Beyond tipping points: risks, equity and the ethics of intervention

Laura M. Pereira 1, 2, , Steven R. Smith 3, 4 , Lauren Gifford 5 , Peter Newell 6 , Ben Smith 7 , Sebastian Villasante 8 , Therezah Achieng 3 , Azucena Castro 2, 9 , Sara M. Constantino 10 , Tom Powell, 3, Ashish Ghadiali 3 , Coleen Vogel 1 , Caroline Zimm 11

1 Global Change Institute, University of the Witwatersrand, Johannesburg, South Africa
2 Stockholm Resilience Centre, Stockholm University, Stockholm, Sweden
3 GSI, University of Exeter, UK
4 CUSP, University of Surrey, UK
5 Department of Ecosystem Science and Sustainability, Colorado State University, USA
6 University of Sussex, UK
7 Department of English, University of Exeter, UK
8 EqualSea Lab-CRETUS, University of Santiago de Compostela, Spain
9 Stanford University, Stanford, USA
10 Northeastern University, USA
11 International Institute of Applied Systems Analysis, Vienna, Austria

Correspondence to: Laura M Pereira (laura.pereira@wits.ac.za)

Abstract

Earth system tipping points pose existential threats to current and future generations, both human and non-human, with those least responsible for causing them facing the greatest risks. ‘Positive’ social tipping points (that we shorten to positive tipping points, or PTPs) are often deliberate interventions into human systems with the aim of rapidly mitigating the risks of Earth system tipping. However, the desire to intervene should neither increase risks nor perpetuate unjust or inequitable outcomes through the creation of sacrifice zones. In this paper, we argue that considerations of what needs to change, who is being asked to change and where and by whom the change or its impacts will be felt are fundamental and normative questions that require reflexivity and systemic understanding of decision-making across scales. All actors have a role to play in ensuring that justice, equity and ethics are carefully considered before any intervention. Enabling positive tipping points for radical transformations would thus benefit from more diverse perspectives, with a particular emphasis on the inclusion of marginalised voices in offering solutions. We conclude that taking a cautious approach to positive tipping interventions, including careful consideration of distributional and unintended consequences, and stepping back to explore all options, not just those appearing to offer a quick fix, could lead to more equitable and sustainable outcomes.

500 character blurb
Earth system tipping points pose existential threats requiring urgent action. However, this imperative should neither increase risks nor perpetuate injustices. We argue that considerations of what needs to change, who is asked to change and where the impacts will be felt and by whom, are fundamental questions that need to be addressed in decision-making. Everyone has

a role to play in ensuring that justice and equity are incorporated into actions towards a more sustainable future.

1. Introduction

The world is facing a series of era-defining, existential threats including climate change, biodiversity loss, increased inequality and poverty. In response to these critical challenges, there have been calls for transformative change (IPBES, 2019). Some of these transformations are proposed as advancing 'positive' social tipping points, which we shorten to positive tipping points (PTPs). PTPs are defined as changes to a system that become self-perpetuating beyond a threshold, and which lead to substantial, often abrupt impacts that are predominantly beneficial to humans and the natural systems we rely on (McKay et al., 2022; Milkoreit et al., 2018). As we argue, 'positive' is a value judgement, and not all the changes associated with PTPs are universally welcome; difficult decisions and trade-offs need to be made as we weigh up the distribution of anticipated harms and benefits. Nevertheless, we argue that there is a collective duty to bring about "intentional transformation towards global sustainability" (Lenton et al., 2022: 2), and this is clearly a normative enterprise. The moral 'force' in our usage of the 'positive' descriptor is based on the science of Earth system boundaries and the ethics of Earth system justice (Gupta et al., 2023a; Rockström et al., 2023).

However, undertaking or operationalizing such transformations that attempt to orient complex systems onto more safe and just trajectories is messy and complicated (Olsson and Moore, 2024). As history shows, there are dark sides of transformations, with unintended consequences, distributional impacts and the potential for vested interests to co-opt or reap the benefits of such processes (Blythe et al., 2018). Caution and care is thus necessary when considering the use of PTPs, including clarity about what transformations are intended, whom they benefit, and whom they may harm (Pereira et al., 2024).

Any moment of societal change will inevitably generate winners and losers (O'Brien and Leichenko, 2003), and this should also be taken into account in the identification and operationalisation of PTPs, where the aim is often to create both rapid and radical change. Indeed, in this context, the language of positive tipping needs to be exercised with caution since the very definition of a PTP is likely to be experienced by many actors as a polarising event and can have differential welfare impacts on different segments of the population (Ehret et al., 2022). For example, while some welcome a tipping point away from a fossil fuel-based economy towards one dominated by renewables, (IEA, 2022b; IRENA, 2022; Systemiq, 2023), others in fossil fuel and related industries may fear the loss of their livelihoods and communities. Pollution, habitat destruction and poor working conditions in the expansion of cobalt and lithium mining for battery production, for example, driven by the rapid increase in the production of electric vehicles, may create problems for some communities and opportunities for others (Hernandez and Newell, 2022).

An approach to tipping point governance that centres principles of equity and justice (Okereke and Dooley, 2010) will recognise that tipping points, whether conceived primarily as positive or negative, will leave segments of the population behind without the engagement of

complementary redistribution mechanisms that can help mitigate against the worst impacts of change (Rammelt et al., 2023). This paper is not proposing how to govern tipping points, but rather focuses on the equity and justice challenges that are often overlooked in discussions of both Earth system and social tipping points. When identifying or triggering a tipping point through an intervention, it is necessary to ask: What kind of trade-offs are necessary and what sacrifice zones are being created? Who ends up occupying these sacrifice zones? Who is left behind? And how can a comprehensive understanding of justice be included in a rigorous way when examining PTPs? An example of sacrifice zones are extractive zones created by the advancement of coordinated forms of capitalism that see those territories and the communities inhabiting them as commodifiable (Gómez-Barris, 2017).

1.1. Climate Justice in light of Tipping Points

Recent UNFCCC climate summits have seen increasing calls from climate justice campaigners and representatives of the Global South, including the small island developing states, for a global recognition of the uneven historical and ongoing responsibility for climate change, articulated in the concept of “common but differentiated responsibilities” and calls for ‘loss and damage’ and elsewhere for reparations (Constantino et al., 2023; Huq et al., 2013). These calls are supported by the work of climate historians, decolonial critics and authors who assert that we cannot hope to advance climate action if we do not address the systems of capitalism and colonialism that have created the current crisis and still shape responses to it (Bhambra and Newell, 2022; Ghosh, 2022; Sultana, 2022; Yusoff, 2018). The future-focus of much scientific, political and popular discourse around climate change can create a disconnect with the past, occluding the fact that climate change and its associated crises ‘are deeply rooted in history’ (Ghosh 2022, 158). In this context, there is a danger that the language of tipping points can be used to reinforce a discourse that abstracts climate change from past inequities and local contexts. The notion of tipping points that are rooted in a biophysical framing, which assumes some ‘threshold’ and ‘set of shocks’ that tips a system over, ignores the grinding every-day realities of life that many of the poor and most vulnerable endure as an interconnected set of social, economic and environmental crises (Nixon, 2013). These vulnerabilities will only be compounded by the increased risks associated with unmitigated climate change, biophysical pressures, and tipping points (O’Brien and Leichenko, 2000).

Moreover, a focus on preventing negative tipping points can distract attention from the deep structural imbalances of capital and the asymmetric power that both drive tipping and the precarity and increased vulnerability to the impacts of tipping events in poorer regions (Roberts and Parks, 2006). The urgency that accompanies the notion of tipping points can overshadow the slow process of rebuilding trust and relationships that have been broken through past harms, referred to by Kyle Whyte as “relational tipping points” (Whyte, 2020). For many Indigenous peoples and local communities who have faced the existential crisis of colonialism and who are now at the forefront of the climate crisis (Gilio-Whitaker, 2019), relational tipping points may have already been breached (Whyte, 2020, 2021). The process of rebuilding consent, trust, accountability, and reciprocity—qualities of relationships necessary to avoid further injustices—require time and commitment (Whyte, 2020). Attempts to avoid tipping points

through geoengineering, for example, could merely pass on costs and irreversible effects onto future generations (Biermann et al., 2022), while contemporary drives to reach technological tipping points, such as the push towards electric vehicles, can produce new vulnerabilities for communities situated in areas that are rich in rare Earth minerals (Calvão et al., 2021). Hence without due care, attempts to address tipping points, while important, can also perpetuate spatial and temporal inequities and injustices (Sovacool et al., 2022).

In this paper, we discuss considerations of ethics, equity and justice in relation to the complex interconnection of biophysical and social, 'positive' and 'negative' tipping points. The destabilising of critical Earth systems is already contributing to adverse effects on human well-being and the global ecosystems on which it depends, and will continue to worsen (Rockström et al., 2023). Crossing biophysical and social tipping points will exacerbate current injustices and inequities (Rammelt et al., 2023), as well as increasing potential harms on future generations and limiting their response capacity by triggering potentially irreversible processes. It is thus necessary to approach PTPs with due precaution and humility in our understanding of how complex social-ecological processes unfold- as such we refer to the need for an ethics of tipping points interventions that centres considerations of equity and justice as central tenets.

1.2. Discourse matters

Within the framework of tipping points, it is crucial to remember that all human and non-human actors (sometimes referred to as more-than-human actors) are, in Donna Haraway's words, 'situated.. in complicated histories' (Haraway, 2016), which inform complex and plural visions for the future. The IPCC AR6 report urges immediate action and deep emissions reductions in this decade whilst also calling for climate resilient development that prioritises risk reduction, equity and justice (IPCC, 2023). In seeking to build a majority of people in favour of stronger, faster action, it is vital that values-inclusive forms of discourse are identified to 'create a sense of collective responsibility and action' (Wiedmann et al., 2020).

The challenges and tradeoffs inherent in achieving a safe and just operating space for life on Earth need to be understood (Gupta et al., 2023a). Dominant discourses that centre efficiency and technocratic solutions must shift towards ones that instead aim to reconcile the need to meet the internationally agreed temperature targets with the need to address over-consumption and inequalities within and between nations (Constantino and Weber, 2021; Hickel and Kallis, 2019; Lamb et al., 2020; Steinberger et al., 2020; Wiedmann et al., 2020). A growing understanding of tipping points in the Anthropocene challenges 'the peaceful and reassuring project of sustainable development' (Bonneuil and Fressoz, 2016: 29). We have entered what Bruno Latour calls 'the new climatic regime' (Latour, 2018) in which the geophysical framework that we have always taken for granted, the ground on which our history, politics and economics have played out, has become destabilised. An ethical community of nations that respects the Earth's biophysical limits and minimum social foundations for human flourishing must recognise that the only viable solutions are ones that prioritise strong sustainability and sufficient access to resources for all (Haberl, 2015; Trebeck and Williams, 2019). For example, Raworth's (2017) 'doughnut economics' has as its goal the establishment of a safe and just operating space for

humanity that includes staying above social 'floors' such that everyone has access to necessary goods and services while also staying below the planetary boundaries, beyond which the economy begins to outstrip the planet's natural resources (Gupta et al., 2023b; Raworth, 2017). This implies differential responsibilities on different groups of people as we seek to navigate towards more just, equitable and sustainable futures.

1.3. What do we mean by equity and justice?

Gupta et al. (2023a,b) propose an integrated "Earth system justice" framework to approach questions of climate justice and understand how to reduce risks associated with crossing tipping points while ensuring well-being for all and an equitable distribution of benefits, risks and related responsibilities. Earth system justice is conceptualised through multiple approaches and understandings of justice including, but not limited to, intragenerational, intergenerational justice and interspecies justice. Intragenerational justice refers to the relationships between humans right now and includes justice between states and social groups. Intergenerational justice examines relationships across generations, such as the legacy of greenhouse gas emissions or ecosystem destruction by current and past generations on youth and future generations, and assumes that natural resources and environmental quality should be shared across generations (Tremmel, 2009). In this context, interspecies justice requires considering the rights of nature and other species. It draws on a rights of nature discourse (Harden-Davies et al., 2020) that also counters the idea of human exceptionalism as a lens for thinking through development impacts (Srinivasan and Kasturirangan, 2016) and potential remedies like ecocide (Setiyono and Natalis, 2021). Drawing on these frameworks can help us to assess the uneven impacts of nearing Earth system tipping points, but also the differential responsibility for efforts to avoid tipping points and the distributional and procedural aspects of positive tipping dynamics.

Within the domains mentioned above, one can discriminate between different dimensions of justice, i.e., distributive (or equity across different populations), procedural (how decision or research processes are designed, who is involved), and reparative (e.g. recognition of wrongs, restoration where possible, and compensation for negative impacts and past injustices) (Byskov and Hyams, 2022). Such justice approaches also include recognition and epistemic justice, which consider the value of multiple knowledge systems, especially local, Indigenous, and unrecognised, misrecognized or marginalised groups (de Sousa Santos, 2008). Finally, 'intersectional' justice that includes multiple and overlapping social identities and categories underpinning inequality, underrepresentation, marginalisation, and the capacity to respond (i.e. gender, race, age, class, health) must be considered in the context of Earth system justice (Gupta et al., 2023c). These different forms of justice are not mutually exclusive: procedural justice may be used to arrive at restoration or compensatory payments, which can be assessed through the lens of distributive justice. Changes related to tipping points can be analysed with reference to these myriad justice considerations to design forward looking actions that avoid negative impacts.

