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Equity and justice should underpin the discourse on tipping points

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Abstract. Radical and quick transformations towards sustainability will be fundamental to achieving a more sustainable future. However, deliberate interventions to reconfigure systems will result in winners and losers, with the potential for greater or lesser equity and justice outcomes. Positive tipping points (PTPs) have been proposed as interventions in complex systems with the aim to (a) reduce the likelihood of negative Earth system tipping points and/or (b) increase the likelihood of achieving just social foundations. However, many narratives around PTPs often do not take into account the entire spectrum of impacts the proposed alternatives could have or still rely on narratives that maintain current unsustainable behaviours and marginalize many people (i.e. do not take "b" into account). One such example is the move from petrol-based to electric vehicles. An energy transition that remains based on natural resource inputs from the Global South must be unpacked with an equity and justice lens to understand the true cost of this transition. There are two arguments why a critical engagement with these and other similar proposals needs to be made. First, the idea of transitioning through a substitution (e.g. of fuel) while maintaining the system structure (e.g. of private vehicles) may not necessarily be conceived as the kind of radical transformation being called for by global scientific bodies like the Intergovernmental Panel on Climate Change (IPCC) and Intergovernmental Science-Policy Platform on Biodiversity and Ecosystem Services (IPBES). Second, and probably more importantly, the question of positive for whom, positive where, and positive how must be considered. In this paper, we unpack these narratives using a critical decolonial view from the south and outline their implications for the concept of tipping points.

1 Introduction

Earth system tipping points may lead to abrupt, irreversible, and dangerous impacts with serious implications for humanity (Armstrong McKay et al., 2022). Avoiding these thresholds, particularly addressing climate change and species extinction, requires transformative changes (Rockström et al., 2023). A tipping point, coming from a mathematical theory by Henri Poincaré on bifurcation to understand change in non-linear systems, is a point at which a system changes from one qualitative type of behaviour to another. The role of feedbacks, which is when change in part of a system, becomes self-perpetuating beyond some threshold, leading to substantial, widespread, often abrupt, and irreversible impacts we consider sufficient but not necessary conditions for tipping points to exist. We further argue that, from the mathematical point of view, it does not matter if the system is ecological, social, political, or cellular; the theory is still successful at achieving the explanatory power of a wide range of social and natural phenomena.

While tipping points in biophysical systems have been thoroughly investigated because, for example, Earth system tipping points pose serious implications for humanity (Lenton, 2011; Lenton et al., 2008; Armstrong McKay et al., 2022; Banerjee et al., 2022; Brook et al., 2013; Lenton et al., 2019), the concept of social tipping points is gaining traction (Milkoreit et al., 2018; Otto et al., 2020). However, it is important to note that social scientists have used tools from bifurcation theory to understand purely social phenomena such as poverty (in the 1950s), segregation (in the 1970s), the emergence of cooperation, or political polarization, to name a few examples. More recently, social tipping points have been discussed in the context of Earth system dynamics (Bentley et al., 2014), climate adaptation, and systemic risks but also with an acknowledgement that more research is needed (Juhola et al., 2022). References to "positive" tipping points, or PTPs, as critical interventions to avoid the looming threat of biophysical tipping points are also growing (Lenton et al., 2022a; Tàbara et al., 2018; Tàbara, 2023). In this issue, PTPs have been defined as interventions in complex systems with the aim to (a) reduce the likelihood of negative Earth system tipping points and/or (b) increase the likelihood of achieving just social foundations. But they are also defined as "emergent properties of systems that would allow the reaching of evolutionary-like transformative solutions to successfully tackle the present socio-climate quandary" (Tàbara et al., 2018, p. 121). Here, we argue that whether a tipping point is "positive" or "negative" depends on the perspective of the observer, and conflicts or disagreements are expected to emerge when multiple observers exist and lack consensus. As such, there can and should be a more rigorous discussion of these normative dynamics, which we aim to start to unpack from an equity and justice perspective.

PTPs can be seen as one type of transformative change, where non-linear social responses to the existential threats triggered by Earth system tipping points alter either the system structure, components, or feedbacks into more "desirable" states (Scheffer, 2009). The adoption of norms against indoor smoking or shifting value systems that allowed for the abolition of slavery are historical examples of positive tipping points in society (Nyborg et al., 2016). Shifts in behaviours needed to move away from current unsus-

tainable practices or overconsumption towards behaviours that will keep global society within a safe operating space are often framed as positive tipping (Lenton et al., 2023). PTPs can be imagined as an interplay of actors exercising their agency towards desired transformations, leveraging the multiple feedback processes necessary to propel and secure changes (Lenton et al., 2022b). These conceptualizations, however, often ignore the issue of who desired the changes or who can be negatively affected by PTPs.

2 Tipping points and just transformations

Radical and quick transformations towards sustainability will have winners and losers (Blythe et al., 2018) with implications for equity and justice, depending on who is affected and when, how, and where. For example, the wealthiest 1 %–4 % will radically need to change their consumption, behaviours, societal values, and beliefs to enable an equitable and sustainable future for nature and people (Hickel et al., 2022; Rammelt et al., 2023). This societal shift could be defined as a PTP but may not be seen as desirable for those whose consumption and production patterns have to change. Many "positive" tipping points still rely on narratives that maintain current unsustainable and unjust behaviours, as well as power structures. These narratives often marginalize many people, exploit places as mere commodities or stocks, and downplay the need for people in consuming regions to alter the system structure, components, or feedbacks. While the concept of PTPs has been useful in outlining what can be done in the global discourse of change, it has not engaged with or confronted existing imbalances in how the current global system is configured in terms of power and inequality (Leach et al., 2018; Hamann et al., 2018). For instance, the question of positive for whom, where, and at what cost has not been adequately considered when referring to positive tipping points. This is specifically relevant within the climate community, where sometimes all interventions that avoid a climate catastrophe are often framed as positive irrespective of potential consequences, feasibility, or trade-offs. It is within this framing that we offer this contribution, drawing on critiques from the regime shift and transformation communities that also grapple with the ethics of intervening in complex systems with non-linear dynamics.

Although some work has been done to identify the winners and losers of ecological regime shifts, it remains a critical gap (Biggs et al., 2018). A tipping point towards an energy, food, or other systemic transition in the Global North or amongst big consumers that remains based on natural resources exploitation in the Global South must be critiqued, not least because these systems are so fundamentally interconnected and interdependent across scales, but also because by reinforcing the status quo, they are unlikely to achieve the sustainability ambitions that are needed (Downing et al., 2021; Pereira et al., 2021). To research such telecouplings holistically, an environmental justice lens is needed (Boillat et al., 2020; Carmenta et al., 2023).

Many injustices are founded in historical legacies of marginalization reinforced in current geopolitical agendas and environmental policies. Ghosh (2022) traces the current planetary crisis, showing that the irreversible negative tipping points that we know we need to avoid are rooted in Western colonialism's violent exploitation of human life and the natural environment. Ghosh (2022) argues that the dynamics of climate change arise from the geopolitical order that was established by colonialism centuries ago and continues to play out and reinforce present-day inequities. This argument is supported by Hickel et al. (2021), who also extends the driver of our contemporary crises to colonialism but centres capitalism as the main perpetrator of the exploitation suffered by many people in places over the past 5 (or so) centuries. The available data on historical emissions are helpful in this regard (Jones et al., 2023). The colonial legacy not only impacts the climate crisis but is also intimately linked to the biodiversity crisis (Pörtner et al., 2021; Adam, 2014).

All life on Earth, not just people, are affected by this colonial discourse which impacts across regions unevenly. Environmental justice, as elaborated from Afro-Indigenous world-views in environmental humanities, involves the rights of all human and nonhuman communities to a healthy environment (Adamson et al., 2002), and the idea of "multispecies justice" refers to forms of justice that consider entanglements with the nonhuman worlds (Chao et al., 2022). Gupta et al. (2023) propose an integrated "Earth system justice framework" to understand how to reduce risks from crossing tipping points, which includes multiple dimensions of justice including procedural, recognitional, and distributive dimensions linked to intragenerational justice (the relationships between humans right now), intergenerational justice (relationships with people across generations), and interspecies justice (generally including the rights of nature and other species to co-existence on Earth). These diverse forms of justice seek to foreground the differential impacts that climate change and the solutions to negative tipping points might have, particularly, in already vulnerable populations.

