020) "Re-imagining the driver–pressure–state–impact–response framework from an equity and inclusive development perspective." Sustain. Sci. 503–520

Gupta, J. et al. (2024, Submitted). A just world on a safe planet: Earth system boundaries, translations, and transformations. The Lancet Planetary Health.

Gupta, J., & Lebel, L. (2020). Access and allocation in earth system governance: lessons learnt in the context of the Sustainable Development Goals. International Environmental Agreements: Politics, Law and Economics, 20(2), 393–410. https://doi.org/10.1007/s10784-020-09486-4

Gupta, J., et al (2021). Reconciling safe planetary targets and planetary justice: Why should social scientists engage with planetary targets?.Earth System Governance, 10, 100122.

Gupta, J., et al (2023). Earth system boundaries and Earth system justice: Sharing the ecospace. Environmental Politics, 1-21.

Gupta, J., et al (2023). Earth system justice needed to identify and live within Earth system boundaries. Nature Sustainability, 1-9.

Gupta, J., Rempel, A., & Verrest, H. (2020). Access and allocation: The role of large shareholders and investors in leaving fossil fuels underground. International Environmental Agreements: Politics, Law and Economics, 20(2), 303-322.

Gupta, J., Schmeier, S. Future proofing the principle of no significant harm. Int Environ Agreements 20, 731–747 (2020). https://doi.org/10.1007/s10784-020-09515-2

Gupta, S., et al. (2007). Policies, Instruments and Co-operative Arrangements. In Climate Change 2007: Mitigation. Contribution of Working Group III to the Fourth Assessment Report of the Intergovernmental Panel on Climate Change. Cambridge University Press, Cambridge, United Kingdom and New York, USA.

Hallegatte, S., & Rozenberg, J. (2017). Climate change through a poverty lens. Nature Climate Change, 7(4), 250-256.

Häyhä, T., et al (2016). From Planetary Boundaries to national fair shares of the global safe operating space—How can the scales be bridged? Global Environmental Change, 40, 60-72.

Herzog-Hawelka, J., & Gupta, J. (2023). The role of (multi) national oil and gas companies in leaving fossil fuels underground: A systematic literature review. Energy Research & Social Science, 103, 103194.

Hickel, J. (2019). Is it possible to achieve a good life for all within planetary boundaries? Third World Quarterly, 40(1), 18-35.

Hickel, J. (2020). Quantifying national responsibility for climate breakdown: an equality-based attribution approach for carbon dioxide emissions in excess of the planetary boundary. The Lancet Planetary Health, 4(9), e399-e404.

Hickel, J., Dorninger, C., Wieland, H., & Suwandi, I. (2022). Imperialist appropriation in the world economy: drain from the global south through unequal exchange, 1990–2015. Global Environmental Change, 73, 102467.

Horbach, J., Rammer, C., & Rennings, K. (2012). Determinants of eco-innovations by type of environmental impact—The role of regulatory push/pull, technology push and market pull. Ecological economics, 78, 112-122.

Howlett, M., & Rayner, J. (2007). Design principles for policy mixes: Cohesion and coherence in 'new governance arrangements'. Policy and society, 26(4), 1-18.

IPCC. (2023) Climate Change 2023: Synthesis Report. Sixth Assessment Report of the Intergovernmental Panel on Climate Change. Cambridge University Press, Cambridge, UK and New York, NY, USA.

IRP. (2019). Global Resources Outlook 2019: Natural Resources for the Future We Want. A Report of the International Resource Panel. United Nations Environment Programme. Nairobi, Kenya. Available from: https://wedocs.unep.org/20.500.11822/27517

Kallis, G. (2019). Limits: Why Malthus was wrong and why environmentalists should care. Stanford University Press.

Lamb, W. F., et al. (2014). "Transitions in pathways of human development and carbon emissions." Environmental Research Letters 9.1: 014011.

Lamb, W. F., et al. (2020). Discourses of climate delay. Global Sustainability, 3, e17.

Lazarus, M., & van Asselt, H. (2018). Fossil fuel supply and climate policy: exploring the road less taken. Climatic Change, 150(1-2), 1-13.

Liverman, D. M., & Vilas, S. (2006). Neoliberalism and the environment in Latin America. Annu. Rev. Environ. Resour., 31, 327-363.