2. Blind Spots of intervention

Policymakers often overlook the normative dimensions of climate policy and the possibility of unintended social consequences (Klinsky et al., 2017; Okereke and Dooley, 2010). However, all actors in the process – from scientists to world leaders – must take efforts to avoid creating a situation in which today's solutions become tomorrow's harms. This is especially true when considering interventions designed to trigger exponential rates of positive social change, or quick 'fixes' such as geo-engineering (Sovacool, 2021), which could have substantial negative impacts that could be difficult to mitigate if they are not considered before a social tipping point is reached. It is thus imperative that all actors take responsibility to acknowledge potential risks and centre questions of justice when considering PTPs as solutions to the ongoing climate and other social-ecological crises.

2.1. Risks and unintended consequences of interventions to mitigate climate change

Interventions aimed at mitigating climate change can have unintended consequences including poorly aligned interventions that can exacerbate existing vulnerabilities and risks. A good example of risks associated with the quest for PTPs is the transformation to a renewable energy economy. The growth in demand for renewable energy worldwide, including for batteries and solar panels, is increasing the demand for lithium, cobalt and other rare earth minerals (Dutta et al., 2016). While this creates economic benefits for mining communities, it can also produce negative ecological, economic and social impacts in the near, medium and long-term (Hernandez and Newell, 2022; Manzetti and Mariasiu, 2015). A recent study finds that if today's demand for electric vehicles is projected to 2050, the lithium requirements for the US market alone would triple the amount of lithium currently produced for the global market (Rionfrancos et al., 2023). However, lithium demand could be reduced by 92% in 2050 relative to the most lithium-intensive scenarios by decreasing car dependency (e.g. through increasing public transit or biking), limiting the size of EV batteries, and creating a robust recycling system (Rionfrancos et al., 2023). Within this context, the industrial mining sector has been accused of supporting state violence and corruption, polluting ecosystems (Banza Lubaba Nkulu et al., 2018), and exacerbating poverty, while the informal mining sector is known for ignoring occupational safety and health standards and human rights concerns (Sovacool, 2019).

Other prominent examples of unintended consequences have been documented for: a) large-scale renewable and bioenergy projects, resulting in significant local opposition (Cavicchi, 2018; (Torres Contreras, 2022); b) the displacement of Indigenous peoples, local communities (Zurba and Bullock, 2020) and coastal fishers (Beckensteiner et al., 2023); c) deforestation (Kraxner et al., 2013); d) biodiversity losses (Pedroli et al., 2013); e) competition for land and water resources (Haberl, 2015; Tarhule, 2017); f) food insecurity (Hasegawa et al., 2018); and g) for decarbonisation of the built environment, particularly the housing stock, resulting in health impacts from poor indoor air quality, and fuel poverty (Davies and Oreszczyn, 2012).

An example of climate policy leading to unintended outcomes with social justice implications is 'carbon leakage' (Carbon leakage, 2023; Grubb et al., 2022). Although often difficult to measure and distinguish from the more general offshoring of emissions due to globalisation of trade and deindustrialisation in richer countries, carbon leakage in response to climate policy measures is

an example of a negative spill-over effect. Unilateral climate policies such as carbon pricing and emissions trading schemes (ETSs), designed to encourage carbon-intensive sectors to invest in carbon-neutral production domestically, may lead firms to relocate to regions with equal access to the same markets, but with fewer or less stringent regulations (Prellezo et al., 2023).

Relatedly, significant policy research has focused on the concept of a 'just transition' (Newell and Mulvaney, 2013; Wang and Lo, 2021), spurred by the negative labour market impacts of decarbonization measures in coal-intensive regions of the Global North (Abraham, 2017). Unless sufficient government investment, regional regeneration, support and skills retraining are provided to those workers and communities facing the greatest risks from a transition away from fossil fuels, severe economic, social and cultural hardships are likely to follow. Furthermore, this could reduce trust in government and strengthen counter-narratives aimed at delaying climate action (Lamb et al., 2020; Patterson et al., 2018). Participatory and deliberative governance approaches that include potential losers and other stakeholder groups in designing and implementing policy for sustainability transitions can help to lower the barriers to a transition by building political will and legitimacy, and negotiating effective compromises for more just outcomes (Fesenfeld et al., 2022). More generally, climate policy needs to be designed to subsidise lower-income households for the higher costs that may accompany measures such as carbon pricing, emissions trading, new standards for energy-efficient buildings, smart energy systems, and the electrification of transport systems. Failure to do so could increase poverty, inequality, hunger and other health impacts, popular protest and political instability (Davies and Oreszczyn, 2012; Newell et al., 2021).

In the Global South, the transition to net-zero carbon emissions must happen alongside reductions in poverty and multidimensional vulnerabilities, and while ensuring decent living standards for all. These countries are confronted with a toxic mix of shrinking carbon budgets, growing inequalities, heightened climate-related risks, and limited capabilities for mitigation and adaptation due, in part, to increasing debt burdens (Steele and Patel, 2020). But the debate on historic responsibilities, development rights, and net-zero efforts is gaining renewed attention (Mishra, 2021). From the perspective of the Global South, achieving just transitions requires addressing the double inequality of the climate crisis where developing countries bear a disproportionate share of the risks, while industrialised nations are primarily responsible for historical emissions (Gardiner, 2004). Therefore, developing countries are demanding fair procedures for distributing the costs and benefits of mitigation and adaptation, such as the Warsaw International Mechanism for Loss and Damage. However, concrete financing commitments from rich countries remained absent at COP28 in Dubai in 2023 (Jessop et al., 2023).

Unpopular climate policies can sometimes trigger a widespread 'backlash' (Patterson, 2023). Examples of climate policy backlash include the response to the Australian carbon pricing scheme (Crowley, 2017) and the French fuel tax increase that gave rise to the Gilets Jaunes or Yellow Vests protest movement in 2018-2019 (Kinniburgh, 2019). Other well-researched forms of unintended impacts of policy measures include rebound effects (Chakravarty et al., 2013).

Unintended consequences can also emerge from a failure to build broad coalitions based on value-inclusive narratives and norms (Constantino and Weber, 2021; Evans, 2017; Klein, 2015; Meadowcroft, 2011; Rowson and Corner, 2014; Sloterdijk, 2012). Procedural justice is also key as small producers and/or vulnerable actors are often excluded from the political processes and negotiations that determine climate policy (Villasante et al., 2022). In centering justice and combining multiple, intersecting social movements under the climate justice umbrella, many campaigners and scholars believe that the strength of their combined movements can be amplified (Mikulewicz et al., 2023). However, there are also concerns that strong social justice framings can increase political polarisation rather than build broader coalitions (Patterson et al., 2018; Smith, 2022). Research has also shown that some actors recognise the need for greater urgency in climate policy, but are reluctant to champion it to avoid being labelled as 'extremists' (Willis, 2020). As a result, climate policymakers and other actors may prefer to focus on the more technocratic, less politically risky aspects of transition governance (Patterson et al., 2018).

If decarbonisation is left mainly to market-based mechanisms that prioritise only profitability, the speed and up-scaling of technological change may threaten the human rights and well-being of some people while allowing other, more powerful, incumbent actors and structures to prevail (Newell et al., 2022). Unique opportunities to redesign entire systems and sectors along more efficient, ethical, sustainable, and equitable lines may be lost where speed and capital accumulation is allowed to trump inclusivity and depth of process (Leach and Scoones, 2006). For example, U.S. solar photovoltaic deployment is forecast to grow non-linearly in the near-term, generating around 12% of all US power by 2027 (SEIA/Wood MacKenzie, 2023). While this is a positive development in terms of the speed of overall decarbonisation, the perpetuation of an energy system dominated by profit-maximising utility companies would be viewed as a missed opportunity for advocates of energy democracy and place-based, cooperative and community-owned energy (Hoffman and High-Pippert, 2005; Stone et al., 2022). Likewise, 'plug and play' approaches that seek to electrify cars, but not boost the accessibility of public transport can serve to reinforce private automobility (Rionfrancos et al., 2023).

Additionally, there is a risk that a growing concern regarding Earth system tipping dynamics could propel research into speculative interventions such as widespread carbon dioxide removal,geoengineering or solar radiation modification—a set of hypothetical solutions aimed at reducing incoming sunlight and thus lowering global mean temperatures (National Academies of Sciences, Engineering, and Medicine, 2021). The most common solar geoengineering proposal involves injecting aerosols into the stratosphere to limit the influx of solar energy, but there are also more regional or local proposals involving different technologies. Proponents often argue for these hypothetical solutions on the grounds that we have made little progress in reducing carbon emissions and that solar geoengineering could be used to buy time or as a failsafe (Keith, 2013; Keith et al., 2017). However, solar geoengineering and other more speculative solutions often come with substantial uncertainty and risks, which are likely to vary across regions, and insufficient governance mechanisms to equitably and effectively manage such risks (Kravitz and MacMartin, 2020; McLaren, 2018; Schneider et al., 2020; Stephens et al., 2021). This has led groups of scholars to call for an "international non-use agreement" and for limits on related research as well (Biermann et al., 2022).

2.2. Winners and Losers: Sacrifice Zones

To include equity and justice in the discourse of tipping points, it is necessary to consider how resource extraction can drive tipping points through resource dispossession whilst also exacerbating the drivers leading to a transgression of planetary boundaries (Pereira et al., 2024). Resource extraction, be it for fossil fuels or green energy sources, creates sacrifice zones– places permanently impaired by environmental degradation and divestment- mainly in the Global South, but also in marginalised areas of the Global North, for example, the green energy developments in Sapmi territories in Scandinavia (Kårtveit, 2021), or lithium mining in Portugal (Canelas and Carvalho, 2023). These actions exacerbate the transgression of planetary boundaries (Sultana, 2023b), cutting across North and South, and are reflective of the uneven control of production, technology and the finance which drives extractivism between global ('polluter') elites and more marginalised social groups (Kenner, 2019).

Even well-intentioned interventions have the potential to put pressure on lands held by Indigenous and marginalised communities and reshape their ecologies into "green sacrifice zones" by reproducing a form of climate colonialism in the name of the energy transition (Lang, 2024; Zografos and Robbins, 2020). Climate colonialism involves ''the deepening or expanding of domination of less powerful countries and peoples through initiatives that intensify foreign exploitation of poorer nations' resources or undermine the sovereignty of native and Indigenous communities in the course of responding to the climate crisis'' (Zografos & Robbins, 2020: 543). Green sacrifice zones then are "spaces or ecologies, places and populations that will be severely affected by the sourcing, transportation, installation, and operation of solutions for powering low-carbon transitions, as well as end-of-life treatment of related material waste" (Zografos & Robbins, 2020: 543). Current examples include 'green grabs' for critical minerals, biofuels and water or the acquisition of land for forestry carbon offset projects (Fairhead et al., 2012; Scoones et al., 2015).

The violence that capitalism inflicts on places designated as sacrifice zones can be immediate, but it can also be slow and imperceptible. Rob Nixon describes the "slow violence" that befalls marginalised communities over a long period of time and which is almost imperceptible in the marking out of zones for development (Nixon, 2013). This extractive view from corporations and governments meets the resistance of "submerged perspectives", that is, the ways in which the local humans and nonhumans that inhabit those territories perceive life as entangled, where the destruction of one part affects the rest of the entities and breaks the spiritual heritage in a region (Gómez-Barris, 2017). Slow violence has delayed effects and requires justice to take new forms to secure effective legal measures for prevention, restitution, and redress (Nixon, 2013). To include justice and equity in climate mitigation actions, Latin American countries, for example, have developed the first regional agreement *Acuerdo de Escazú* in 2018 (CEPAL, 2018). This agreement proposes three concrete objectives to include climate justice in environmental policies and transition actions: (1) access to environmental information, (ii) public participation in environmental decision-making processes, and (iii) access to justice in environmental matters. Such attempts to involve communities in discussions of climate justice are crucial for an approach to PTPs that aims to centre equity and justice frameworks. For the concept of

sustainability and just sustainable futures to address local realities, environmental justice scholar Julie Sze argues that a “situated sustainability” is necessary (Sze, 2018). Situated sustainability should “set the parameters for why and how vulnerability (environmental or other) is disproportionately distributed, one of the key questions in environmental justice research” (Sze, 2018: 13). In other words, if the questions we ask aim at transformative change or positive tipping points, they cannot neglect how racial capitalism contributes to inequalities and environmental degradation (Newell, 2005; Sze, 2018).

2.3. Reinforcing current power dynamics and structures

While averting negative biophysical tipping points in the Earth system is a global challenge that will require a coordinated global effort, the research and policymaking surrounding positive tipping must also grapple with historical and contemporary inequalities in the production of environmental harms, and the differentiated and uneven capacity and responsibility to respond or to withstand such impacts. These concerns are echoed in the principle enshrined in the UNFCCC of ‘common but differentiated responsibilities and respective capabilities’ and highlights the greater responsibility to act to reduce emissions and the likelihood of crossing critical thresholds by richer countries and polluter elites, whether through their own direct efforts or through the support of efforts in countries with fewer economic resources (O’Brien and Leichenko, 2000). Refocusing mitigation attention on high-emitting groups, countries and sectors highlights the need for interventions and policy measures that attempt to shift the current consumption patterns of the wealthy and the actions of large private corporations (Kenner, 2019; Newell, 2021; Rammelt et al., 2023; Wiedmann et al., 2020) and the infrastructures of high-impact sectors such as food (reducing industrialised meat and dairy consumption) and energy production (switching to non-fossil fuel based energy), transport (reducing car use and air travel) and housing that, combined, comprise about 75% of total carbon footprints (Newell et al., 2021). Furthermore, this view also highlights the need for substantial financial transfers from the Global North to the Global South to help build climate resilience, to compensate for irreparable losses due to climate change, and to offset the costs of mitigation efforts (Jackson et al., 2023). Without such measures, efforts to address Earth System tipping points risk reinforcing unequal power dynamics and current inequities.