In this paper, we expand on the argument for including equity and justice in the discussion on tipping points, emphasizing the need for acknowledging tensions and trade-offs and considering a Global South lens. In this way, we go beyond addressing the discussion based on regions or nations but rather imply a deterritorialized approach that challenges the structures and processes that generate global inequalities (Mahler, 2017). This requires switching the narrative away from "silver bullet solutions" and identifying what biophysical and social–ecological trade-offs we are willing to accept in order to prevent negative tipping points. Although win–win social tipping points may exist, everything comes down to asking why a tipping point is positive, for whom it is claimed to be positive, and whether it can really be positive if it maintains the current inequitable status quo or repeats the

passing of the burden of losses to disadvantaged groups or future generations but in different ways to the status quo. When the trade-offs occur between two or more social groups, some of whom are already vulnerable or marginalized, this discussion becomes even more pertinent, as it means we have the potential to either reduce, or increase, inequality. Taking justice considerations seriously also means that if a tipping point affects the wellbeing of future generations or other species, it may also not be ethical to call it positive. As such, in the same way that the transformation literature has started to refer to "just transformations" (Bennett et al., 2019), the tipping point community needs to centre equity and justice in their discussions too.

Below we explore examples and cases where delineating the positivity or negativity of tipping points becomes a political and ethical issue. In particular, we hope to contribute to a critical engagement with the concept of PTPs from a southern and BIPOC (black, indigenous, and people of colour) perspective in order to see where and how the concept of PTPs can be useful to further equity and justice and where it can be problematic by reinforcing ongoing structural dynamics of exclusion and marginalization (and therefore not be framed as positive). While PTPs generally refer to interventions in social systems, we use the term positive tipping point rather than social tipping point so as to be able to engage critically with the normative aspect of this framing.

3 Conceptual framing: a Global South perspective on tipping points

To situate these ethical challenges, we use three illustrative case studies: (1) the potential of the 30×30 protected area targets to (a) exacerbate ocean inequity and (b) increase human–wildlife conflict if not implemented inclusively; (2) the energy transition in developed economies and its implications for exacerbated extra-activist behaviour in mineral-rich countries of the south, as well as the deep ocean in both national and international waters; and (3) the discourse on carbon sequestration interventions to avoid climate tipping points in (a) the Amazon as a global public good and the exclusion of indigenous peoples and local communities (IPLCs) from governance and (b) nature-based solution (NbS) in open grassy ecosystems as solutions to the problems created by the rich in distant locations. These are not intended to be universal or systematic examples but are illustrative of the challenges that we as authors from the Global South encounter in our work and in which we have specific expertise.

Each case in this section references an Earth system tipping point related to either the biosphere or the climate, illustrates how predominant narratives are being framed to tackle existential threats, and unpacks the equity and equality implications that this intervention could have, with disproportionate negative impacts in the Global South. The implications in all of these cases are that some of the global recommendations for "staying within planetary boundaries", which involve reconfigurations of how society organizes itself (from where it gets energy to how it conserves biodiversity), lead to impacts not only on people but also on ecosystems in the Global South. Given that the wellbeing of people and places is tightly coupled (Hamann et al., 2018), these cases illustrate how cross-scale interactions between initiatives trying to address sustainability in one part of the world invariably rely on ecosystems in other regions (Downing et al., 2021), leading to potential injustices perpetrated against the people and nature in these "other" or "sacrificed" zones (Zografos and Robbins, 2020; Gonzalez, 2021; Scott and Smith, 2017; Saleth and Varov, 2023; Valenzuela-Fuentes et al., 2021). We then apply an equity lens from a Global South perspective to reframe alternative options that could have more equitable and just outcomes.

We acknowledge that the positive impact of such proposed interventions largely rely on how they are implemented without aggravating equity problems both within countries and between the Global South and the Global North. In doing so, we try to shift the narrative away from rehashing "solutions" to recognizing that transformation requires the current system to fade (creating losers) and be replaced (creating winners) (Hebinck et al., 2022). We conclude with a set of recommendations for practising more reflexive and ethical approaches to tipping points and sustainability that takes present and future inequities into account.

4 Case studies

4.1 The solution space of protected areas (PAs) and the importance of governance in potential PTPs for halting biodiversity loss

The integrity of the biosphere is in jeopardy, as humanity has overshot a safe and just Earth-supporting system (Rockström et al., 2023). The recently agreed Kunming–Montreal Global Biodiversity Framework (GBF) seeks, in Target 3, to protect 30 % of land and ocean by 2030 (30×30) through protected areas (PAs) and other effective area-based conservation measures (OECMs) (CBD, 2022). While appearing to be a positive intervention, the initiative risks perpetuating historical injustices, colonial legacies, and power imbalances by imposing Western conservation models on the Global South (Obura et al., 2021).

The goal of protecting 30 % of the Earth is a political ambition claimed to be supported by scientific evidence. However, it is neither an exact threshold nor an intrinsic biophysical property of terrestrial and ocean systems. While a lower boundary of PAs must exist to halt biodiversity loss, where that boundary is and how it should be allocated to maximize biodiversity outcomes vary in the scientific literature (O'Leary et al., 2016; Allan et al., 2022; Woodley et al., 2019; Dinerstein et al., 2020; Wilson, 2016; Rockström

et al., 2023; Claudet et al., 2008). Regardless of the exact figure and the more efficient configuration of PAs, the global concerted effort to protect 30 % of the planet could be seen to act as a governance threshold, which is a potential PTP towards transformative biodiversity governance and conservation (IPBES, 2019; O'Leary et al., 2016; Dinerstein et al., 2019). To address Target 3 from a PTP perspective, which has not yet been done, we argue that the discussion around the positiveness should place less emphasis on the percentage that needs to be protected but more emphasis on how to implement conservation to reduce biodiversity loss without aggravating inequities between the Global South and Global North (Sandbrook et al., 2023).

Below, we unpack two case studies of PAs foregrounding inclusivity and equity as a priority. We argue that the focus on PAs as the only way to safeguard critical life support systems is often short-sighted as a solution and instead offer alternatives from a Global South perspective.

4.1.1 Ocean equity and the role of marine protected areas (MPAs)

The novel GBF seeks to expand MPAs to up to 30 % of the ocean, making MPAs the main area-based institutional tool for halting and reversing marine biodiversity loss by 2030. By increasing the resilience of key marine ecosystems and their services (Mellin et al., 2016), MPAs are also part of the solution space to reduce the likelihood of Earth system tipping points occurring in tipping elements such as low-latitude coral reefs (Armstrong McKay et al., 2022). They further aim to contribute to human wellbeing and health in coastal areas through nature-related livelihood (e.g. ecotourism) or improved fisheries through spillover effects (Lester et al., 2009; Villasante et al., 2023).

However, measuring marine conservation success based solely on a coverage metric is problematic. Countries report that 8.2 % (about 30 million km^2) of the ocean is under some form of MPAs, but only about 6 % has actually been implemented on the ground, of which a smaller extent is managed actively (Grorud-Colvert et al., 2021). For instance, at the time of writing this article, only 2.9 % of the ocean is fully or highly protected from fishing impacts (https://mpatlas.org/, last access: 28 March 2024). A looming time horizon for urgently expanding MPAs up to 30 % of the ocean may discourage participatory and collaborative processes that take longer to achieve but often yield long-standing positive social outcomes (Grorud-Colvert et al., 2021; O'Leary et al., 2018). The race to achieve 30 % ocean protection may incentivize the establishment of large, centrally governed MPAs at the expense of relatively small but locally managed MPAs or fisheries management areas (De Santo, 2013; Smallhorn-West et al., 2020). Since large MPAs are often placed in former colonies (O'Leary et al., 2018), former colonial powers from the Global North are more likely to meet ocean conservation targets without compromising their own access to coastal areas.