Loboguerrero, A.M., et al. (2019). Food and Earth Systems: Priorities for Climate Change Adaptation and Mitigation for Agriculture and Food Systems. Sustain Sci Pract Policy. Mar 5;11(5):1372.

Mora, L., Deakin, M., & Reid, A. (2019). Strategic principles for smart city development: A multiple case study analysis of European best practices. Technological Forecasting and Social Change, 142, 70-97.

Nielsen, K.S, et al. (2021). The role of high-socioeconomic-status people in locking in or rapidly reducing energy-driven greenhouse gas emissions. Nature Energy. Sep 30;6(11):1011–6.

O'Brien, K. (2012). Global environmental change II: From adaptation to deliberate transformation. Progress in Human Geography, 36(5), 667-676. https://doi.org/10.1177/0309132511425767

O'Neill, D. W., Fanning, A. L., Lamb, W. F., & Steinberger, J. K. (2018). A good life for all within planetary boundaries. Nature sustainability, 1(2), 88-95.

Odijie, M. E. (2022). Unintentional neo-colonialism? Three generations of trade and development relationship between EU and West Africa. Journal of European Integration, 44(3), 347-363.

OECD (2023), Fertility rates (indicator). doi: 10.1787/8272fb01-en (Accessed on 20 September 2023)

Oliveira, L., et al. (2015). Key issues of lithiumion batteries - From resource depletion to environmental performance indicators. Journal of Cleaner Production, 108, 354–362. Retrieved From: https://doi.org/10.1016/j.jclepro.2015.06.021

Ortiz, I., Burke, S., Berrada, M., & Saenz Cortés, H. (2022). World protests: A study of key protest issues in the 21st century (p. 185). Springer Nature.

Otto, I.M.,et al. (2019). Shift the focus from the super-poor to the super-rich. Nature Climate Change. Jan 28;9(2):82–4.

Park, J. T. (2015). Climate Change and Capitalism (Issue 14). Retrieved From: https://www.jstor.org/stable/26188749

Pettinotti, L., et al. (2022). Surfacing perceptions of equity in the finance themes of the Global Stocktake. iGST, Independent Global Stocktake.

Piketty, T. (2014). Capital in the twenty-first century. Harvard University Press.

Rammelt, C. F., & Gupta, J. (2021). Inclusive is not an adjective, it transforms development: A post-growth interpretation of Inclusive Development. Environmental Science & Policy, 124, 144–155. https://doi.org/https://doi.org/10.1016/j.envsci.2021.06.012

Rammelt, C. F., & Gupta, J. (2022) "Inclusive is not an adjective, it transforms development: A post-growth interpretation of Inclusive Development." Environmental Science & Policy: 144–155

Rammelt, C. F., et al (2023). Impacts of meeting minimum access on critical earth systems amidst the Great Inequality. *Nature Sustainability*, *6*(2), 212-221.

Rempel, A., & Gupta, J. (2022). Equitable, effective, and feasible approaches for a prospective fossil fuel transition. Wiley Interdisciplinary Reviews: Climate Change, 13(2), e756.

Ribot, J. (2014). Cause and response: Vulnerability and climate in the anthropocene. The Journal of Peasant Studies, 41(5), 667–705. https://doi.org/10.1080/03066150.2014.894911

Richardson, J., et.al. (2023). Earth beyond six of nine Planetary Boundaries. Science Advances, 9, 37.

Rivera, J. L., & Lallmahomed, A. (2016). Environmental implications of planned obsolescence and product lifetime: a literature review. In International Journal of Sustainable Engineering (Vol. 9, Issue 2, pp. 119–129). Taylor and Francis Ltd. Retrieved From: https://doi.org/10.1080/19397038.2015.1099757

Rockström, J. et al. (2021) Identifying a Safe and Just Corridor for People and the Planet. Earth's Future 9.

Rockström, J., et al (2023). Safe and just Earth system boundaries. Nature, 1-10.

Rockström, J., et.al. (2009). Planetary boundaries: exploring the safe operating space for humanity. Ecology and Society 14(2): 32

Rogelj, J., et al (2016). Paris Agreement climate proposals need a boost to keep warming well below 2 C. Nature, 534(7609), 631-639.