3. Illustrative case studies

3.1 Risks and justice implications in Marine Protected Areas

The ocean economy is expected to grow faster than the global economy in the coming decades, reaching $3 trillion by 2030 (OECD, 2016), with well-established (e.g. fisheries, aquaculture) and novel ocean sectors (e.g. seabed mining, ocean wave energy) multiplying their activity and footprint in recent years (Jouffray et al., 2020). Yet, opportunities, access and benefits from ocean interventions remain highly unequal. For instance, seafood production is highly concentrated in a few Global North large corporations (Österblom et al., 2015), while in most places of the Global South, the local nutritional needs are jeopardised by the activity of distant fishing fleets, seafood trade, and the use of catches for fish oil/fish meal for animal feed (Hicks

et al., 2019). The unprecedented race for food, spaces and materials, but also the effects of other drivers such as climate change and pollution, are exacerbating social inequities and threatening marine ecosystems functioning and productivity. The race to occupy the oceans and exploit more resources and at greater depths, combined with the impacts of climate change, are leading to an increasing risk of reaching dangerous ocean tipping points (Jouffray et al., 2020; McKay et al., 2022). Thus, there is a pressing call for transformative actions that halt and reverse marine biodiversity loss rates (IPBES, 2019), particularly in some Global South biodiversity hotspots.

The recent Kunming-Montreal Global Biodiversity Framework target 3 seeks to protect 30% of the ocean by 2030 to halt biodiversity loss (30x30 target) (CBD, 2022). Through the global Convention on Biological Diversity negotiations, conserving 30% of the ocean (and land) is seen as an important threshold for addressing biodiversity loss and maintaining ecosystem function, as previous levels of protection were insufficient (Baillie and Zhang, 2018; Dinerstein et al., 2019). With Target 3 set 'to ensure and enable that by 2030 at least 30% of terrestrial and inland water areas, and of marine and coastal areas, are effectively conserved and managed (CBD, 2022),' it could function as a potential driver of a PTP if appropriately implemented. However, the 30x30 target risks perpetuating historical injustices, colonial legacies and power imbalances by imposing Western conservation models on communities in the Global South (Obura et al., 2023). In effect, it is essential to explore the intricate social aspects of the initiative (Sandbrook et al., 2023), offering a more nuanced and equitable discourse on PTPs in ocean governance and conservation and the role of Marine Protected Areas (MPAs) in achieving them.

Although the positive ecological impacts of MPAs are relatively well understood (i.e. large, old, well-enforced and 'no-take' MPAs would provide greater ecological benefits within the area effectively protected (Sala and Giakoumi, 2018), less attention is paid to the negative socio-economic impacts that MPA establishment can have on dependent and marginalised communities (Bennett and Dearden, 2014; Rasheed, 2020). Past research has shown that the MPAs can exacerbate equity issues currently present in the Global South, by further marginalising already vulnerable coastal communities (Hill et al., 2016; Sowman and Sunde, 2018). MPAs establishment and management may exclude local and Indigenous participation, which in turn can also lead to reduced conservation and management gains (Hill et al., 2016). A heightened focus on increasing MPAs may entail undesirable consequences for social well-being of vulnerable communities in a variety of ways, including forced removals and displacement of Indigenous peoples from traditional lands and waters, loss or restricted access rights, as well as negative impacts on food security, health, livelihoods, identity and culture (Bennett and Dearden, 2014; Hill et al., 2016; Oracion et al., 2005; Sowman and Sunde, 2018). Additionally, current extent and distribution of MPAs, for example in the Philippines, do not adequately represent biodiversity, with only 2.8% of coral reef protected within no-take MPAs (Weeks et al., 2010) or, in the context of the 11.4% of EU waters that are covered by MPAs where 86% showed light, minimal, or no protection from the most harmful human activities, such as dredging, mining, or the most damaging fishing gears (Aminian-Biquet et al., 2024).

A strong global focus on increasing MPAs as a 'tipping point' towards conserving marine biodiversity, may fail to carefully and comprehensively address historical impacts and ongoing equity issues experienced by coastal communities. In addition, measuring conservation success based solely on a coverage metric can incentivize the establishment of large centrally-governed MPAs (often situated in former colonies) (O'Leary et al., 2018), at the expense of relatively small, but locally managed MPAs (Smallhorn-West et al., 2020). A looming time horizon for 30x30 may also discourage participatory and collaborative processes that may take longer to achieve, but are more efficient in the long term (O'Leary et al., 2018). Concerning global planning of MPAs expansion, maps are not apolitical. Global conservation planning exercises informed by biophysical variables and cumulative human impacts placed a significant fraction of priority areas within the Global South (e.g. Coral Triangle, Southwest Indian Ocean, Caribbean Sea) (Jenkins and Van Houtan, 2016; Selig et al., 2014; Zhao et al., 2020), occupying the entire Exclusive Economic Zones (EEZs) of some Global South countries (e.g. Indonesia) and thereby perpetuating a form of green sacrifice zone. While providing important foundations, this literature hardly discusses the ethical and governance considerations of such "conservation planning exercises" and local socio-economics needs are either conceptualised as an extra map layer that competes with wildlife or something to consider in future analyses.

The 30x30 initiative and the revitalization and empowerment of local communities toward PTPs may be reconciled by balancing both biodiversity and well-being outcomes of local communities when enhancing existing MPAs and designing new ones and seriously considering the wide range of "other effective area-based conservation measures", including those where small-scale actors, especially IPLCs, are empowered and included from the very beginning of decision-making processes to enhance procedural justice (Atlas et al., 2021). Importantly, the expansion of MPAs, across both large and small areas, should not be seen as a single strategy to balance marine biodiversity and socio-economic needs; it must be part of a broader and more diverse management and governance portfolio to govern our oceans in a sustainable and equitable manner (O'Leary et al., 2018).

3.2 Positive financial tipping points: actors and mechanisms

In today's world, the prevailing financial ideology wields an overwhelming influence on the course of human lives and the health of the Earth system, posing a significant threat to the fabric of society and the environment. At the core of this paradigm lies a series of unchallenged "absolute truths" that prioritise wealth accumulation, power, and unchecked economic growth, at the expense of communal well-being and ecological sustainability (Fullerton, 2018). Achieving a sustainable future leaves no choice but to avoid a transgression of planetary boundaries and tipping points in key Earth system processes (Lenton et al., 2019; Richardson et al., 2023). Financial actors are key players in the global economy and affect sustainability biodiversity around the world. Several recent policy and private initiatives have been launched with the ambition to redirect financial flows towards activities that protect natural capital, influence ecosystems and generate equitable outcomes to people in a positive way (Galaz et al., 2015).

Large financial actors have been shown to possess significant corporate control globally (Fichtner et al., 2017). Through their influence over economic activities that modify ecosystems associated with tipping elements, financial actors can also affect climate stability and biodiversity. A financial sector tipping point that reconfigures flows of finance towards climate mitigation, adaptation, loss and damage compensation, biodiversity conservation, addressing vulnerability etc. requires reimagining and reconfiguring governance of public and private finance (Rammelt et al., 2023). This includes changing the mandates of multilateral development banks, reforming central banks and regulating private company law and disclosure policies while also addressing issues such as debt and taxation as part of a more transformative approach to climate finance (Newell, 2024).

Higher costs of accessing finance in the Global South, for example, may mean that many countries are unable to invest sufficiently in providing access to basic services like electricity (Ameli et al., 2021), which underpin provision of healthcare and clean water, food security, and access to information and economic opportunity. The most vulnerable in these countries stand to gain significantly from the low-carbon transition, with cost reductions in renewable energy generation making solar PV the most viable way to provide electricity to the majority of those currently without access (nearly 600 million people in Sub-Saharan Africa alone) (IEA, 2022a). Low investment due to the difficulty of accessing finance creates a higher risk-perception of investment in these countries further increasing the cost of capital and leading to an 'investment trap' that can be further exacerbated by climate impacts (Ameli et al., 2021). Interventions that lower the cost of accessing capital, like credit guarantees and supporting growth of domestic capital markets, can help to break out of this cycle and open up flows of finance to address critical vulnerabilities and support adaptation.

There is an increasing call to change the core cause of failure of the financial system (Deutz et al., 2020; Pinney et al., 2019; UNEP, 2023). At its core, the flawed design of finance rests on the assumption that we can separate finance from the Earth system, and reduce the complexity of our interconnected global economy into simplistic financial optimization calculations without any consideration of equity and justice. Finance cannot be understood in a vacuum. Holistically understood, finance is embedded in the real economy, which in turn must be understood as embedded in and inseparable from the Earth system. Recently, there have been proposals to envision a more sustainable and just financial system (Deutz et al. 2020; UNEP, 2022). For example, regenerative 'capitalism' provides a new paradigm for finance in which true wealth is not merely money in the bank. Rather, it must be defined and managed in terms of the well-being of the whole, achieved through the inclusion of multiple types of wealth or capital, including social, cultural, living, and experiential (Fullerton, 2018). To operationalize some of these changes, a framework for guiding sustainable and equitable investments, and a taxonomy of these investments is currently not universally defined. It is necessary to provide a classification system of activities that comply with the principles of such investments, thereby guiding capital investment decisions and development policy towards an improved sustainability (Sumaila et al., 2021). One example is the United Nations Principles for Responsible

Investment[1] committing to responsible investment, which has been signed by 1400 signatories from all over the world since 2015, and with 59 trillion USD of assets under their management. In practice, this means that publicly listed companies globally need to abide by international principles, even if the countries they operate in might be insensitive to such standards (Galaz et al., 2015). Another example is the United Nations Environmental Programme (UNEP) Sustainable Blue Economy Finance Principles where UNEP works with financial institutions to incorporate environmental, social, and governance issues into business principles and financial market practices (UNEP, 2020) and the Principles for Responsible Banking developed with the United Nations Environment Programme Finance Initiative (UNEP FI) – a UN-private sector collaboration that includes membership of more than 240 finance institutions, aimed to guide banks to integrate sustainability across all its business areas and to align bank actions with sustainability needs (UNEP, 2019).

The recent vision for a global, multi-directional and interconnected public investment to design a new architecture of the finance system based on the application of a global and progressive tax system on wealth and on more democratic ways of deciding how best to spend public investments is one proposal for reform of the global financial structure (Global Public Investment Network, 2023). In addition, Zucman (2016) suggests that there are several ways that would help limit tax evasion and avoidance in the global economy. For example, the creation of a global financial registry that tracks wealth regardless of where it is located, reforming the corporate tax system so that the global profits of multinational companies are distributed where the resources are extracted, and more strictly regulating banks that help evade taxes with lax regulations. Although the secrecy practices afforded by tax havens hinder a precise quantification, Fortune 500 companies are estimated to have US$2.3 trillion in offshore accounts and capital positions. Tax havens cost governments between US$ 500-600 billion/year in lost taxation, including an estimated loss to non-OECD economies of US$200 billion. Individual wealth sheltered in tax havens is an estimated US$ 8-36 trillion, costing public accounts further (Shaxson, 2019).

For comparison, financing needed to preserve global biodiversity is estimated at US$ 722-967 billion per year until 2030 (Deutz et al., 2020). In addition, the average global statutory corporate tax rate has gone from 40% in 1980 to 24% in 2020, with an actual tax rate much lower in many jurisdictions (Dempsey et al., 2022). This reduction in the tax rate for large companies has already been shown to lead to increased inequality in different countries around the world, with a higher risk in developing countries that are highly dependent on natural resource-based exports (Banerjee and Duflo, 2020). At the national level, positioning sustainability as a tax principle, integrating this dimension into corporate social responsibility on financial markets and reducing the acceptability of tax avoidance can be powerful levers for generating the funds needed for sustainability agendas (Bird and Davis-Nozemack, 2018). Moreover, reducing tax avoidance, tackling illicit financial transfers, and reducing the debts of developing countries can produce in many cases more governmental income than what has been identified in the biodiversity finance gap (Dempsey et al., 2022).

[1] www.unpri.org/about-pri/the-six-principles

The above distortions are not simply a market failure, they signal a broader institutional failure. Governments almost everywhere exacerbate the problem by paying people more to exploit nature than to protect it, and to prioritise unsustainable economic activities (Dasgupta, 2021). Therefore, another way to unlock the funding needed to reverse nature loss by 2030 as well as the cost of reaching net zero carbon emissions by 2050 is to remove harmful subsidies that harm biodiversity, such as in agriculture, fisheries and fossil fuel production (Dasgupta, 2021; Sumaila et al., 2021). According to Koplow and Steenblik (2022), the world is spending at least $1.8 trillion a year, equivalent to 2% of global GDP on subsidies that are driving ecosystem destruction and species extinction. In other words, public money is funding our own extinction (Dasgupta, 2021). To address this problem, Costello et al (2016) recently showed that global governments could repurpose some or all of the roughly US$22 billion they annually allocate as harmful fisheries subsidies to directly support fishers' incomes without incentivizing overfishing. This funding could support business development capacities for fishers, be given to fishers as lump sum cash transfers, or be used to develop and institute management reforms all of which would support low-income fishers, particularly in the countries of the Global South. Likewise, there have been proposals to redirect a significant percentage of the USD $11 million a minute governments currently spend on fossil fuel subsidies to a Global Transition Fund to support low carbon energy pathways in poorer regions of the world (Newell and Simms, 2020).