While the ecological benefits of well-managed MPAs are relatively well documented (e.g. Lester et al., 2009; Grorud-Colvert et al., 2021; Sala and Giakoumi, 2018; Edgar et al., 2014), although not without controversy (Hilborn, 2018), the social outcomes resulting from MPA establishment are ambiguous (Ban et al., 2019). MPAs can compromise the social wellbeing of vulnerable communities and indigenous peoples via forced removals or displacement from traditional areas, loss or restriction of access rights, or threats to food security, health, and livelihood (Bennett and Dearden, 2014; Sowman and Sunde, 2018; Oracion et al., 2005). Together with other negative wellbeing outcomes related to identity and culture (Ban et al., 2019), research shows that a strong global focus on increasing MPAs towards conserving and halting marine biodiversity loss may fail, carefully and comprehensively, to address historical impacts and ongoing inequity issues experienced by coastal communities in the Global South. For instance, in South Africa, some MPAs led to the weakening of local governance rights and processes, loss of livelihood, culture, and tenure rights, and increasing conflict in already marginalized coastal communities (Sowman and Sunde, 2018). Similarly, Oracion et al. (2005) documented that in some MPAs in the Philippines, the tourism sector marginalized small-scale fishers in terms of access and control, jeopardizing fishing-dependent communities' economic and sociocultural viability. An illustrative example of how MPAs can perpetuate historical inequities via neocolonialism is the declaration of a large "no-take" MPA in the Chagos Archipelago by the British government. In doing so, the indigenous peoples from the Archipelago, who were expatriated by the British colonial power in the past, were deprived of any eventual resettlement, since fishing is their main livelihood and central to their culture (Dunne et al., 2014). To describe these and other types of injustices experienced by small-scale fishers and perpetuated by external, often powerful, actors on behalf of coastal protection Arias Schreiber et al. (2022) coined the term "eco-harassment".

To foster a more equitable and just discourse around the positiveness of MPAs, we argue for (1) acknowledging customary, traditional, and local practices when protecting coastal areas, which is articulated in Target 22 and the core principles (section C) of the GBF; (2) involving communities from the very beginning to enhance procedural justice, increasing the likelihood of equitable outcomes; (3) balancing both biodiversity and wellbeing outcomes of local communities and among stakeholders; (4) implementing a balanced portfolio of government and rights-holder-led protected and conserved areas within the 30×30 target (accommodated by the reference to "Other Effective Conservation Measures, or OECMs", within the target text), favouring those where small-scale actors and indigenous peoples are empowered; and (5) not getting carried away by the whirlwind of the looming deadline and quantitative metric while neglecting

meaningful participatory design, management, and governance processes. Overall, MPA expansion must be part of a broader and more diverse governance portfolio to manage our oceans sustainably and equitably both in the present and in the future (O'Leary et al., 2016).

A potentially impactful alternative for promoting ocean conservation without overburdening coastal communities would be closing the high seas to fishing. Fishing on the high seas is mostly possible because of harmful public subsidies yet only provides jobs and significant incomes to relatively few, mainly in the Global North (McCauley et al., 2018). This intervention could enable a much more equitable share of the ocean's bounty, as the majority of those fishing in the high seas are high-income nations (Sumaila et al., 2015). Closing the high seas could benefit biodiversity while being catch- and global-food-security neutral (Sumaila et al., 2015; Schiller et al., 2018). Furthermore, inequality in the distribution of fishery benefits among the world's maritime countries could be reduced by 50 %, contributing to resource sustainability and wellbeing in some of the poorest and most fish-dependent countries worldwide (Teh et al., 2017). Yet, as a potential PTP towards a healthier ocean, this intervention faces barriers in gaining traction outside academia and advocacy groups, as the current winners or keystone actors (see Österblom et al., 2015) like the fleets of some wealthier nations would become the losers (White and Costello, 2014).

4.1.2 Human–wildlife conflict, militarization, and conservation in southern Africa

Africa faces rapid biodiversity loss due to habitat loss, poaching, deforestation, climate change, and human–wildlife conflict (HWC) (Archer et al., 2020). How human–wildlife conflict such as crop raiding, livestock predation, and even attacks on humans by wildlife have been addressed further exacerbate inequality in marginalized communities, with a substantial negative impact on both livelihood and wildlife conservation (Nyirenda and Tembo, 2016; Gross et al., 2021; Song, 2023). Such efforts have largely been guided by a model of conservation rooted in colonial legacies that prioritizes tourists' privileges and perspectives of external conservation organizations to the detriment of local communities' needs. This has created a sense of "us versus them" among the local authorities and the people who coexist with wildlife (Mutanga et al., 2021), aggravating social injustices and violence through forced evictions of marginalized populations (Koot and Büscher, 2019).

Implementing the 30×30 as a "socially desirable" target within current conservation frameworks and mindsets may worsen the ongoing exploitation of marginalized groups if socially just conservation practices that account for the needs of the local communities are not considered. For instance, to mitigate future biodiversity loss, conservation activities in Zimbabwe and across southern Africa have become more militarized (Duffy, 2014; Duffy et al., 2019), leading to a "green militarization" in the name of conservation and anti-poaching efforts (Lunstrum, 2014) within a broader shift towards "green violence" (Mushonga, 2021). The intensity of this militarization is often more pronounced due to factors such as colonial legacies, socioeconomic inequality, and political instability in Africa and the Global South (Duffy et al., 2015; Pennaz et al., 2018; Büscher and Fletcher, 2018). The creation and expansion of PAs often involve the demarcation of borders and the exclusion of local communities, who may have lived and depended on these areas for generations. This can have severely negative impacts on the populations that live alongside wildlife, as well as on the wildlife itself, as this exclusion can lead to conflicts between conservationists and local communities, who may feel that they are being deprived of their land and livelihood (Mushonga and Matose, 2020). The militarization of conservation efforts often relies on reactive responses to HWC, such as killing problematic animals, rather than addressing the root causes of the conflict, which can escalate conflict and lead to a cycle of retaliation (Ramutsindela et al., 2022). However, it has been shown that militarized conservation efforts, such as the use of armed guards, are not effective in reducing poaching or protecting endangered species (Lunstrum, 2015). When conservation is framed as a security issue, it legitimizes violence, overlooking the wider socioeconomic and political contexts and therefore undermining efforts to address the root causes of environmental degradation, HWC, and unsustainable resource use (Büscher and Ramutsindela, 2016). While the militarization of conservation efforts may provide short-term benefits, it may not be effective in the long term and may have negative impacts on local communities. Implementing the 30×30 target in this context, without a much wider reconfiguration of governance and power, is likely to have negative impacts on biodiversity conservation and livelihoods in the Global South.

To address the equity and justice issues in the 30×30 target, a decolonized model of conservation is needed. This model should (1) address the underlying causes of environmental problems, such as unsustainable production and consumption patterns, rather than just protecting ecosystems and species; (2) involve meaningful participation of local communities in decision-making and implementation, fostering accountability, transparency, and empowerment, while also respecting traditional knowledge; (3) recognize the customary rights and interests of IPLCs over land and resources and acknowledges that conservation and development are not mutually exclusive; and (4) attempt to jointly develop solutions that are advantageous to people and the environment (Büscher and Fletcher, 2019, 2020; Massarella et al., 2022; Mavhura and Mushure, 2019; Obura et al., 2021, 2023). These benefits are captured in the concept of convivial conservation, which aims to achieve a just and equitable conservation system with an equal benefit distribution (Büscher and Fletcher, 2019). However, while the convivial conservation approach may be considered a radical and plausible al-

ternative, its implementation in the Global South will remain challenging in the face of the existing conservation problems without a complementary social–ecological justice approach to incorporate the rights and responsibilities of different conservation stakeholders from the perspective of procedural, recognition, distributive, and environmental justice (Kiwango and Mabele, 2022). Addressing these core challenges should be a key focus before any conservation intervention is initiated.

4.2 Not-so-positive PTPs: the battery industry and extractivism in the South for the benefit of the North

Addressing climate change tipping points has become an existential crisis facing the planet that will only be addressed through reconfiguring global energy and transport systems away from fossil fuels (IPCC, 2023). Greater uptake of renewable energy, together with storage improvements, are part of the systemic transition to net-zero energy systems that will reduce greenhouse gas (GHG) emissions (IPCC, 2023). Electric vehicles (EVs) have a "large potential to reduce land-based transport emissions, on a life-cycle basis", provided they are charged by a low-GHG-emission electricity source (IPCC, 2023, C3.3). This will not be achieved without maximizing battery production from cleaner energy and an efficient supply chain of minerals (ECOS et al., 2023).