Romanello, M., et al (2021). The 2021 report of The Lancet countdown on health and climate change: Code red for a healthy future. The Lancet, 398(10311), 1619–1662. https://doi.org/10.1016/s0140-6736(21)01787-6

Ross, F. (2020). Kate Raworth - Doughnut Economics: Seven ways to think like a 21st century economist (2017). Regional and Business Studies, 11(2). https://doi.org/10.33568/rbs.2409

Schmelzer, M., Vetter, A., & Vansintjan, A. (2022). The future is degrowth: A guide to a world beyond capitalism. books.google.com.

Scoones, Ian, & Andy Stirling, (2020). "Uncertainty and the politics of transformation." The politics of uncertainty: Challenges of transformation. 1-30.

Sharma, N. K., & Kushwaha, G. S. (2019). Eco-labels: A tool for green marketing or just a blind mirror for consumers. Electronic Green Journal, 1(42).

Stavins, Eg R. (2003). 'Experience with Market-Based Environmental Policy Instruments' in K Maler and J Vincent (eds), Handbook of Environmental Economics, Elsevier, 355, 359.

Steffen, W., Crutzen, P. J., & McNeill, J. R. (2007). The Anthropocene: are humans now overwhelming the great forces of nature. Ambio-Journal of Human Environment Research and Management, 36(8), 614-621.

Steffen, W., Richardson, K., Rockström, J. & Cornell, S.E., et.al. (2015). Planetary boundaries: Guiding human development on a changing planet. Science 347: 736, 1259855

Stuart, D., Gunderson, R., & Petersen, B. (2020). Overconsumption as ideology: Implications for addressing global climate change. Nature and Culture, 15(2), 199-223.

Tàbara, J. D., & Chabay, I. (2013). Coupling human information and knowledge systems with social–ecological systems change: Reframing research, education, and policy for sustainability. Environmental Science & Policy, 28, 71-81.

Tàbara, J.D., Chabay, I. (2013). Coupling Human Information and Knowledge Systems with social–ecological systems change: Reframing research, education, and policy for sustainability. Environ Sci Policy. Apr 1;28:71–81.

The State of Tax Justice. (2021). Global Alliance for Tax Justice, Public Services International, & Tax Justice Network.; 2021. Available from:
https://taxjustice.net/wp-content/uploads/2021/11/State_of_Tax_Justice_Report_2021_ENGLISH.pdf

Trout, K., et al (2022). Existing fossil fuel extraction would warm the world beyond 1.5 C. Environmental Research Letters, 17(6), 064010.

Turnhout, E., Hisschemöller, M., & Eijsackers, H. (2007). Ecological indicators: between the two fires of science and policy. Ecological indicators, 7(2), 215-228.

UN, Water is a common good not a commodity. 22 March 2023. https://www.ohchr.org/en/statements-and-speeches/2023/03/water-common-good-not-commodity-un-experts

UN, Transforming Our World: The 2030 Agenda for Sustainable Development (UN, New York, 2015); http://bit.ly/TransformAgendaSDG-pdf.

UNU-WIDER, (2021). Sustainable Development Goals Report. Available at: https://www.wider.unu.edu/database/world-income-inequality-database-wiid

Van der Ven, H., Rothacker, C., & Cashore, B. (2018). Do eco-labels prevent deforestation? Lessons from non-state market driven governance in the soy, palm oil, and cocoa sectors. Global environmental change, 52, 141-151.

Watt, R. (2021). The fantasy of carbon offsetting. Environmental Politics, 30(7), 1069-1088.

Watts, N., et al. (2018). The Lancet Countdown on health and climate change: from 25 years of inaction to a global transformation for public health. Lancet. Feb 10;391(10120):581–630.

Watts, N., et al. (2021). The 2020 report of The Lancet Countdown on health and climate change: Responding to converging crises. The Lancet, 397(10269), 129–170. https://doi.org/10.1016/S0140-6736(20)32290-X

Whitehorn, P. R., et al (2019). Mainstreaming biodiversity: A review of national strategies. Biological conservation, 235, 157-163.

Willett, W., et al. (2019). Food in the Anthropocene: the EAT–Lancet Commission on healthy diets from sustainable food systems. The lancet, 393(10170), 447-492.

Winter, C. J. (2020). Does time colonise intergenerational environmental justice theory? Environmental Politics, 29(2), 278-296.

World Bank, (2021). http://iresearch.worldbank.org/PovcalNet/povDuplicateWB.aspx

Yu, E., et al. (2020). Greenwashing in environmental, social and governance disclosures. Research in International Business and Finance. Apr 1;52:101192.