4. Implications for practice

Above we have laid out a series of risks and potential injustices associated with the need to act quickly to address the existential threat of climate change and related sustainability concerns, like biodiversity loss. We argue that interventions, especially concerning narratives of positive tipping points, cannot be divorced from current injustices and inequities in the global Earth system and should be approached ethically. Below, we set out some specific key messages for different actors to internalise as we all seek to shift the planet onto a more sustainable and equitable trajectory.

4.1. Researchers

4.1.1. Employ inclusive and plural approaches.

Biophysical and social system tipping points are interconnected, and do not exist in isolation (Sultana, 2023a). Avoiding an increase of harms requires a broad set of expertise, approaches and acknowledgment that we need multiple and plural approaches not only within academic disciplines, but also of diverse knowledge systems beyond academia and that these need to be taken seriously (Tàbara et al., 2022). Interactions with other knowledge systems are only slowly developing, and participatory approaches that involve stakeholders in science can still be very superficial and not go beyond consultation into more embedded modes of knowledge co-production (Chambers et al., 2021; Osinski, 2021). By being more mindful about inclusiveness, we can increase justice in research through participatory co-design, action research and humility on the part of researchers (Huybrechts et al., 2017).

4.1.2. Diversify expertise across multiple places.

Science has an agenda-setting function that could benefit from accounting for the heterogeneity of the expertise that is needed to solve complex problems like tipping points. Diversity is a key principle of resilience and should also be a core framing when thinking through justice, so that diverse groups, perspectives, knowledge systems and research methods are not side-lined in the quest for addressing global tipping points. Place- and context-specific information and experience is often lacking as traditional research is concentrated in high-income countries. A more inclusive global research programme to reflect on the justice and risk aspects of the Earth system and understanding the full breadth of impacts of positive and negative tipping points needs to be undertaken. Greater diversity in research is therefore needed - in terms of cultural, religious, ethnic, gender or background of the researcher, but also in the disciplines that are engaged. For example, considering social sciences in the intention, design, implementation and evaluation of interventions are also more likely to avoid harms and associated costs, with potential to achieve both positive social and ecological impacts on people (Latulippe and Klenk, 2020). Including diverse groups, perspectives, and knowledge systems in the quest for addressing global tipping points will enhance resilience and success for social tipping and will broaden the type and scope of research undertaken (Stirling, 2010). To harness relevant social tipping opportunities we need to learn about diverse living realities and interact with actors outside science (Bentley et al., 2014). Diversity and inclusivity of research teams–within and beyond academia– are needed to help find solutions to tipping points that do not exacerbate existing injustices and inequalities (Latulippe and Klenk, 2020; de Souza, 2021).

4.2. Business and finance

4.2.1. Transform financial systems

Finance and business are a part of social and ecological systems and not apart from them. Active steering and regulation are therefore required to divest, de-finance and divert financial resources away from the drivers of unsustainability towards sectors and regions where they are most required and where positive tipping points can be found (Newell, 2024). Transformation of financial systems must extend to providing mechanisms to transform sufficient financial assets back into biodiversity and climate assets held in secure commons instruments that can ensure equitable access to all, in particular in developing countries (IPBES, 2022). This requires a greatly strengthened architecture of global financial governance that prioritises sustainability and social justice (UNEP, 2015). Reaching a financial sector tipping point implies changing the mandates of multilateral development banks, reforming central banks and regulating the need to change company law and disclosure policies. But as part of a global just transition and social compact, issues of debt relief and reform of taxation have to be on the table to ensure positive tipping points in the financial system that reduces rather than entrenches poverty.

4.2.2. Introduce investment restrictions for non-compliant companies

Financial actors, such as international development banks, institutional and private investors, venture capital, credit rating agencies and international commercial banks, are increasingly interested in the financial risks of climate change and associated changes in ecosystems (Galaz et al., 2018). It is crucial that capital investments steer the sector toward improved sustainability and PTPs, as opposed to overexploitation of labour and resources (Hickel et al., 2021) by

integrating sustainability and equity into traditional finance mechanisms (Jouffray et al., 2019), through ESG approaches or measures like the social cost of carbon (Prellezo et al., 2023). Cutting off investment for companies that are seen to be complicit in transgressing planetary boundaries, such as some oil majors and powerful cattle lobby groups in the Brazilian Amazon (Piotrowski, 2019), has the potential to reshape the business environment towards more ethical practices. Another area where investments could leverage positive tipping points, for instance, would be to finance a structural shift from car dependency as this could potentially ease pressure in the mining sector, reinforcing reduced social and environmental harms and a densification of metropolitan areas, which would experience myriad benefits from improved air quality to pedestrian safety (Rionfrancos et al., 2023).

4.2.3. Develop more supportive and inclusive investments

Redirecting public and private money to innovative tools and instruments can enable new entrants while reducing the degradation of biodiversity. With this improved and new direction of finance mechanisms, businesses should then be able to both meet standards and operate in vulnerable areas that need finance to become more resilient. This includes moving money to key areas where it is needed (adaptation, biodiversity, social common goods) rather than just for profit (Crona et al., 2021). For example, the IIX Sustainability Bonds are debt securities that can be listed on a social stock exchange, and they explicitly address the inclusion of women in economic activities. There are also initiatives to supplement gaps in the national currency systems such as Community Inclusion Currencies[2] that empower communities to create their own financial systems based on local goods and services (Ruddick, 2023). The Netherlands, for example, provides special green investment funds that are exempt from income taxation, thus allowing investors in green projects (e.g. green shipping, renewable energy development), to contract loans at reduced interest rates (usually ~2% below commercial rates). Another example is the Raven Indigenous Impact Fund[3], a new innovative financial product committed to Indigenous-led equity investments in mission-driven and innovative indigenous enterprises to help build a renewed and sustainable Indigenous economy in Canada and the US. The Climate Bonds Initiative[4] has also a number of sector criteria (e.g. for marine energy and water utilities); while other relevant initiatives include the Blue Natural Capital Positive Impacts Framework[5] and the technical guideline for blue bonds. Mainstreaming these examples as best practice is critical for leveraging the financial system to enable PTPs.

4.3. Decision and Policy-makers

4.3.1. Design fiscal policies that are cognizant of extant configurations

Fiscal policy needs to be designed to subsidise lower-income households for the higher costs that may accompany climate policies such as carbon pricing, emissions trading, new standards for energy-efficient buildings, smart energy systems, and the electrification of transport. Failure to do so could set off a cascade of unintended consequences and increase poverty, inequality,

[2] https://grassrootseconomics.org/
[3] https://ravencapitalpartners.ca/investments/impact-funds
[4] www.climatebonds.net
[5] https://bluenaturalcapital.org

hunger and other health impacts, popular protest and political instability. Hypothecation, for example redirecting funds from fossil fuel subsidies to affordable public transport or from windfall taxes on oil companies for home insulation schemes, can build support among poorer groups for measures that might otherwise be opposed. Policy and governance actors attracted to tipping interventions need not only to design targeted, sector- and actor-specific approaches, but also to combine disciplines and sectors for a coordinated, complex systems thinking approach and capabilities. Including potential losers in the design process can also reduce opposition and ensure more equitable outcomes.

4.3.2. Foster anticipatory governance to account for unanticipated consequences

While “positive” tipping interventions are appealing for policymakers by promising to initiate rapid, significant and potentially irreversible change towards a desired state, careful deliberation and participatory processes should be used to reach an agreement on what the desired change is, what the associated trade-offs are, and which populations it is likely to benefit or harm. Given the high levels of uncertainty associated with tipping point dynamics in complex systems, and the multiplicity of possible post-tipping states, careful consideration must be given before initiating a deliberate “positive” tipping intervention, with a focus on anticipatory governance that seeks to imagine the potential futures that could arise and act accordingly (Olsson and Moore, 2024; Vervoort and Gupta, 2018). Interventions for transformation should be carefully monitored to avoid unintended negative consequences and to address distributional harms that might ensue (Olsson and Moore, 2024; Tàbara, 2024). The risk of unintended consequences that might ensue after a tipping process has been initiated may require new governance mechanisms or a stronger commitment to adaptive management practices anc capacities, including a specific focus on monitoring the change process so that corrective measures can be introduced. Accountability structures for ‘tipping gone wrong’ should be included in legal frameworks in order to hold actors accountable for the impacts of their actions.

4.3.3. Build appropriate institutions to govern non-linear dynamics

Existing governance institutions may be poorly fit to the challenges associated with the governance Earth system tipping points, which are non-linear, can have cascading or systemic effects, and span long time horizons (Milkoreit et al., 2024; Pereira and Viola, 2018). Additional research is needed to identify adequate governance principles and institutional structures to manage Earth System tipping points, including ensuring equity and justice are centred in efforts to prevent tipping points and efforts to respond to their impacts (Milkoreit et al., 2024). Tipping-point governance should include lessons learnt from multi-scale, anticipatory governance (Boyd et al., 2015), grounded in systemic risk approaches (Centeno et al., 2015).

4.4. Media and communications

4.4.1. Be aware of the politics of language and power dynamics in science

Communicators are a key actor who interpret the world and they are capable of constructing new social realities and inspire action (Kegan and Lahey, 2001). They must be alert to the ideologies, values and systems of power that affect which messages are communicated and how they are encoded. For example, how a tipping point is identified (Juhola et al., 2022), what

specific language is used to define and communicate it (Milkoreit et al., 2018), and when it may be used inappropriately in discussing solutions (Milkoreit, 2023). This is particularly relevant in relation to the language of 'positive' and 'negative' tipping points, which can imply a universality of effect that is insensitive to the diverse experiences (and responsibilities) of different communities illustrated above.

4.4.2. Recognize contested framings of key messages in the scientific landscape.

In an equity and justice context, media and communicators must be alert to the competing ideologies and value systems that affect how a message is 'decoded' or interpreted by different communities (Holmes, 2020). The meaning of a message is not necessarily determined by the messenger or the message, but 'a complex interplay of how this meaning is framed though ideological values and beliefs' (Hall, 1980). Thus, it is important to view communication not as a neutral process of information transmission, but as a complex, non-linear system that is entangled with competing knowledge and powers. Studies have shown that increased knowledge does not automatically lead to enlightened action (Norgaard, 2011) and, indeed, that more factual information may serve to further entrench dismissive perceptions of climate change (Bain et al., 2012). There is, therefore, a need to go beyond the linear 'information deficit' models of communication, moving instead towards 'non-linear' models of communication that prioritise open, reflective dialogue between different stakeholders. For example, case studies of communication strategies involving Indigenous people and local communities on the frontline of climate change have found that messages rooted in empirical research and using simple language are insufficient and that researchers should investigate different stakeholders' understandings of what good climate change communication is and through this determine the needs of different audiences from their unique cultural standpoints (Barau and Tanko, 2018; Gotangco and Leon, 2017). With this in mind, it is important that communication strategies are co-produced with the communities they are seeking to engage (Moser, 2016).

4.4.3. Embrace creative co-production practices.

Different initiatives have been arising from the Arizona State University Imagination and Climate Futures Initiative, the University of Exeter-led 'Climate Stories' and 'We Still Have a Chance' projects, the Rapid Transition Alliance's curation of 'evidence-based hope' and the Seeds of Good Anthropocenes project. These have shown that the arts and humanities offer models for empowering communities to create their own narratives and contextualise climate change in relation to their own systems of value, which is an important step towards the design and implementation of just and equitable transitions (Milkoreit et al., 2016; Roberts et al., 2023; Woodley et al., 2022). The effectiveness of literature, film, theatre and art in promoting ethical responses to climate change is increasingly being recognised in empirical studies (Houser, 2014; James, 2015; von Mossner, 2017). As David Holmes states, 'the arts have an ability to communicate the vulnerability and sensitivity of climate issues that other channels may lack' (Holmes, 2020). Therefore, in the context of tipping points, engaging a wide range of stakeholders in creative co-production would offer an open-ended, non-instrumental approach to communication that could be key to achieving ethical solutions in this complex field.

5. Conclusion

Biophysical tipping points pose existential threats to current and future generations, both human and non-human, with those currently underserved being the most vulnerable. It is therefore imperative to act. We also know positive tipping points are possible, but that any intervention must take care not to perpetuate past and current injustices and inequities. Considerations of what needs to transform, who is being asked to change and where the change or its impacts will be felt and by whom, require a level of reflexivity and systemic understanding. There are multiple potential points of intervention and strategies that can be adopted within a complex ecosystem of transformation to help address the power inequalities, social exclusions and governance gaps that are currently driving us towards Earth system tipping points. All actors have a role to play in ensuring that justice, equity and ethics are centred in these interventions, with a particular emphasis on the inclusion of those most affected by disruptive environmental change and the least responsible for causing it. Finally, enabling PTPs towards radical transformations will benefit from more diverse perspectives to open up the solution space, leveraging a shift in worldviews and paradigms rather than just reconfiguring materials and feedback (sensu Meadows 1999). Trying to fix a system using the same tools that created it is not the way to address our planetary crises. Taking a cautious step back to explore all options, not just those that seem to offer a quick fix or 'low-hanging' fruit, could offer a more substantial route into thinking through what positive tipping points could create a more equitable as well as sustainable future.

Author contribution

LP conceptualised the paper and prepared the initial draft together with SRS, LG, PN, BS and SV. TA, AC, SC, AG, CV, TP and CZ edited and reviewed the draft.

Competing interests

The authors declare that they have no conflict of interest.