Rapid growth in the EV market has therefore been presented as an imperative to meet global targets for reducing GHG emissions (Harper et al., 2019; Lam and Mercure, 2022). This could arise within the next decade in the leading car markets of the US, EU, China, Japan, and South Korea, which could "induce" an EV transition in the rest of the world, bringing self-reinforcing benefits in terms of further cost reduction and product diversity (Lam and Mercure, 2022; Azevedo et al., 2018). This has been proposed as a potential PTP (Systemiq, 2023). The reorganization and retooling of production lines to manufacture EVs, which signal profit expectations over at least a decade, can be seen as irreversible within the climate policy timescale (Lam and Mercure, 2022). According to the Paris Declaration on Electro-Mobility and Climate Change & Call to Action, the goal is to have more than 100 million EVs and 400 million two- and three-wheelers by 2030 (PD 2015 in Ajanovic and Haas, 2018).

However, while EVs may have the potential to reduce GHG emissions, their batteries currently rely on minerals such as lithium, cobalt, and nickel, the extraction of which have considerable and frequently devastating social and environmental impacts in the Global South (Ajanovic and Haas, 2018; Harper et al., 2019). Global demand for lithium ion (Li-ion) batteries is expected to soar over the next decade, from a demand of around 700 GWh in 2022 to around 4700 GWh in 2030 (Azevedo et al., 2018), with an estimated 1500 % rise in global demand of lithium by 2050 (Canelas and Carvalho, 2023). The lithium, cobalt, and nickel currently required to manufacture Li-ion batteries are mined under highly oligopolistic and even monopolistic conditions in Australia, China, and Chile for lithium (85 % of global production) and the Democratic Republic of the Congo (DRC) for cobalt (70 % of global production) (Azevedo et al., 2018; Campbell, 2020). Despite being framed under "green transition" discourses, these corporatized transitions tend to follow a mineral-intensive pathway that increases demand for critical raw materials and expands extractivism to new commodities and marginal territories, with the social–ecological impacts of mining largely being overlooked, despite driving significant environmental conflicts (Canelas and Carvalho, 2023).

In recent decades, soaring demand has intensified cobalt mining in the Democratic Republic of Congo (DRC) (Calvão et al., 2021). The pressure to meet increasing demand has reinforced integration of wageless artisanal cobalt miners into the corporate chain through the so-called formalization of informal mines, where the knowledge and acceptance of consequences becomes hidden within bureaucracy and structures (Calvão et al., 2021). The emergent exploitative regimes are characterized by disregard for the occupational health and labour security of artisanal miners, health risks, and environmental degradation in the new mining communities (Banza Lubaba Nkulu et al., 2018). As demand continues to rise, the formalization strategies of small-scale miners in the DRC, imposed by large corporations, will deepen insecurities and vulnerabilities of local communities (Calvão et al., 2021), reinforcing and locking artisanal miners in a dependent and complex chain.

In Chile's Salar de Atacama, a major centre of lithium production, 65 % of the region's water is consumed by mining activities, affecting farmers who must then import water or migrate, as they have been forced to sell their water rights on the desert rivers to mining industries. The demands on water from the processing of lithium are substantial, with a tonne of lithium requiring 1900 t of water (Katwala, 2018). In the Andes, local lithium, salt flats, and solar exploitation could perpetuate green-grabbing practices developed by mining and energy stakeholders that reinforce and even extend pre-existing processes of commodification of nature and accumulation of resources for use outside of local contexts (Forget and Bos, 2022). Even in the Global North, there are cases of marginalization. In northern Portugal, local communities are mobilizing against Li mining projects that threaten to turn their regions into "green sacrifice zones," driving significant environmental conflicts and grassroots resistance to what they term infrastructural colonization (Canelas and Carvalho, 2023). Sacrifice zones are defined as "extractive areas" characterized by the advancement of coordinated forms of capitalism that perceive those territories and the communities inhabiting them as extractable and commodifiable (Gómez-Barris, 2017). Green sacrifice zones are spaces or ecologies, places, and populations that will be severely affected by the sourcing, transportation, installation, and operation of solu-

tions for powering low-carbon transitions, as well as end-of-life treatment of related material waste (Zografos and Robbins, 2020, p. 543).

Increasing demand for these rare Earth minerals is now expanding extractive focus to the deep sea, both within and beyond national jurisdictions, where minerals such as cobalt and nickel occur. Within national jurisdictions, interest has been largely in the Global South, including the Cook Islands, Namibia, and Papua New Guinea, whereas in areas beyond national jurisdictions, 30 exploration contracts have been granted by the International Seabed Authority (ISA) totalling over 1 million km^2 (https://www.isa.org.jm/exploration-contracts/exploration-areas/ (last access: 28 March 2024; Levin et al., 2020).

Although no deep-sea mining has as yet occurred, there are major sustainability and equity concerns (Jaeckel et al., 2023; Levin et al., 2020; Wilde et al., 2023). These include intense and irreversible damage to some of the planet's most pristine and poorly understood habitats across enormous scales, which could have knock-on effects on ecosystem services such as climate resilience, fisheries production, and marine genetic resources, as well as critically important cultural connections between humans and the deep ocean (Amon et al., 2022b; Jaeckel et al., 2023; Le et al., 2017; Tilot et al., 2021). Negative social and economic effects are also possible from this unproven industry, particularly for developing states; e.g. Papua New Guinea saw losses of over USD 100 million when a partnership with a Global North deep-sea mining entity collapsed (Jaeckel et al., 2023). These risks are compounded by a lack of science to guide effective decision-making and management (Amon et al., 2022a).

In areas beyond national jurisdictions, equity concerns are exacerbated by the minerals as the "common heritage of [hu]mankind" narrative (United Nations, 1982). According to this narrative, mineral resources are supposed to be "vested in [hu]mankind as a whole" and should be managed to ensure that any mining benefits as many people as possible, including future generations. However, there is not yet a financial mechanism to accomplish this and little clarity around who benefits and who carries the burden of environmental, economic, and social risk. Diverse mechanisms have been devised to ensure that developing states are able to participate in deep-sea mining and receive an equitable share of the benefits, but most of these measures are yet to be implemented. The recent trend of partnerships between private deep-sea mining companies and developing states might also jeopardize the original objectives (Willaert, 2022). There are no governance frameworks, no robust and inclusive engagement of all those with a stake, and no transparent decision-making processes (Jaeckel et al., 2023; Morgera and Lily, 2022; Wilde et al., 2023). Furthermore, and ultimately, the reliance on these minerals maintains relationships whereby the lands and ocean in the south and a global commons (international waters) serve only as inputs to maintain lifestyles in the north, with potentially profound geopolitical and social implications (e.g. Carrasco and Madariaga, 2022; Kingsbury, 2022).

While there are many sound suggestions for improving the conditions for specific mining sites and industries (Mancini et al., 2021; Deberdt, 2021), these suggestions do not address the elephant in the room: the continued expectation of the convenience of private passenger transport in the developed world. Instead of looking at niche innovations like EVs as transition pathways to alternative mobility structures, without unpacking the equity and justice implications of where these materials come from or who benefits (see Geels, 2018), perhaps a more transformative approach that limits personal vehicles in favour of large-scale public transport might be a more equitable, just, and even profitable solution (Gössling, 2020; Riofrancos et al., 2023). This would require a change in mindset and lifestyle for those responsible for the most consumption, while benefiting more people, with improved access to transport and less burden on raw materials. Furthermore, the fact that some scientists advance the EV transition as a PTP without considering the systemic implications of increased mineral extraction is startling, if not contradictory (e.g. Lam and Mercure, 2022; U.S. Department of Energy, 2020). We assert that this positioning is symptomatic of a continued malaise, an intentional disregard of the material base of existence and wellbeing by the rich.