Acknowledgements

LP is funded by the Future Ecosystems for Africa Programme in partnership with Oppenheimer Generations Research and Conservation and by the Swedish Research Council FORMAS Project No 2020-00670. SV gratefully acknowledges the financial support from EQUALSEA (Transformative adaptation towards ocean equity) project, under the European Horizon 2020 Program, ERC Consolidator (Grant Agreement # 101002784) funded by the European Research Council. TP is funded by the Bezos Earth Fund and the Oppenheimer Programme in African Landscape Systems in partnership with Oppenheimer Generations Research and Conservation.

References:

Abraham, J.: Just Transitions for the Miners: Labor Environmentalism in the Ruhr and Appalachian Coalfields, New Political Science, 39, 218–240, https://doi.org/10.1080/07393148.2017.1301313, 2017.

Ameli, N., Dessens, O., Winning, M., Cronin, J., Chenet, H., Drummond, P., Calzadilla, A.,

Anandarajah, G., and Grubb, M.: Higher cost of finance exacerbates a climate investment trap in developing economies, Nat Commun, 12, 4046, https://doi.org/10.1038/s41467-021-24305-3, 2021.
Aminian-Biquet, J., Gorjanc, S., Sletten, J., Vincent, T., Laznya, A., Vaidianu, N., Claudet, J., Young, J., and Costa, B. H. e: Over 80% of the European Union's marine protected area only marginally regulates human activities, One Earth, 0, https://doi.org/10.1016/j.oneear.2024.07.010, 2024.
Atlas, W. I., Ban, N. C., Moore, J. W., Tuohy, A. M., Greening, S., Reid, A. J., Morven, N., White, E., Housty, W. G., Housty, J. A., Service, C. N., Greba, L., Harrison, S., Sharpe, C., Butts, K. I. R., Shepert, W. M., Sweeney-Bergen, E., Macintyre, D., Sloat, M. R., and Connors, K.: Indigenous Systems of Management for Culturally and Ecologically Resilient Pacific Salmon (Oncorhynchus spp.) Fisheries, BioScience, 71, 186–204, https://doi.org/10.1093/biosci/biaa144, 2021.
Baillie, J. and Zhang, Y.-P.: Space for nature, Science, 361, 1051–1051, https://doi.org/10.1126/science.aau1397, 2018.
Bain, P. G., Hornsey, M. J., Bongiorno, R., and Jeffries, C.: Promoting pro-environmental action in climate change deniers, Nature Clim Change, 2, 600–603, https://doi.org/10.1038/nclimate1532, 2012.
Banerjee, A. V. and Duflo, E.: Good Economics for Hard Times: Better Answers to Our Biggest Problems, 1st edition., Penguin, London, 2020.
Banza Lubaba Nkulu, C., Casas, L., Haufroid, V., De Putter, T., Saenen, N. D., Kayembe-Kitenge, T., Musa Obadia, P., Kyanika Wa Mukoma, D., Lunda Ilunga, J.-M., Nawrot, T. S., Luboya Numbi, O., Smolders, E., and Nemery, B.: Sustainability of artisanal mining of cobalt in DR Congo, Nat Sustain, 1, 495–504, https://doi.org/10.1038/s41893-018-0139-4, 2018.
Barau, A. and Tanko, A. I.: In Search of New Narratives for Informed Decisions on Climate Change Crisis in the African Drylands, in: Handbook of Climate Change Communication: Vol. 3: Case Studies in Climate Change Communication, edited by: Leal Filho, W., Manolas, E., Azul, A. M., Azeiteiro, U. M., and McGhie, H., Springer International Publishing, Cham, 1–20, https://doi.org/10.1007/978-3-319-70479-1_1, 2018.
Beckensteiner, J., Boschetti, F., and Thébaud, O.: Adaptive fisheries responses may lead to climate maladaptation in the absence of access regulations, npj Ocean Sustain, 2, 1–5, https://doi.org/10.1038/s44183-023-00010-0, 2023.
Bennett, N. J. and Dearden, P.: Why local people do not support conservation: Community perceptions of marine protected area livelihood impacts, governance and management in Thailand, Marine Policy, 44, 107–116, https://doi.org/10.1016/j.marpol.2013.08.017, 2014.
Bentley, R. A., Maddison, E. J., Ranner, P. H., Bissell, J., Caiado, C. C. S., Bhatanacharoen, P., Clark, T., Botha, M., Akinbami, F., Hollow, M., Michie, R., Huntley, B., Curtis, S. E., and Garnett, P.: Social tipping points and Earth systems dynamics, Frontiers in Environmental Science, 2, 35, https://doi.org/10.3389/fenvs.2014.00035, 2014.
Bhambra, G. K. and Newell, P.: More than a metaphor: 'climate colonialism' in perspective, Global Social Challenges Journal, 1–9, https://doi.org/10.1332/EIEM6688, 2022.
Biermann, F., Oomen, J., Gupta, A., Ali, S. H., Conca, K., Hajer, M. A., Kashwan, P., Kotzé, L. J., Leach, M., Messner, D., Okereke, C., Persson, Å., Potočnik, J., Schlosberg, D., Scobie, M., and VanDeveer, S. D.: Solar geoengineering: The case for an international non-use agreement, WIREs Climate Change, 13, e754, https://doi.org/10.1002/wcc.754, 2022.
Bird, R. and Davis-Nozemack, K.: Tax Avoidance as a Sustainability Problem, Journal of Business Ethics, 151, 1009–1025, 2018.
Blythe, J., Silver, J., Evans, L., Armitage, D., Bennett, N. J., Moore, M., Morrison, T. H., and Brown, K.: The Dark Side of Transformation: Latent Risks in Contemporary Sustainability Discourse, Antipode, 50, 1206–1223, https://doi.org/10.1111/anti.12405, 2018.
Bonneuil, C. and Fressoz, J.-B.: The Shock of the Anthropocene: The Earth, History and Us,

913 Verso Books, 315 pp., 2016.
914 Boyd, E., Nykvist, B., Borgström, S., and Stacewicz, I. A.: Anticipatory governance for social-
915 ecological resilience, AMBIO, 44, 149–161, https://doi.org/10.1007/s13280-014-0604-x, 2015.
916 Byskov, M. F. and Hyams, K.: Epistemic Injustice in Climate Adaptation, Ethical Theory and
917 Moral Practice, 25, 613–634, https://doi.org/10.1007/s10677-022-10301-z, 2022.
918 Calvão, F., Mcdonald, C. E. A., and Bolay, M.: Cobalt mining and the corporate outsourcing of
919 responsibility in the Democratic Republic of Congo, Extractive Industries and Society, 8,
920 https://doi.org/10.1016/j.exis.2021.02.004, 2021.
921 Canelas, J. and Carvalho, A.: The dark side of the energy transition: Extractivist violence,
922 energy (in)justice and lithium mining in Portugal, Energy Research & Social Science, 100,
923 103096, https://doi.org/10.1016/j.erss.2023.103096, 2023.
924 CBD: COP15: Final text of Kunming-Montreal Global Biodiversity Framework, 2022.
925 Centeno, M. A., Nag, M., Patterson, T. S., Shaver, A., and Windawi, A. J.: The Emergence of
926 Global Systemic Risk, Annual Review of Sociology, 41, 65–85, https://doi.org/10.1146/annurev-
927 soc-073014-112317, 2015.
928 CEPAL: Acuerdo Regional sobre el Acceso a la Información, la Participación Pública y el
929 Acceso a la Justicia en Asuntos Ambientales en América Latina y el Caribe | CEPAL, CEPAL,
930 Santiago, Chile, 2018.
931 Chakravarty, D., Dasgupta, S., and Roy, J.: Rebound effect: how much to worry?, Current
932 Opinion in Environmental Sustainability, 2, 216–228,
933 https://doi.org/10.1016/j.cosust.2013.03.001, 2013.
934 Chambers, J. M., Wyborn, C., Ryan, M. E., Reid, R. S., Riechers, M., Serban, A., Bennett, N. J.,
935 Cvitanovic, C., Fernández-Giménez, M. E., Galvin, K. A., Goldstein, B. E., Klenk, N. L., Tengö,
936 M., Brennan, R., Cockburn, J. J., Hill, R., Munera, C., Nel, J. L., Österblom, H., Bednarek, A. T.,
937 Bennett, E. M., Brandeis, A., Charli-Joseph, L., Chatterton, P., Curran, K., Dumrongrojwatthana,
938 P., Durán, A. P., Fada, S. J., Gerber, J.-D., Green, J. M. H., Guerrero, A. M., Haller, T., Horcea-
939 Milcu, A.-I., Leimona, B., Montana, J., Rondeau, R., Spierenburg, M., Steyaert, P., Zaehringer,
940 J. G., Gruby, R., Hutton, J., and Pickering, T.: Six modes of co-production for sustainability, Nat
941 Sustain, 1–14, https://doi.org/10.1038/s41893-021-00755-x, 2021.
942 Constantino, S. M. and Weber, E. U.: Decision-making under the deep uncertainty of climate
943 change: The psychological and political agency of narratives, Curr Opin Psychol, 42, 151–159,
944 https://doi.org/10.1016/j.copsyc.2021.11.001, 2021.
945 Constantino, S. M., Skaredina, O., and Ivanova, M.: Catalytic leadership in climate change
946 negotiations: a reply to ‘Why do climate change negotiations stall? Scientific evidence and
947 solutions for some structural problems’ by Ulrich Frey and Jazmin Burgess, Global Discourse,
948 1–8, https://doi.org/10.1332/204378921X16842177275040, 2023.
949 Costello, C., Ovando, D., Clavelle, T., Strauss, C. K., Hilborn, R., Melnychuk, M. C., Branch, T.
950 A., Gaines, S. D., Szuwalski, C. S., Cabral, R. B., Rader, D. N., and Leland, A.: Global fishery
951 prospects under contrasting management regimes, Proceedings of the National Academy of
952 Sciences, 113, 5125–5129, https://doi.org/10.1073/pnas.1520420113, 2016.
953 Crona, B., Folke, C., and Galaz, V.: The Anthropocene reality of financial risk, One Earth, 4,
954 618–628, https://doi.org/10.1016/j.oneear.2021.04.016, 2021.
955 Crowley, K.: Up and down with climate politics 2013–2016: the repeal of carbon pricing in
956 Australia, WIREs Climate Change, 8, e458, https://doi.org/10.1002/wcc.458, 2017.
957 Dasgupta, P.: The Economics of Biodiversity : the Dasgupta Review., HM Treasury, London,
958 2021.
959 Davies, M. and Oreszczyn, T.: The unintended consequences of decarbonising the built
960 environment: A UK case study, Energy and Buildings, 46, 80–85,
961 https://doi.org/10.1016/j.enbuild.2011.10.043, 2012.
962 Dempsey, J., Irvine-Broque, A., Bigger, P., Christiansen, J., Muchhala, B., Nelson, S., Rojas-
963 Marchini, F., Shapiro-Garza, E., Schuldt, A., and DiSilvestro, A.: Biodiversity targets will not be

met without debt and tax justice, Nat Ecol Evol, 6, 237–239, https://doi.org/10.1038/s41559-021-01619-5, 2022.
Deutz, A., Heal, G., Niu, R., Swanson, E., Townshend, T., Li, Z., Delmar, A., Meghji, A., Sethi, S., and Tobin- de la Puente, J.: Financing Nature: Closing the Global Biodiversity Financing Gap, The Paulson Institute, The Nature Conservancy, and the Cornell Atkinson Center for Sustainability., Washington D.C, https://doi.org/10.13140/RG.2.2.26226.32968, 2020.
Dinerstein, E., Vynne, C., Sala, E., Joshi, A. R., Fernando, S., Lovejoy, T. E., Mayorga, J., Olson, D., Asner, G. P., Baillie, J. E. M., Burgess, N. D., Burkart, K., Noss, R. F., Zhang, Y. P., Baccini, A., Birch, T., Hahn, N., Joppa, L. N., and Wikramanayake, E.: A Global Deal For Nature: Guiding principles, milestones, and targets, Science Advances, 5, eaaw2869, https://doi.org/10.1126/sciadv.aaw2869, 2019.
Dutta, T., Kim, K.-H., Uchimiya, M., Kwon, E. E., Jeon, B.-H., Deep, A., and Yun, S.-T.: Global demand for rare earth resources and strategies for green mining, Environmental Research, 150, 182–190, https://doi.org/10.1016/j.envres.2016.05.052, 2016.
Ehret, S., Constantino, S. M., Weber, E. U., Efferson, C., and Vogt, S.: Group identities can undermine social tipping after intervention, Nat Hum Behav, 6, 1669–1679, https://doi.org/10.1038/s41562-022-01440-5, 2022.
Carbon leakage: https://climate.ec.europa.eu/eu-action/eu-emissions-trading-system-eu-ets/free-allocation/carbon-leakage_en, last access: 28 June 2023.
Evans, A.: The myth gap: what happens when evidence and arguments aren't enough?, Penguin Random House, UK, 119 pp., 2017.
Fairhead, J., Leach, M., and Scoones, I.: Green Grabbing: a new appropriation of nature?, The Journal of Peasant Studies, 39, 237–261, https://doi.org/10.1080/03066150.2012.671770, 2012.
Fesenfeld, L. P., Schmid, N., Finger, R., Mathys, A., and Schmidt, T. S.: The politics of enabling tipping points for sustainable development, One Earth, 5, 1100–1108, https://doi.org/10.1016/j.oneear.2022.09.004, 2022.
Fichtner, J., Heemskerk, E. M., and Garcia-Bernardo, J.: Hidden power of the Big Three? Passive index funds, re-concentration of corporate ownership, and new financial risk, Business and Politics, 19, 298–326, https://doi.org/10.1017/bap.2017.6, 2017.
Galaz, V., Gars, J., Moberg, F., Nykvist, B., and Repinski, C.: Why Ecologists Should Care about Financial Markets, Trends in Ecology & Evolution, 30, 571–580, https://doi.org/10.1016/j.tree.2015.06.015, 2015.
Galaz, V., Crona, B., Dauriach, A., Jouffray, J.-B., Österblom, H., and Fichtner, J.: Tax havens and global environmental degradation, Nat Ecol Evol, 2, 1352–1357, https://doi.org/10.1038/s41559-018-0497-3, 2018.
Gardiner, S. M.: Ethics and Global Climate Change, Ethics, 114, 555–600, https://doi.org/10.1086/382247, 2004.
Ghosh, A.: The Nutmeg's Curse: Parables for a Planet in Crisis, University of Chicago Press, Chicago, IL, 336 pp., 2022.
Gilio-Whitaker, D.: As Long as Grass Grows: The Indigenous Fight for Environmental Justice, from Colonization to Standing Rock, Beacon Press, 226 pp., 2019.
Global Public Investment Network: Time for Global Public Investment: Leaders and experts rethinking sustainable development finance, Global Public Investment Network, Online, 2023.
Gómez-Barris, M.: The Extractive Zone: Social Ecologies and Decolonial Perspectives, Duke University Press, Durham, NC, https://doi.org/10.1215/9780822372561, 2017.
Gotangco, C. K. and Leon, I. P. de: Balancing Paradigms in Climate Change Communication Research to Support Climate Services, Environmental Science Faculty Publications, 2017.
Grubb, M., Jordan, N. D., Hertwich, E., Neuhoff, K., Das, K., Bandyopadhyay, K. R., van Asselt, H., Sato, M., Wang, R., Pizer, W. A., and Oh, H.: Carbon Leakage, Consumption, and Trade, Annual Review of Environment and Resources, 47, 753–795, https://doi.org/10.1146/annurev-environ-120820-053625, 2022.

Gupta, J., Liverman, D., Prodani, K., Aldunce, P., Bai, X., Broadgate, W., Ciobanu, D., Gifford, L., Gordon, C., Hurlbert, M., Inoue, C. Y. A., Jacobson, L., Kanie, N., Lade, S. J., Lenton, T. M., Obura, D., Okereke, C., Otto, I. M., Pereira, L., Rockström, J., Scholtens, J., Rocha, J., Stewart-Koster, B., David Tàbara, J., Rammelt, C., and Verburg, P. H.: Earth system justice needed to identify and live within Earth system boundaries, Nat Sustain, 1–9, https://doi.org/10.1038/s41893-023-01064-1, 2023a.

Gupta, J., Liverman, D., Prodani, K., Aldunce, P., Bai, X., Broadgate, W., Ciobanu, D., Gifford, L., Gordon, C., Hurlbert, M., Inoue, C. Y. A., Jacobson, L., Kanie, N., Lade, S. J., Lenton, T. M., Obura, D., Okereke, C., Otto, I. M., Pereira, L., Rockström, J., Scholtens, J., Rocha, J., Stewart-Koster, B., David Tàbara, J., Rammelt, C., and Verburg, P. H.: Earth system justice needed to identify and live within Earth system boundaries, Nat Sustain, 1–9, https://doi.org/10.1038/s41893-023-01064-1, 2023b.

Gupta, J., Liverman, D., Prodani, K., Aldunce, P., Bai, X., Broadgate, W., Ciobanu, D., Gifford, L., Gordon, C., Hurlbert, M., Inoue, C. Y. A., Jacobson, L., Kanie, N., Lade, S. J., Lenton, T. M., Obura, D., Okereke, C., Otto, I. M., Pereira, L., Rockström, J., Scholtens, J., Rocha, J., Stewart-Koster, B., David Tàbara, J., Rammelt, C., and Verburg, P. H.: Earth system justice needed to identify and live within Earth system boundaries, Nature Sustainability, https://doi.org/10.1038/s41893-023-01064-1, 2023c.

Haberl, H.: Competition for land: A sociometabolic perspective, Ecological Economics, 119, 424–431, https://doi.org/10.1016/j.ecolecon.2014.10.002, 2015.

Hall, S.: Encoding/decoding *, in: Culture, Media, Language, Routledge, 1980.

Haraway, D.: Staying with the Trouble: Making kin in the Chthulucene, Duke University Press, Baltimore, USA, 2016.

Harden-Davies, H., Humphries, F., Maloney, M., Wright, G., Gjerde, K., and Vierros, M.: Rights of Nature: Perspectives for Global Ocean Stewardship, Marine Policy, 122, https://doi.org/10.1016/j.marpol.2020.104059, 2020.

Hasegawa, T., Fujimori, S., Havlík, P., Valin, H., Bodirsky, B. L., Doelman, J. C., Fellmann, T., Kyle, P., Koopman, J. F. L., Lotze-Campen, H., Mason-D'Croz, D., Ochi, Y., Pérez Domínguez, I., Stehfest, E., Sulser, T. B., Tabeau, A., Takahashi, K., Takakura, J., van Meijl, H., van Zeist, W.-J., Wiebe, K., and Witzke, P.: Risk of increased food insecurity under stringent global climate change mitigation policy, Nature Clim Change, 8, 699–703, https://doi.org/10.1038/s41558-018-0230-x, 2018.

Hernandez, D. S. and Newell, P.: Oro blanco: assembling extractivism in the lithium triangle, The Journal of Peasant Studies, 49, 945–968, https://doi.org/10.1080/03066150.2022.2080061, 2022.

Hickel, J. and Kallis, G.: Is Green Growth Possible?, New Political Economy, 25, 469–486, https://doi.org/10.1080/13563467.2019.1598964, 2019.

Hickel, J., Sullivan, D., and Zoomkawala, H.: Plunder in the Post-Colonial Era: Quantifying Drain from the Global South Through Unequal Exchange, 1960–2018, New Political Economy, 26, 1030–1047, https://doi.org/10.1080/13563467.2021.1899153, 2021.

Hicks, C. C., Cohen, P. J., Graham, N. A. J., Nash, K. L., Allison, E. H., D'Lima, C., Mills, D. J., Roscher, M., Thilsted, S. H., Thorne-Lyman, A. L., and MacNeil, M. A.: Harnessing global fisheries to tackle micronutrient deficiencies, Nature, 574, 95–98, https://doi.org/10.1038/s41586-019-1592-6, 2019.

Hill, L. S., Johnson, J. A., and Adamowski, J.: Meeting Aichi Target 11: Equity considerations in Marine Protected Areas design, Ocean & Coastal Management, 134, 112–119, https://doi.org/10.1016/j.ocecoaman.2016.09.017, 2016.

Hoffman, S. M. and High-Pippert, A.: Community Energy: A Social Architecture for an Alternative Energy Future, Bulletin of Science, Technology & Society, 25, 387–401, https://doi.org/10.1177/0270467605278880, 2005.

Holmes, D. C.: Introduction to the Research handbook on communicating climate change, in: Research Handbook on Communicating Climate Change, Edward Elgar Publishing, 1–20, 2020.
Houser, H.: Ecosickness in Contemporary U.S. Fiction: Environment and Affect, in: Ecosickness in Contemporary U.S. Fiction, Columbia University Press, https://doi.org/10.7312/hous16514, 2014.
Huq, S., Roberts, E., and Fenton, A.: Loss and damage, Nature Clim Change, 3, 947–949, https://doi.org/10.1038/nclimate2026, 2013.
Huybrechts, L., Benesch, H., and Geib, J.: Institutioning: Participatory Design, Co-Design and the public realm, CoDesign, 13, 148–159, https://doi.org/10.1080/15710882.2017.1355006, 2017.
IEA: Africa Energy Outlook 2022 – Analysis, IEA, Paris, France, 2022a.
IEA: Renewables 2022 – Analysis, IEA, Paris, 2022b.
IPBES: The Global Assessment Report on Biodiversity and Ecosystem Services of the Intergovernmental Science-Policy Platform on Biodiversity and Ecosystem Services, Intergovernmental Science-Policy Platform on Biodiversity and Ecosystem Services, Bonn, Germany, 2019.
IPBES: Methodological Assessment Report on the Diverse Values and Valuation of Nature of the Intergovernmental Science-Policy Platform on Biodiversity and Ecosystem Services, IPBES secretariat, Bonn, Germany, https://doi.org/10.5281/zenodo.6522522, 2022.
IRENA: Renewable Power Generation Costs in 2021, International Renewable Energy Agency, Abu Dhabi, 2022.
Jackson, G., N'Guetta, A., Rosa, S. P. D., Scown, M., Dorkenoo, K., Chaffin, B., and Boyd, E.: An emerging governmentality of climate change loss and damage, Progress in Environmental Geography, https://doi.org/10.1177/27539687221148748, 2023.
James, E.: The Storyworld Accord: Econarratology and Postcolonial Narratives, edited by: Matz, J. E. and Herman, D., University of Nebraska Press, https://doi.org/10.2307/j.ctt1d9898m, 2015.
Jenkins, C. N. and Van Houtan, K. S.: Global and regional priorities for marine biodiversity protection, Biological Conservation, 204, 333–339, https://doi.org/10.1016/j.biocon.2016.10.005, 2016.
Jessop, S., Stanway, D., and Abnett, K.: COP28 calls for adapting to warmer world without resolving how to pay, Reuters, 13th December, 2023.
Jouffray, J.-B., Crona, B., Wassénius, E., Bebbington, J., and Scholtens, B.: Leverage points in the financial sector for seafood sustainability, Science Advances, 5, eaax3324, https://doi.org/10.1126/sciadv.aax3324, 2019.
Jouffray, J.-B., Blasiak, R., Norström, A. V., Österblom, H., and Nyström, M.: The Blue Acceleration: The Trajectory of Human Expansion into the Ocean, One Earth, 2, 43–54, https://doi.org/10.1016/j.oneear.2019.12.016, 2020.
Juhola, S., Filatova, T., Hochrainer-Stigler, S., Mechler, R., Scheffran, J., and Schweizer, P.-J.: Social tipping points and adaptation limits in the context of systemic risk: Concepts, models and governance, Front. Clim., 4, 1009234, https://doi.org/10.3389/fclim.2022.1009234, 2022.
Kårtveit, B.: Green colonialism: The story of wind power in Sápmi, in: Stories of Change and Sustainability in the Arctic Regions, Routledge, 2021.
Kegan, R. and Lahey, L. L.: How the Way We Talk Can Change the Way We Work: Seven Languages for Transformation, John Wiley & Sons, 255 pp., 2001.
Keith, D.: A Case for Climate Engineering, MIT Press, 2013.
Keith, D. W., Wagner, G., and Zabel, C. L.: Solar geoengineering reduces atmospheric carbon burden, Nature Clim Change, 7, 617–619, https://doi.org/10.1038/nclimate3376, 2017.
Kenner, D.: Carbon Inequality: The Role of the Richest in Climate Change, Routledge, London, 146 pp., https://doi.org/10.4324/9781351171328, 2019.
Kinniburgh, C.: Climate Politics after the Yellow Vests, Dissent Magazine, Spring, 2019.
Klein, N.: This Changes Everything: Capitalism vs. The Climate, Reprint edition., Simon &

Schuster, 576 pp., 2015.
Klinsky, S., Roberts, T., Huq, S., Okereke, C., Newell, P., Dauvergne, P., O'Brien, K., Schroeder, H., Tschakert, P., Clapp, J., Keck, M., Biermann, F., Liverman, D., Gupta, J., Rahman, A., Messner, D., Pellow, D., and Bauer, S.: Why equity is fundamental in climate change policy research, Global Environmental Change, 44, 170–173, https://doi.org/10.1016/j.gloenvcha.2016.08.002, 2017.
Koplow, D. and Steenblik, R.: Protecting Nature by Reforming Enviornmentall Harmful Subsidies: The Role of Business, Earth track, Cambridge, Mass., 2022.
Kravitz, B. and MacMartin, D. G.: Uncertainty and the basis for confidence in solar geoengineering research, Nat Rev Earth Environ, 1, 64–75, https://doi.org/10.1038/s43017-019-0004-7, 2020.
Kraxner, F., Nordström, E.-M., Havlík, P., Gusti, M., Mosnier, A., Frank, S., Valin, H., Fritz, S., Fuss, S., Kindermann, G., McCallum, I., Khabarov, N., Böttcher, H., See, L., Aoki, K., Schmid, E., Máthé, L., and Obersteiner, M.: Global bioenergy scenarios – Future forest development, land-use implications, and trade-offs, Biomass and Bioenergy, 57, 86–96, https://doi.org/10.1016/j.biombioe.2013.02.003, 2013.
Lamb, W. F., Mattioli, G., Levi, S., Roberts, J. T., Capstick, S., Creutzig, F., Minx, J. C., Müller-Hansen, F., Culhane, T., and Steinberger, J. K.: Discourses of climate delay, Global Sustainability, 3, e17, https://doi.org/10.1017/sus.2020.13, 2020.
Lang, M.: Degrowth, global asymmetries, and ecosocial justice: Decolonial perspectives from Latin America, Review of International Studies, 1–11, https://doi.org/10.1017/S0260210524000147, 2024.
Latour, B.: Down to Earth: Politics in the New Climatic Regime, 1st edition., Polity, Cambridge, UK ; Medford, MA, 140 pp., 2018.
Latulippe, N. and Klenk, N.: Making room and moving over: knowledge co-production, Indigenous knowledge sovereignty and the politics of global environmental change decision-making, Current Opinion in Environmental Sustainability, 42, 7–14, https://doi.org/10.1016/j.cosust.2019.10.010, 2020.
Leach, M. and Scoones, I.: The slow race: Making science and technology work for the poor, Demos, London, U.K., 2006.
Lenton, T. M., Rockström, J., Gaffney, O., Rahmstorf, S., Richardson, K., Steffen, W., and Schellnhuber, H. J.: Climate tipping points - too risky to bet against, Nature, 575, 592–595, https://doi.org/10.1038/d41586-019-03595-0, 2019.
Lenton, T. M., Benson, S., Smith, T., Ewer, T., Lanel, V., Petykowski, E., Powell, T. W. R., Abrams, J. F., Blomsma, F., and Sharpe, S.: Operationalising positive tipping points towards global sustainability, Global Sustainability, 5, e1, https://doi.org/10.1017/sus.2021.30, 2022.
Manzetti, S. and Mariasiu, F.: Electric vehicle battery technologies: From present state to future systems, Renewable and Sustainable Energy Reviews, 51, 1004–1012, https://doi.org/10.1016/j.rser.2015.07.010, 2015.
McKay, D. I. A., Staal, A., Abrams, J. F., and et al.: Exceeding 1.5 C global warming could trigger multiple climate tipping points, Science, 377, https://doi.org/DOI: 10.1126/science.abn7950, 2022.
McLaren, D. P.: Whose climate and whose ethics? Conceptions of justice in solar geoengineering modelling, Energy Research & Social Science, 44, 209–221, https://doi.org/10.1016/j.erss.2018.05.021, 2018.
Meadowcroft, J.: Engaging with the politics of sustainability transitions, Environmental Innovation and Societal Transitions, 1, 70–75, https://doi.org/10.1016/j.eist.2011.02.003, 2011.
Meadows, D. H.: Leverage Points: Places to Intervene in a System, The Sustainability Institute, Hartland, VT, USA, 1999.
Mikulewicz, M., Caretta, M. A., Sultana, F., and J. W. Crawford, N.: Intersectionality & Climate Justice: A call for synergy in climate change scholarship, Environmental Politics, 0, 1–12,