4.3 Addressing negative Earth system tipping points

Climate change due to rising greenhouse gas emissions has generated the push for a global commitment to achieve net-zero emissions by the middle of this century (IPCC, 2023). Achieving this requires a balance between reducing emission sources and enhancing greenhouse gas sinks. However, we argue that the role of the sinks and, in particular, critical ecosystems that are approaching biophysical tipping points cannot be understood only as global public goods of carbon sequestration.

4.3.1 Equitable solutions in the Amazon basin

The Amazon Rainforest is approaching a biophysical tipping point, which, if crossed, would trigger irreversible phenomena with planetary consequences (Boulton et al., 2022; Lapola et al., 2023). The destruction of the Amazon Rainforest leads to biodiversity and cultural loss, as well as reduced carbon storage affecting the global climate. Furthermore, self-reinforcing interactions between deforestation, climate change, and fire are pushing the Amazon biome towards a tipping point with large quantifiable economic losses (USD 256.6 billion in cumulative gross domestic product by 2050) and environmental costs (Banerjee et al., 2022; Lapola et al., 2018). In a similar mode to the 30×30 target, a dominant proposal to avoid the Amazon Rainforest reaching a tipping point is to classify it as a PA (Walker et al., 2009). A strong narrative underpinning such solutions is that,

similar to the global commons argument about the deep seas made in Sect. 4.2, tropical forest basins like the Amazon and the Congo are considered global public goods and need to be protected for the good of the planet, with little consideration or reparations for the people who have lived within these regions for generations, maintaining these ecosystems, and what their aspirations might be and how their autonomy might be affected (Navrud and Strand, 2013; Neves et al., 2021; Nobre et al., 2016). While avoiding a biophysical tipping point in the Amazon is imperative, we argue that there is a need to address the drivers of deforestation and degradation at the global level rather than simply putting the burden of protection on national and local actors.

As such, we offer three alternative mechanisms to reframe how to avoid a tipping point in the Amazon. The first emphasizes the need for self-determination and agency for local communities to protect their own territories, disbanding this "global public good" narrative, by recognizing the rights of nature in connection to stewardship forms and ancestral cosmologies of the Afro-Indigenous inhabitants of the Amazon. Using an equity and justice lens entails accepting the forms of forest stewardship that the indigenous peoples inhabiting the Amazon have been practising ancestrally, such as recognizing that the Amazonian Floresta is a vibrant, animated being in ancestral cosmology and a living forest, with its own rights, as a subject of law (Biemann and Tavares, 2014). A legal mechanism to enshrine this is the Rights of Nature (RoN) approach, whereby nature has a legal standing in a court of law, with its own rights to be protected. This is institutionalized in the Ecuadorian Constitution, although not without challenges (Tanasescu, 2013; Akchurin, 2015; Kotzé and Calzadilla, 2017; Berros, 2021). The potential of a RoN approach, rather than just setting aside a PA that may not in any case work, is becoming an increasingly recognized option that should be taken into consideration (Cano Pecharroman, 2018; Harden-Davies et al., 2020; Putzer et al., 2022). In particular, it offers an interesting option that transcends European modernity and allows for indigenous world-views to take precedent (Knauß, 2018).

The second mechanism looks to address the global drivers that are moving the Amazon towards a tipping point by asking whose interests and what actors are actually driving the degradation of the Amazon. By analysing the wave of forest fires that had been affecting the Amazon in 2019, Raftopoulos and Morley (2020) reflect on the claims of "ecocide" made by large sectors of civil society in the human rights areas as a legal term that could have a positive impact in stopping the destruction of the Amazon:

> In recognition of the limitations of current international law to protect the environment, an increasing number of academics, activists and legal scholars have campaigned for the criminalisation of ecocide and the need to recognize human-caused environmental damage and degradation (whether committed during or outside of war-time), as a crime of strict liability. (Raftopoulos and Morley, 2020, p. 10)

Including ecocide as a crime could constitute an effective solution that directly addresses the ecological crimes driving the Amazon tipping point. Mega-corporations, governments, and powerful groups like cattle raisers in Brazil (Piotrowski, 2019) should be held accountable if they destroy, damage, or contaminate the entangled ecologies of the Amazon rainforest. In fact, for the first time, lawsuits have been applied to illegal deforestation by land grabbers that increased carbon emissions (Bragança et al., 2021).

Finally, the third mechanism lies in the potential for leveraging a PTP in the global financial system that moves money away from nature-eroding behaviour towards nature-supporting investments. Reconfiguring financial flows to the Amazon basin could have transformative and equitable impact in addressing the threats driving Amazon degradation. For example, targeting tax havens could go a long way towards holding companies to account or ensuring their financial liabilities are transparent. Galaz et al. (2018) showed that between October 2000 and August 2011, 68 % of all investigated foreign capital to nine focal companies in the soy and beef sectors in the Brazilian Amazon was transferred through one, or several, known tax havens, which represent as much as 90 %–100 % of foreign capital for some companies investigated. As a key source of capital for companies, cutting them off from these sources would make it easier to hold them to account for ecocide crimes in the countries within which they operate.

From a Global South lens, looking at avoiding the Amazon tipping point through an equity and justice lens necessarily implies listening to these claims of civil society and local inhabitants to link ecological destruction with social–ecological injustice (Pinho, 2016). Using the power of the global legal and financial systems to produce a real change in the politics underlying the destruction of the Amazon could be potential PTPs. An ecocide law in the International Court of Justice has the potential to avoid the Amazon reaching a tipping point, not because it will not stop mining or deforestation projects per se, or because it will reverse the damage to the forest already inflicted, but because it will be a means to enforce responsible practices and hold powerful actors accountable for decisions that cause, or risk causing, mass environmental damage or destruction (Bragança et al., 2021; Roupé and Ragnarsdóttir, 2022). As climate change reveals the profound inequalities between social classes and countries, stopping the Amazon crossing an irreversible threshold necessarily involves centring justice in responding to climate change and biodiversity loss (IPCC, 2018, 2022; Banerjee et al., 2022; Bastos Lima et al., 2021; Lapola et al., 2018). Taking that perspective into action requires attending to the local inhabitants' rights through legislation that recognizes the links between ecocide and ethnocide in the pan-Amazonian

Floresta rather than perpetuating a model whereby they remain the losers in the global system.

4.3.2 Nature-based solutions in African grassy ecosystems

Land-based carbon sequestration has become a popular strategy to offset emissions (Allen et al., 2022), particularly through the concept of nature-based solutions (NbSs), which has become a dominant discourse being incorporated into multiple agreements (European Commission, 2023). NbS is an umbrella term linking approaches that involve enhancing and working with nature to solve societal challenges through protecting and managing natural and semi-natural ecosystems. It is underpinned by the idea that healthy ecosystems provide valuable ecosystem services that support human wellbeing, including carbon storage, flood control, and clean air and water (Seddon, 2022; Sowińska-Świerkosz and García, 2022). Yet, in practice, NbS actions often reflect an expanding interest in carbon offsets, which has led to a disproportionate focus on climate change mitigation over adaptation and restoration (Seddon et al., 2020). Certainly, NbS can provide immediate opportunities to reduce CO_2 emissions and, if applied with care, can also offer significant co-benefits (Girardin et al., 2021). Yet, evidence suggests that (1) carbon offset potentials of NbS-based actions are often overestimated, and (2) the assumed ecological co-benefits of increasing carbon stocks are often incorrect and could result in biodiversity losses and degradation rather than restoration (Bond et al., 2019; Seddon et al., 2020). While best practices for equitable and just NbSs have been discussed in the context of water (Bremer et al., 2021), the potential for non-linear dynamics of NbS interventions in carbon markets have, to our knowledge, not been unpacked.