https://doi.org/10.1080/09644016.2023.2172869, 2023.
Milkoreit, M.: Social tipping points everywhere?—Patterns and risks of overuse, WIREs Climate Change, 14, e813, https://doi.org/10.1002/wcc.813, 2023.
Milkoreit, M., Martinez, M., and Eschrich, J.: Everything Change: An Anthology of Climate Fiction, Arizona State University, Tempe, Arizona, 2016.
Milkoreit, M., Hodbod, J., Baggio, J., Benessaiah, K., Calderón-Contreras, R., Donges, J. F., Mathias, J.-D., Rocha, J. C., Schoon, M., and Werners, S. E.: Defining tipping points for social-ecological systems scholarship—an interdisciplinary literature review, Environ. Res. Lett., 13, 033005, https://doi.org/10.1088/1748-9326/aaaa75, 2018.
Milkoreit, M., Boyd, E., Constantino, S. M., Hausner, V. H., Hessen, D. O., Kääb, A., McLaren, D., Nadeau, C., O'Brien, K., Parmentier, F.-J., Rotbarth, R., Rødven, R., Treichler, D., Wilson-Rowe, E., and Yamineva, Y.: Governance for Earth system tipping points – A research agenda, Earth System Governance, 21, 100216, https://doi.org/10.1016/j.esg.2024.100216, 2024.
Mishra, S.: India demands US and other largest historic carbon emitters start taking responsibility for their actions, The Independent, 7th April, 2021.
Moser, S. C.: Editorial overview: Transformations and co-design: Co-designing research projects on social transformations to sustainability, Current Opinion in Environmental Sustainability, 20, v–viii, https://doi.org/10.1016/J.COSUST.2016.10.001, 2016.
von Mossner, A. W.: Affective Ecologies: Empathy, Emotion, and Environmental Narrative, Ohio State University Press, https://doi.org/10.2307/j.ctv11hpszq, 2017.
National Academies of Sciences, Engineering, and Medicine: Reflecting Sunlight: Recommendations for Solar Geoengineering Research and Research Governance, National Academies Press, Washington, D.C., https://doi.org/10.17226/25762, 2021.
Newell, P.: Race, Class and the Global Politics of Environmental Inequality, Global Environmental Politics, 5, 70–94, https://doi.org/10.1162/1526380054794835, 2005.
Newell, P.: Power Shift: The Global Political Economy of Energy Transitions, Cambridge University Press, Cambridge, https://doi.org/10.1017/9781108966184, 2021.
Newell, P.: Towards a more transformative approach to climate finance, Climate Policy, 0, 1–12, https://doi.org/10.1080/14693062.2024.2377730, 2024.
Newell, P. and Mulvaney, D.: The political economy of the 'just transition,' The Geographical Journal, 179, 132–140, https://doi.org/10.1111/geoj.12008, 2013.
Newell, P. and Simms, A.: Towards a fossil fuel non-proliferation treaty, Climate Policy, 2020.
Newell, P., Srivastava, S., Naess, L. O., Torres Contreras, G. A., and Price, R.: Toward transformative climate justice: An emerging research agenda, WIREs Climate Change, 12, e733, https://doi.org/10.1002/wcc.733, 2021.
Newell, P. J., Geels, F. W., and Sovacool, B. K.: Navigating tensions between rapid and just low-carbon transitions, Environ. Res. Lett., 17, 041006, https://doi.org/10.1088/1748-9326/ac622a, 2022.
Nixon, R.: Slow Violence and the Environmentalism of the Poor:, Harvard University Press, Cambridge, MA, 368 pp., 2013.
Norgaard, K. M.: Living in Denial: Climate Change, Emotions, and Everyday Life, The MIT Press, https://doi.org/10.7551/mitpress/9780262015448.001.0001, 2011.
O'Brien, K. L. and Leichenko, R. M.: Double exposure: assessing the impacts of climate change within the context of economic globalization, Global Environmental Change, 10, 221–232, 2000.
O'Brien, K. L. and Leichenko, R. M.: Winners and Losers in the Context of Global Change, Annals of the Association of American Geographers, 93, 89–103, https://doi.org/10.1111/1467-8306.93107, 2003.
Obura, D. O., DeClerck, F., Verburg, P. H., Gupta, J., Abrams, J. F., Bai, X., Bunn, S., Ebi, K. L., Gifford, L., Gordon, C., Jacobson, L., Lenton, T. M., Liverman, D., Mohamed, A., Prodani, K., Rocha, J. C., Rockström, J., Sakschewski, B., Stewart-Koster, B., van Vuuren, D., Winkelmann, R., and Zimm, C.: Achieving a nature- and people-positive future, One Earth, 6, 105–117,

https://doi.org/10.1016/j.oneear.2022.11.013, 2023.
Okereke, C. and Dooley, K.: Principles of justice in proposals and policy approaches to avoided deforestation: Towards a post-Kyoto climate agreement, Global Environmental Change, 20, 82–95, https://doi.org/10.1016/j.gloenvcha.2009.08.004, 2010.
O'Leary, B. C., Ban, N. C., Fernandez, M., Friedlander, A. M., García-Borboroglu, P., Golbuu, Y., Guidetti, P., Harris, J. M., Hawkins, J. P., Langlois, T., McCauley, D. J., Pikitch, E. K., Richmond, R. H., and Roberts, C. M.: Addressing Criticisms of Large-Scale Marine Protected Areas, BioScience, 68, 359–370, https://doi.org/10.1093/biosci/biy021, 2018.
Olsson, P. and Moore, M.-L.: Transformations, Agency and Positive Tipping Points: A Resilience-Based Approach, in: Positive Tipping Points Towards Sustainability: Understanding the Conditions and Strategies for Fast Decarbonization in Regions, edited by: Tàbara, J. D., Flamos, A., Mangalagiu, D., and Michas, S., Springer International Publishing, Cham, 59–77, https://doi.org/10.1007/978-3-031-50762-5_4, 2024.
Oracion, E. G., Miller, M. L., and Christie, P.: Marine protected areas for whom? Fisheries, tourism, and solidarity in a Philippine community, Ocean & Coastal Management, 48, 393–410, https://doi.org/10.1016/j.ocecoaman.2005.04.013, 2005.
Osinski, A.: From Consultation to Coproduction: A Comparison of Participation in Poverty Research, JPRM, 2, https://doi.org/10.35844/001c.18875, 2021.
Österblom, H., Jouffray, J.-B., Folke, C., Crona, B., Troell, M., Merrie, A., and Rockström, J.: Transnational Corporations as 'Keystone Actors' in Marine Ecosystems, PLOS ONE, 10, e0127533, https://doi.org/10.1371/journal.pone.0127533, 2015.
Patterson, J. J.: Backlash to Climate Policy, Global Environmental Politics, 23, 68–90, https://doi.org/10.1162/glep_a_00684, 2023.
Patterson, J. J., Thaler, T., Hoffmann, M., Hughes, S., Oels, A., Chu, E., Mert, A., Huitema, D., Burch, S., and Jordan, A.: Political feasibility of 1.5°C societal transformations: the role of social justice, Current Opinion in Environmental Sustainability, 31, 1–9, https://doi.org/10.1016/j.cosust.2017.11.002, 2018.
Pedroli, B., Elbersen, B., Frederiksen, P., Grandin, U., Heikkilä, R., Krogh, P. H., Izakovičová, Z., Johansen, A., Meiresonne, L., and Spijker, J.: Is energy cropping in Europe compatible with biodiversity? – Opportunities and threats to biodiversity from land-based production of biomass for bioenergy purposes, Biomass and Bioenergy, 55, 73–86, https://doi.org/10.1016/j.biombioe.2012.09.054, 2013.
Pereira, J. C. and Viola, E.: Catastrophic Climate Change and Forest Tipping Points: Blind Spots in International Politics and Policy, Global Policy, 9, 513–524, https://doi.org/10.1111/1758-5899.12578, 2018.
Pereira, L. M., Gianelli, I., Achieng, T., Amon, D., Archibald, S., Arif, S., Castro, A., Chimbadzwa, T. P., Coetzer, K., Field, T.-L., Selomane, O., Sitas, N., Stevens, N., Villasante, S., Armani, M., Kimuyu, D. M., Adewumi, I. J., Lapola, D. M., Obura, D., Pinho, P., Roa-Clavijo, F., Rocha, J., and Sumaila, U. R.: Equity and justice should underpin the discourse on tipping points, Earth System Dynamics, 15, 341–366, https://doi.org/10.5194/esd-15-341-2024, 2024.
Pinney, C., Lawrence, S., and Lau, S.: Sustainability and Capital Markets—Are We There Yet?, Journal of Applied Corporate Finance, 31, 86–91, https://doi.org/10.1111/jacf.12350, 2019.
Piotrowski, M.: Nearing the tipping point: Drivers of deforestation in the Amazon Region, Inter-American Dialogue, Washington D.C., USA, 2019.
Prellezo, R., Da-Rocha, J. M., Palomares, M. L. D., Sumaila, U. R., and Villasante, S.: Building climate resilience, social sustainability and equity in global fisheries, npj Ocean Sustain, 2, 1–7, https://doi.org/10.1038/s44183-023-00017-7, 2023.
Rammelt, C. F., Gupta, J., Liverman, D., Scholtens, J., Ciobanu, D., Abrams, J. F., Bai, X., Gifford, L., Gordon, C., Hurlbert, M., Inoue, C. Y. A., Jacobson, L., Lade, S. J., Lenton, T. M., McKay, D. I. A., Nakicenovic, N., Okereke, C., Otto, I. M., Pereira, L. M., Prodani, K., Rockström, J., Stewart-Koster, B., Verburg, P. H., and Zimm, C.: Impacts of meeting minimum

access on critical earth systems amidst the Great Inequality, Nature Sustainability, 6, 212–221, https://doi.org/10.1038/s41893-022-00995-5, 2023.
Rasheed, A. R.: Marine protected areas and human well-being – A systematic review and recommendations, Ecosystem Services, 41, 101048, https://doi.org/10.1016/j.ecoser.2019.101048, 2020.
Raworth, K.: A Doughnut for the Anthropocene: humanity's compass in the 21st century, The Lancet Planetary Health, 1, e48–e49, https://doi.org/10.1016/S2542-5196(17)30028-1, 2017.
Richardson, K., Steffen, W., Lucht, W., Bendtsen, J., Cornell, S. E., Donges, J. F., Drüke, M., Fetzer, I., Bala, G., von Bloh, W., Feulner, G., Fiedler, S., Gerten, D., Gleeson, T., Hofmann, M., Huiskamp, W., Kummu, M., Mohan, C., Nogués-Bravo, D., Petri, S., Porkka, M., Rahmstorf, S., Schaphoff, S., Thonicke, K., Tobian, A., Virkki, V., Wang-Erlandsson, L., Weber, L., and Rockström, J.: Earth beyond six of nine planetary boundaries, Science Advances, 9, eadh2458, https://doi.org/10.1126/sciadv.adh2458, 2023.
Rionfrancos, T., Kendall, K. K., Haugen, M., McDonald, K., Hassan, B., and Slattery, M.: Achieving Zero Emissions with More Mobility Less Mining, University of California, Davis, Davis, California, USA, 2023.
Roberts, H. G. A., Barciela, R., Flint, S., Fussell, I., Maestri, E., Nyblon, C. M., Marple, A., Sabet, F., and Stott, P.: New narratives for a healthy planet: creative writing and art projects reveal We Still Have a Chance, The Lancet Planetary Health, 7, e646–e647, https://doi.org/10.1016/S2542-5196(23)00144-4, 2023.
Roberts, J. T. and Parks, B.: A Climate of Injustice: Global Inequality, North-South Politics, and Climate Policy, The MIT Press, Cambridge, Mass., 404 pp., 2006.
Rockström, J., Gupta, J., Qin, D., Lade, S. J., Abrams, J. F., Andersen, L. S., Armstrong McKay, D. I., Bai, X., Bala, G., Bunn, S. E., Ciobanu, D., DeClerck, F., Ebi, K., Gifford, L., Gordon, C., Hasan, S., Kanie, N., Lenton, T. M., Loriani, S., Liverman, D. M., Mohamed, A., Nakicenovic, N., Obura, D., Ospina, D., Prodani, K., Rammelt, C., Sakschewski, B., Scholtens, J., Stewart-Koster, B., Tharammal, T., van Vuuren, D., Verburg, P. H., Winkelmann, R., Zimm, C., Bennett, E. M., Bringezu, S., Broadgate, W., Green, P. A., Huang, L., Jacobson, L., Ndehedehe, C., Pedde, S., Rocha, J., Scheffer, M., Schulte-Uebbing, L., de Vries, W., Xiao, C., Xu, C., Xu, X., Zafra-Calvo, N., and Zhang, X.: Safe and just Earth system boundaries, Nature, 1–10, https://doi.org/10.1038/s41586-023-06083-8, 2023.
Rowson, J. and Corner, A.: How framing can move climate change from scientific to social fact, The Guardian, 23rd May, 2014.
Ruddick, W.: Sarafu Network Community Asset Vouchers, 2022-2023, 2023.
Sala, E. and Giakoumi, S.: No-take marine reserves are the most effective protected areas in the ocean, ICES Journal of Marine Science, 75, 1166–1168, https://doi.org/10.1093/icesjms/fsx059, 2018.
Sandbrook, C., Albury-Smith, S., Allan, J. R., Bhola, N., Bingham, H. C., Brockington, D., Byaruhanga, A. B., Fajardo, J., Fitzsimons, J., Franks, P., Fleischman, F., Frechette, A., Kakuyo, K., Kaptoyo, E., Kuemmerle, T., Kalunda, P. N., Nuvunga, M., O'Donnell, B., Onyai, F., Pfeifer, M., Pritchard, R., Ramos, A., Rao, M., Ryan, C. M., Shyamsundar, P., Tauli, J., Tumusiime, D. M., Vilaça, M., Watmough, G. R., Worsdell, T., and Zaehringer, J. G.: Social considerations are crucial to success in implementing the 30×30 global conservation target, Nat Ecol Evol, 7, 784–785, https://doi.org/10.1038/s41559-023-02048-2, 2023.
Schneider, T., Kaul, C. M., and Pressel, K. G.: Solar geoengineering may not prevent strong warming from direct effects of CO2 on stratocumulus cloud cover, Proceedings of the National Academy of Sciences, 117, 30179–30185, https://doi.org/10.1073/pnas.2003730117, 2020.
Scoones, I., Leach, M., and Newell, P.: The Politics of Green Transformations, Routledge, 2015.
SEIA/Wood MacKenzie: US Solar Market Insight, Wood MacKenzie, Boston, Massachusetts, 2023.
Selig, E. R., Turner, W. R., Troëng, S., Wallace, B. P., Halpern, B. S., Kaschner, K., Lascelles,

B. G., Carpenter, K. E., and Mittermeier, R. A.: Global Priorities for Marine Biodiversity Conservation, PLOS ONE, 9, e82898, https://doi.org/10.1371/journal.pone.0082898, 2014.
Setiyono, J. and Natalis, A.: Ecocides as a Serious Human Rights Violation: A Study on the Case of River Pollution by the Palm Oil Industry in Indonesia | IIETA, International Journal of Sustainable Development and Planning, 16, 1465–1471, https://doi.org/10.18280/ijsdp.160807, 2021.
Shaxson, N.: The True Cost of Global Tax Havens, International Monetary Fund, Paris, France, 2019.
Sloterdijk, P.: You Must Change Your Life, Wiley, London, U.K., 2012.
Smallhorn-West, P. F., Weeks, R., Gurney, G., and Pressey, R. L.: Ecological and socioeconomic impacts of marine protected areas in the South Pacific: assessing the evidence base, Biodivers Conserv, 29, 349–380, https://doi.org/10.1007/s10531-019-01918-1, 2020.
Smith, S. R.: Towards an understanding of advocacy coalitions for rapid transition to net zero carbon in the United Kingdom, University of Surrey, https://doi.org/10.15126/thesis.900563, 2022.
de Sousa Santos, B. (Ed.): Another Knowledge Is Possible, Verso, London, U.K., 2008.
de Souza, G. F. F.: Politcal Ecology of the Global South: The Amazon Fund, Journal on Innovation and Sustainability RISUS, 12, 4–15, https://doi.org/10.23925/2179-3565.2020v12i1p04-15, 2021.
Sovacool, B. K.: The precarious political economy of cobalt: Balancing prosperity, poverty, and brutality in artisanal and industrial mining in the Democratic Republic of the Congo, The Extractive Industries and Society, 6, 915–939, https://doi.org/10.1016/j.exis.2019.05.018, 2019.
Sovacool, B. K.: Reckless or righteous? Reviewing the sociotechnical benefits and risks of climate change geoengineering, Energy Strategy Reviews, 35, 100656, https://doi.org/10.1016/j.esr.2021.100656, 2021.
Sovacool, B. K., Newell, P., Carley, S., and Fanzo, J.: Equity, technological innovation and sustainable behaviour in a low-carbon future, Nat Hum Behav, 6, 326–337, https://doi.org/10.1038/s41562-021-01257-8, 2022.
Sowman, M. and Sunde, J.: Social impacts of marine protected areas in South Africa on coastal fishing communities, Ocean & Coastal Management, 157, 168–179, https://doi.org/10.1016/j.ocecoaman.2018.02.013, 2018.
Srinivasan, K. and Kasturirangan, R.: Political ecology, development, and human exceptionalism, Geoforum, 75, 125–128, https://doi.org/10.1016/j.geoforum.2016.07.011, 2016.
Steele, P. and Patel, S.: Tackling the triple crisis. Using debt swaps to address debt, climate and nature loss post-COVID-19, International Institute for Environment and Development, London, 2020.
Steinberger, J. K., Lamb, W. F., and Sakai, M.: Your money or your life? The carbon-development paradox, Environ. Res. Lett., 15, 044016, https://doi.org/10.1088/1748-9326/ab7461, 2020.
Stephens, J. C., Kashwan, P., McLaren, D., and Surprise, K.: The risks of solar geoengineering research, Science, 372, 1161–1161, https://doi.org/10.1126/science.abj3679, 2021.
Stirling, A.: Keep it complex, Nature, 468, 1029–1031, https://doi.org/10.1038/4681029a, 2010.
Stone, L., Montes de Oca, G., and Christie, I.: A Commoners' Climate Movement, in: Addressing the Climate Crisis: Local action in theory and practice, edited by: Howarth, C., Lane, M., and Slevin, A., Springer International Publishing, Cham, 27–37, https://doi.org/10.1007/978-3-030-79739-3_3, 2022.
Sultana, F.: The unbearable heaviness of climate coloniality, Political Geography, 99, 102638, https://doi.org/10.1016/j.polgeo.2022.102638, 2022.
Sultana, F.: Political ecology III: Praxis - doing, undoing, and being in radical political ecology research, Progress in Human Geography, 03091325231157360, https://doi.org/10.1177/03091325231157360, 2023a.

Sultana, F.: Whose growth in whose planetary boundaries? Decolonising planetary justice in the Anthropocene, Geo: Geography and Environment, 10, e00128, https://doi.org/10.1002/geo2.128, 2023b.
Sumaila, U. R., Walsh, M., Hoareau, K., Cox, A., Teh, L., Abdallah, P., Akpalu, W., Anna, Z., Benzaken, D., Crona, B., Fitzgerald, T., Heaps, L., Issifu, I., Karousakis, K., Lange, G. M., Leland, A., Miller, D., Sack, K., Shahnaz, D., Thiele, T., Vestergaard, N., Yagi, N., and Zhang, J.: Financing a sustainable ocean economy, Nat Commun, 12, 3259, https://doi.org/10.1038/s41467-021-23168-y, 2021.
Systemiq: The Breakthrough Effect: How tipping points can accelerate net zero, Systemiq, The University of Exeter, Bezos Earth Fund, 2023.
Sze, J.: Sustainability: Approaches to Environmental Justice and Social Power., NYU Press, 2018.
Tàbara, J. D.: ESD Ideas: Positive tipping points towards global regenerative systems, Earth System Dynamics, 15, 853–857, https://doi.org/10.5194/esd-15-853-2024, 2024.
Tàbara, J. D., Lieu, J., Zaman, R., Ismail, C., and Takama, T.: On the discovery and enactment of positive socio-ecological tipping points: insights from energy systems interventions in Bangladesh and Indonesia, Sustain Sci, 17, 565–571, https://doi.org/10.1007/s11625-021-01050-6, 2022.
Tarhule, A.: Part 4 - The Future of Water: Prospects and Challenges for Water Management in the 21st Century, in: Competition for Water Resources, edited by: Ziolkowska, J. R. and Peterson, J. M., Elsevier, 442–454, https://doi.org/10.1016/B978-0-12-803237-4.00025-2, 2017.
Torres Contreras, G. A.: Twenty-five years under the wind turbines in La Venta, Mexico: social difference, land control and agrarian change, The Journal of Peasant Studies, 49, 865–883, https://doi.org/10.1080/03066150.2021.1873293, 2022.
Trebeck, K. and Williams, J.: The economics of arrival: Ideas for a grown-up economy, 1st ed., Bristol University Press, https://doi.org/10.2307/j.ctvb1hrn9, 2019.
Tremmel, J. C.: A Theory of Intergenerational Justice, Earthscan, London, U.K., 2009.
UNEP: The financial system we need: Aligning the financial system with sustainable development, UNEP, Nairobi, Kenya, 2015.
UNEP: Principles for Responsible Banking, UN Environment Programme Finance Initiative, Nairobi, Kenya, 2019.
UNEP: Sustainable Blue Finance: Mobilising Capital for a Sustainable Ocean, 2020.
UNEP: State of Finance for Nature 2023: The Big Nature Turnaround – Repurposing $7 trillion to combat nature loss, UN Environment Programme, Nairobi, Kenya, 2023.
Vervoort, J. and Gupta, A.: Anticipating climate futures in a 1.5 °C era: the link between foresight and governance, Current Opinion in Environmental Sustainability, 31, 104–111, https://doi.org/10.1016/j.cosust.2018.01.004, 2018.
Villasante, S., Macho, G., Silva, M. R. O., Lopes, P. F. M., Pita, P., Simón, A., Balsa, J. C. M., Olabarria, C., Vázquez, E., and Calvo, N.: Resilience and Social Adaptation to Climate Change Impacts in Small-Scale Fisheries, Frontiers in Marine Science, 9, 2022.
Wang, X. and Lo, K.: Just transition: A conceptual review, Energy Research & Social Science, 82, 102291, https://doi.org/10.1016/j.erss.2021.102291, 2021.
Weeks, R., Russ, G. R., Alcala, A. C., and White, A. T.: Effectiveness of marine protected areas in the Philippines for biodiversity conservation, Conserv Biol, 24, 531–540, https://doi.org/10.1111/j.1523-1739.2009.01340.x, 2010.
Whyte, K.: Too late for indigenous climate justice: Ecological and relational tipping points, Wiley Interdisciplinary Reviews: Climate Change, 11, e603, https://doi.org/10.1002/wcc.603, 2020.
Whyte, K.: Time as Kinship, in: The Cambridge Companion to Environmental Humanities, edited by: Cohen, J. and Foote, S., Cambridge University Press, Cambridge, 2021.
Wiedmann, T., Lenzen, M., Keyßer, L. T., and Steinberger, J. K.: Scientists' warning on affluence, Nature Communications, 11, 1–10, https://doi.org/10.1038/s41467-020-16941-y,

2020.
Willis, R.: Too Hot to Handle? The Democratic Challenge of Climate Change, Bristol University Press, Bristol, U.K., 2020.
Woodley, E., Barr, S., Stott, P., Thomet, P., Flint, S., Lovell, F., O'Malley, E., Plews, D., Rapley, C., Robbins, C., Pearce, R., and Sandover, R.: Climate Stories: enabling and sustaining arts interventions in climate science communication, Geosci. Commun., 5, 339–354, https://doi.org/10.5194/gc-5-339-2022, 2022.
Yusoff, K.: A Billion Black Anthropocenes or None, U of Minnesota Press, 157 pp., 2018.
Zhao, Q., Stephenson, F., Lundquist, C., Kaschner, K., Jayathilake, D., and Costello, M. J.: Where Marine Protected Areas would best represent 30% of ocean biodiversity, Biological Conservation, 244, 108536, https://doi.org/10.1016/j.biocon.2020.108536, 2020.
Zografos, C. and Robbins, P.: Green Sacrifice Zones, or Why a Green New Deal Cannot Ignore the Cost Shifts of Just Transitions, One Earth, 3, 543–546, https://doi.org/10.1016/j.oneear.2020.10.012, 2020.
Zucman, G.: Sanctions for Offshore Havens, Transparency at Home, New York Times, 7th April, 2016.
Zurba, M. and Bullock, R.: Bioenergy development and the implications for the social wellbeing of Indigenous peoples in Canada, Ambio, 49, 299–309, https://doi.org/10.1007/s13280-019-01166-1, 2020.