The emphasis on carbon offsetting as a key intervention to avoid climate tipping points has led to proposals that aim to enhance aboveground carbon across numerous biomes in the Global South. This comes in many forms from natural forest regeneration, reforestation, tree planting, afforestation, fire abatement, and a switch to early burning in tropical grassy ecosystems (Zomer et al., 2008; Russell-Smith et al., 2021; Veldman et al., 2019). However, these options consider only one metric, carbon as stored in trees, to the detriment of other metrics (biodiversity, livelihood, health, and culture) and biophysical processes like fire regimes. This framing further perpetuates a simple model of allowing people to continue their lifestyles in one place as long as they are rich enough to pay people somewhere else to take the problem away, while not recognizing the full costs to the communities of committing extensive land resources to maximizing aboveground carbon at the expense of other forms of use that also provide ecological benefits (Dooley et al., 2022). Such NbS risk not only exacerbating current paradigms of where interventions must go but may not even meet their initial mitigation targets. For instance, Bastin et al. (2019) suggested tree planting in non-forested landscapes, including extensive areas of Africa's grassy and open ecosystems, could deliver 205 Gt of carbon sequestration. However, this has been shown to overestimate the sequestration potential by more than a factor of 5 (Veldman et al., 2019). These proposals fail to account for risks of afforesting seasonal systems that are prone to drought and fire and where aboveground carbon is therefore not a permanent carbon sink.

Via the Bonn Challenge, through the African Forest Landscape Restoration Initiative (AFR100) (https://afr100.org/, last access: 28 March 2024), Africa has been identified as providing major opportunities for planting at least 1 million km^2 of trees by 2030, with the aim of restoring ecosystems and sequestering carbon (Bond et al., 2019). Yet many of these regions are ancient grassy ecosystems that have co-evolved with fire and herbivory and have a long history of human utilization, resulting in plant and animal assemblages that are functionally distinct from forest species and are not "degraded forests" (Bastin et al., 2018; Droissart et al., 2018; Torello-Raventos et al., 2013; Veldman et al., 2019). The persistent misclassification of ancient grassy ecosystems can be traced back to the colonial era when Western exploration shaped the field of ecology as a global discipline. During this time, grassy ecosystems were mistakenly perceived as early successional or deforested landscapes (Fairhead and Leach, 1996) resulting in an extensive and profound misreading of the landscape (Pausas and Bond, 2019). Tree planting in these cases presents multiple social, economic, and environmental trade-offs, including historical, traditional, and indigenous livelihood of local people, disruption of ecological systems and the services they provide, especially through the introduction of non-native trees, and destruction of rich biodiversity over much of the targeted area in Africa (Martin et al., 2021).

Rather than avoiding a climate tipping point through NbS, such tree-planting interventions in the name of carbon offsets and mitigation could potentially result in another negative biophysical tipping point – that of ancient grasslands shifting into managed monocultures of forests. The increase in tree cover above certain thresholds leads to a complete loss of grazing potential (Scholes, 2003; Anadón et al., 2014) and fundamental changes in biodiversity (Andersen and Steidl, 2019; Blaum et al., 2009) and ecosystem processes, like fire switching from lower-intensity grass field fires to high-intensity crown fires (Bowman et al., 2020). Additionally, evidence suggests that when trees replace grasses in high-rainfall ecosystems it actually results in a reduction in soil carbon (Mureva et al., 2018) and reduces streamflow (Nänni, 1970; Zhao et al., 2012).

Given these concerns, NbS interventions should be viewed with considerable caution before implementation. For African ecosystems, a one-size-fits-all approach and the disproportionate global focus on "carbon", even if well-meaning, places considerable risk on ecosystems and dismisses the paired social–ecological contextualization and

livelihood interdependencies of African ecosystems. The current focus of NbS actions on carbon offsets is likely to exacerbate the degradation of Africa's open and grassy ecosystems, perpetuating a system of transforming African ecosystems to meet the carbon sequestration goals of those financing such interventions, while ignoring equity and justice considerations in Africa and other open ecosystems like the Cerrado. Such an approach perpetuates a legacy of inequity and injustice to the people living in and dependent on these ecosystems. Thus, while NbS actions are promoted as "win–win" solutions, their focus on carbon makes them a poor fit for Africa's open and grassy ecosystems. This same power dynamic also plays out even in forest ecosystems such as the Amazon, where IPLCs become locked into accessing finance from carbon markets that perpetuates unequal burdens (Lapola et al., 2023). These colonial carbon sequestration dynamics, for example, where ecosystems like the Amazon or savannas are valued only as carbon sinks rather than as plural biocultural landscapes, need to be shifted for a more equitable solution space to address climate tipping points.

We argue that there are many more appropriate interventions to consider than those currently prioritized and glamorized by the global community that will result in more robust co-benefits for both biodiversity and climate change adaptation, while still supporting mitigation efforts. For NbSs to work, they must address issues of ecosystem conversion and maintain and/or re-introduce traditional fire and grazing practices that sustain open canopies and support a rich herbaceous ground layer upon which a variety of life forms depend (Smit et al., 2010; Bond and Parr, 2010; Maravalhas and Vasconcelos, 2014). Interventions must be context-specific (e.g. biome-specific), explicitly designed to increase synergies and reduce trade-offs. This includes the protection, appropriate management, and restoration of ecosystems. It is critically important to address the historical misclassification of African ecosystems, in particular grassy ecosystems and the misrepresentation of utilized ecosystems as "degraded" by Global North standards. In ecosystems that are utilized for livelihoods but have reduced woody cover as a result (e.g. wood fuel harvesting and charcoal production), appropriate NbSs are vastly different to those that would be appropriate for a degraded forest system but can still provide climate mitigation and biodiversity co-benefits. Global datasets that specifically focus on rangelands and grassland ecosystems, i.e. the Rangelands ATLAS project (http://www.rangelandsdata.org/atlas/, last access: 28 March 2024), are important steps in the right direction, but such "reclassification" has been slow to gain the required traction in the policy arena and should be a priority before any finance flows for NbSs take place.

5 Discussion: reframing "solutions" by flipping the colonial paradigm to move towards plural pathways

We argue that it is necessary to provide a more nuanced understanding of what addressing tipping points might look like in practice, who gets to define, fund, and drive PTPs, who is supposed to implement them, where they take place, who is expected to benefit, and who is expected to lose. These questions are not trivial, since the voices of minorities, historically colonized peoples, or future generations can be challenging to access, let alone include. Here, we situate some of the common themes emerging from the case studies and expand on what this means from a tipping point perspective.

5.1 Giving governance power back: highlighting a perspective from the majority world

PTPs can perpetuate climate colonialism if the blind spots of winners and losers are not addressed. Even well-intentioned policies, such as the EU's new Green Deal that aims to transition energy systems away from fossil fuels while avoiding transferring the costs to workers, have the potential to put severe pressure on lands held by indigenous and marginalized communities and reshape their ecologies into green sacrifice zones by reproducing a form of climate colonialism in the name of a just transition (Zografos and Robbins, 2020; Canelas and Carvalho, 2023). 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 and Robbins, 2020, p. 543). As shown above, even sectors like conservation could fall into this trap. The agenda underpinning the 30×30 target runs this risk of identifying hotspots for biodiversity investments – thereby inadvertently pushing a narrative whereby these hotspots become sacrifice zones that exclude local people from their lands or increase human wildlife conflict. This is particularly important, as it highlights the unintended consequences or blind spots of positive tipping points, which are largely well-intentioned deliberate interventions. Sacrifice zones are carefully chosen within a colonial paradigm that marks out regions of high biodiversity to reduce them to resources for conversion (Gómez-Barris, 2017). This extractive view from corporations and governments can meet resistance in the ways in which the local humans and nonhumans that inhabit those territories perceive life as entangled, where the destruction of one parcel affects the rest of the entities and breaks the spiritual heritage in a region (Gómez-Barris, 2017). The violence that capitalism inflicts on places designated as sacrifice zones can be immediate, but it can also be slow and imperceptible. Such "slow violence" can happen slowly in marginalized communities under a long period of time and be almost imperceptible.

tible (Nixon, 2013, p. 6). Engaging with the existing justice literature is necessary if PTPs are to foreground equity and justice and may even require a new language in terms of how PTPs are described.

A language that acknowledges the need for dismantling the current global system based on extraction, expropriation, and expulsion that is driving converging social–ecological crises and institutionalized inequality is required (Escobar, 2021). The concept of the Anthropocene – the period in which humans have become the dominant force of change on the planet – has been criticized because it focuses on a singular notion of humankind and does not acknowledge the differential responsibilities and impacts between the world's richest and poorest (Balcarce, 2021; Habersang, 2022; Cunha, 2015; Arora and Stirling, 2016). Some alternative framings include the Plantationocence, referencing the histories of colonialism and race in the development of plantations (Barua, 2023), and, linked to this, the Eurocene, after drivers of change emerging largely from Europe (Grove, 2017; Juárez, 2021); the Capitalocene, referencing capital's role in the planetary crisis (Moore, 2017); the Plastocene, as plastic is now in the sedimentary record (Skinner, 2019); a feminist critique referring to the importance of gender in the Manocene (Ally and Boria, 2023, p. 279); and then the Chluthlucene, as coined by Haraway (2015, 2016), that talks to the need for messier multi-species assemblages in this new epoch. Indigenous and feminist movements from Chile and Argentina have proposed the term "terricide" (Buitrago Arévalo, 2022; Millán and Rosemberg, 2021) as a complement to the idea of the Anthropocene. Terricide, instead, names the layers of violence and inequity lived by indigenous and other marginalized groups when corporations and governments destroy the material ecosystems and spiritual sacred realms of the web of life for profit (Millán and Rosemberg, 2021). As it involves a crime, it demands justice and accountability for the designation, exploitation, and destruction of life in these so-called sacrifice zones. This connects to the legal solutions offered from a Global South perspective in the case studies.

5.2 Dismantling debt and situating sustainability for surfacing burdens and benefits

Similarly, discussions of tipping points need to be aware of the technologies of governance, such as race-making and the processes for labelling countries as indebted or "least developed" (LDCs as per the United Nations' definition), that enable access to and appropriation of stocks for capitalist resource conversion (Leifsen et al., 2017). For example, the reason companies are willing to invest in carbon offsets is because it is cheaper to pay other countries to store carbon than it is to reduce their own emissions. This equation only works when there are disenfranchised countries with low gross domestic product (GDP) and high debt willing to sell their carbon-fixing abilities at low prices; i.e. the entire carbon-offset and biodiversity-offset market depends on global inequality to function (Dempsey et al., 2022).

If the questions we ask are aimed at transformation, these cannot neglect how neo-capital paradigms contribute to inequalities and environmental degradation (Sze, 2018). Furthermore, the financialization of loss arising from crossing biophysical tipping points reinforces these dynamics by trying to attribute a monetary value to existential loss. Most accounts of lived experiences with harm are from rich, not poor, countries, and so the epistemological injustices underrepresent the intangible harm among the poorest people (Tschakert et al., 2019). There is an important and ethical role of research at the science–policy interface that needs to bring these aspects to light, giving policy-makers an urgent wake-up call. The tipping point discourse could play a significant role in highlighting these dynamics at the international level if sufficiently nuanced and tailored to these important critiques.

5.3 Foregrounding ethics in science

The role of science in advocating for certain changes or identifying places where changes can or should occur has ethical implications. Ocean conservation planning exercises place a significant fraction of priority areas (e.g. Coral Triangle, southwest Indian Ocean, and Caribbean Sea) within Global South countries (e.g. French Polynesia, The Bahamas, the Philippines, Colombia, and Indonesia) (Jenkins and Van Houtan, 2016; Selig et al., 2014; Zhao et al., 2020). While important, these scientific exercises hardly discuss the ethical and governance considerations of their results, and local socioeconomic needs are either conceptualized as an extra layer in maps (in competition with conservation) or something to be addressed by others in future analyses or by decision-makers at local levels. A related ethical debate on how to identify global priority areas for ecological restoration was sparked by Fleischman et al. (2022) in response to a paper by Strassburg et al. (2022). As reviewed above, defining these priority areas could be seen as a potential PTP for biodiversity conservation, aiming to fulfil the GBF 30×30 target. The critique, however, highlighted the importance of understanding local context, and in particular the viewpoints and values of the peoples in these areas, before designating these areas as appropriate for conservation, especially as

> most of the priority areas fell in the Global South, where there is a long history of holding rural and indigenous peoples responsible for environmental degradation, while misinterpreting traditional ecosystem management as 'unsustainable' and ignoring the political and social processes that make people vulnerable … (and where) previous efforts to compensate people displaced by conservation projects have often failed and are associated with

> large-scale human-rights violations. (Fleischman et al., 2022, p. E5)

In their response, Strassburg et al. (2022) acknowledge this point but argue that "global spatial-prioritization analyses can adequately incorporate only scale-independent variables, such as those for which the values are less affected by finer scale contexts" and that they never intended for their maps to be used as final products for on-the-ground implementation, putting the onus back on fine-scale participatory work to sort out all the complex, messy details.

This is not a singular incident within the ecological sciences. Another study quantifying the potential to mitigate climate change by planting trees (Bastin et al., 2018) was challenged for producing global maps of "forest restoration potential" that were at odds with the local ecology and social needs. Bastin et al. (2018) responded by saying "our analysis does not ever address whether any actions 'should' or 'should not' take place, our analysis simply estimated the biophysical limits of global forest growth by highlighting where trees 'can exist"'. This response leaves the onus on local authorities to decide whether it is a good idea, with the authors effectively washing their hands of the ethical consequences of producing a map that can be used by some for financial gain at the cost of others. Tear et al. (2021) similarly quantified the money that could be made by changing fire regimes in all conservation areas in Africa and stated that this would have only positive consequences. When challenged on this, again they replied that it was up to the individual conservation managers to decide on their fire management goals and that they were just presenting options. (It is important to note that the rebuttal to this paper authored by ~ 20 African land managers and conservation scientists was rejected.) Again, this shows a lack of understanding of the power dynamics at play when "research" is produced and then used by outside players with money for particular land management goals when they enter a local social–ecological system.

Policy interventions backed by international finance regimes to set aside conservation areas based on disembodied mapping exercises that meet scientific targets could address biosphere tipping points, while at the same time unleashing problematic tipping points of land exclusion and marginalization. The power of science-based maps, irrespective of how the authors describe them to be used and the caveats included in the associated written material, become powerful objects stimulating action (e.g. finance for carbon markets is another potential intervention that could lead to a cascading financial tipping points with implications for the integrity of certain ecosystems) with little contextual work being undertaken. The gaze that these disembodied and decontextualized spatial-mapping exercises enable is related to systems that enable investors abroad to bid for exploitation rights to nature without any understanding of the local dynamics. These dynamics allow the colonial conservation ideologies and narratives highlighted in the case studies to persist and thereby perpetuate injustices at the expense of the environment, local traditions, and culture (Domínguez and Luoma, 2020). To counter this, an improved capacity for self-determination that allows for a better understanding of the diverse conceptions of what positive or "preferable" states are needed. It also requires a much more reflexive academy that is cognizant of the power they wield when producing "science".

5.4 Unpacking positive tipping points requires an enabling environment for self-determination

The voices and tones of development and transformations in the south are often predetermined (Leach et al., 2015) and leave no space for surfacing creativities, authenticities, and capacities inherent in these systems. The capacity of the Global South and other marginalized communities to self-determine has been undermined in diverse ways. First, under the guise of sustainability argued by Lyon and Maxwell (2011), as a greenwash that theoretically promises to uplift "vulnerable" communities and create positive impacts in the Global South. However, often the development frameworks and models that seek to bring positive changes (e.g. payment for ecosystem services initiatives (Bottazzi et al., 2018), carbon trading, and renewable energy initiatives) are designed to reduce and disregard local structures, ultimately creating new structures and feedbacks that largely benefit developers. For instance, in recent years, an important literature on the contested effect of payments for ecosystem services (PESs) has flourished, showing controversial effects on participants from local communities (Bottazzi et al., 2018). While, in some cases, farmers may be willing to be compensated for their nature conservation efforts in PES programmes (Geussens et al., 2019), such payments are often too little to cover the social and economic opportunity costs for local land users (Hayes et al., 2019; Vedeld et al., 2016). The aftermath is usually a created system that welcomes new forms of valuing (often monetary at the expense of other values), exacerbates existing inequalities and injustices, and cultivates division among communities.

Second, there is a tendency for change advocates from the Global North to "piggyback" on existing structures which are easy to work with and require minimal or no reflection on people's actual needs. Such weakening techniques have maintained a status quo that is constantly prioritizing external forces because of associated benefits, while repositioning meaningful community values, efforts, and ideas as secondary. For instance, infrastructural developments in the Global South often leave the countries in crippling debts, with impossible alternatives for recovery, which then forces these countries to keep relying on external aid. Leaving no options for recovery by continuous exploitation of fault lines is a state of capture and a systemic colonialism that underpins contested north–south dynamics (Calvão et al., 2021). Countries end up spending huge amounts of their GDP serving debt instead of using this to develop their citizens.

The PA approach discussed in the case studies emphasizes this further. This is not to say that protection for these critical ecosystems is inherently problematic, but it is in who does the protecting and how that matters. In 2022, the Confederation of Indigenous Organizations of the Amazon Basin (COICA) proposed the goal of protecting 80 % of the Amazon by 2025 – approved by the International Union for Conservation of Nature (IUCN) – and joined by 30 countries and 288 civil society organizations. The aim is to stop deforestation and land use change and therefore prevent the point of no return – or a negative tipping point in the Amazon (Gaia Amazonas, 2022). From the COICA and an Amazonian perspective, the challenge for the Global Biodiversity Framework agreements is to recognize the role of indigenous peoples as key actors in safeguarding the biological and cultural diversity of the Amazon, as these communities are seldom included as active actors in conservation goals. Rather, there is the risk of perpetuating the "fences and fines" model of colonial conservation in Africa that removed people from the land to set up parks where European elites could hunt (Adams, 2008). Instead of implementing this model for hunting, these protected areas would be for the "greater good" but would negate the rights of people to their land and ignore their role as custodians of these places for generations, potentially continuing the negative outcomes such as militarization and increased human–wildlife conflict in the southern Africa case. Indigenous peoples and local communities have co-existed with the forest and land and achieved equal or better conservation results at much lower cost than conventional conservation programmes (ICCA Consortium, 2021; Fa et al., 2020; Garnett et al., 2018). However, in Africa, Asia, and Latin America, governments and non-governmental organizations (NGOs) are setting aside vast areas of indigenous and land for conservation and the good of the planet (Dawson et al., 2023). From an equity and justice perspective, it is clear that conservation projects in regions as the Amazon Basin and Congo Basin cannot take the form of strict protection, as there have always been human communities living in this area, namely indigenous peoples that have cohabited with other life forms (Barlow et al., 2012; Hecht, 2003).

As illustrated in many of the cases, creating a more decolonial future in the PTP or just transformation landscape would mean allowing local voices, tones, and capacities to surface in and by themselves (Leach et al., 2015) to self-organize and design the changes as they see and need them (Shear, 2014; Rocha et al., 2022). Resources provided in their support must then be informed by locally identified needs and framings, without stringent, unrealistic, and locally exploitative terms conditions and indicators of change. It is important to note that "resources" range from development aid through to paying for historic damage (e.g. historical emissions in the climate change negotiations) and then paying for what "everyone" cares about, e.g. investment in conservation. Development aid would be classified as support, whereas the latter two are not necessarily in direct support of countries with biodiversity and/or sequestration potential but rather are investing in a specific agenda for the planetary good – i.e. to avoid negative tipping points. However, this cannot be undertaken at the expense of local needs without any commensurate change in the behaviours of wealthy countries whose development has largely led us to this crisis (Hickel et al., 2022; Hickel and Slamersak, 2022). As recommended by Obura et al. (2023), any positive changes in the human–nature discourse must uphold and respect local rights and voices and as such bear self-propelling agencies for needed changes.

6 Conclusion: recommendations for a more transgressive practice

The main take-home message from this paper is that, when used in the context of climate science or ecological phenomena, the attribution of positivity or negativity to tipping points can be a subjective and often misleading call. The case studies reveal norms and expectations that have the potential to reproduce status quo dynamics, e.g. colonial and power relationships of natural resource exploitation and human inequality, despite the best intentions to avoid Earth system tipping points. The language of PTPs can seem like transformative change can be achieved easily when leveraging nonlinear dynamics, but we counter this with current examples that showcase that this is not necessarily the correct message. With these arguments in mind, we conclude with a set of recommendations that should be considered not only when discussing tipping points but in all considerations of social–ecological interventions.

6.1 Acknowledge the blind spots of winners and losers

Denying that there are winners and losers in interventions to avert climate disaster limits our solution space to the point of impossibility as we seek to achieve win–win situations. The kind of hard decisions around implementing transformations that are required to stay within a safe and just operating space no longer allow for this kind of thinking. Within this framing, we should be very clear about who has the capacity to lose while maintaining their dignity due to their current privilege and power versus those who are already so marginalized that they have no space to lose anymore. It is important to bear in mind that discussions about how to compensate the losers will by definition maintain the status quo of the winners, and so we should instead be shifting a narrative towards how the current winners will repay their debt to society and the planet and how to transition beyond consumerism, thereby expanding the range of PTPs available.

6.2 No more sacrifice zones in the quest to address biophysical tipping points

It is unconscionable that parts of the world and certain people remain sidelined without equal rights to self-determination

but exist merely to fulfil the needs of others. Such considerations when proposing solutions of who is going to lose and whether this perpetuates historical injustices needs to be at the heart of any discussion about enabling PTPs or addressing Earth system tipping points. Furthermore, the exclusion of nonhuman voices from decision-making further perpetuates an injustice. Interspecies justice as a core component of Earth system justice means we need to do a better job at thinking beyond just human needs and drawing more on knowledge systems that see an indivisibility between humans and nonhuman species as having the right to live and thrive on this planet.

6.3 Engage with what PTPs are desirable and from whose perspective

There needs to be a deep engagement with the information, knowledge, and interventions for sustainability transformations that are truly equitable and that spread the burden of change to those that have benefited most from the current system, rather than further marginalizing the most vulnerable. Companies and scientists producing decision tools and solutions need to explicitly recognize the risks and trade-offs associated with their solutions; i.e. together with maps of where trees can be planted or biodiversity conserved, there should be information on the consequences and information for people working in these locations about who can help to assess whether the interventions are ultimately beneficial to the people living there or not. The power dynamics of, for example, a global model (e.g. of carbon sequestration areas) that delineates impacts on local people and places necessitates a deep engagement with justice in thinking through the ethics of generating information that could lead to potential tipping points (e.g. a finance scramble to fund tree-planting). There is a critical need for researchers working on tipping points to reflect on how their findings can be used by other actors to drive either reformist or non-reformist agendas that dismantle a system (Engler and Engler, 2021). Humility rather than hubris should be a core principle when offering new research into the discourse on tipping points (see Terry et al., 2024, on futures).

6.4 Mainstream equity and justice into the governance of PTPs

Ensure that the six equity dimensions (Bennett, 2022) sit at the heart of tipping points discourse. To do so, biodiversity protection and governance need to acknowledge rights, values, visions, knowledge, and needs of local communities in policies (i.e. recognitional equity), as well as to ensure an inclusive and participatory decision-making process (i.e. procedural equity). Biodiversity and wellbeing outcomes (as well as potential harms) should be balanced (i.e. distributional equity), safeguarding the interests of disadvantaged or marginalized groups, including nonhuman species and ecosystems (i.e. environmental equity). Leadership and participatory skills within local communities should be fostered and improved to allow local engagement in management activities (i.e. management equity). Emphasis should also be placed on qualitative factors such as equity and justice of protected areas (i.e. contextual equity) (Pickering et al., 2022) to move beyond over-simplistic quantitative indicators and targets (e.g. how much area is protected and where). Failing to address any of these dimensions may result in reproducing historical injustices and simply "kicks the tipping point down the road". Resistance movements such as Blue Justice, a grassroots initiative to safeguard a secure and viable space for small-scale fisheries in the blue economy (Blythe et al., 2023), are examples of what is needed to ensure that the fundamental structures of unsustainability are dismantled.

6.5 Decolonize the solution space of what is needed to address tipping points

It is necessary to allow space for alternatives that do not come from a Western-dominated perspective (Yusoff, 2018; Yusoff and Gabrys, 2011). Let animism and entanglement be an alternative to dichotomies between people and nature and sectoral approaches that relegate the environment as lesser than the economy. Moreover, be open to alternative economic models based on regeneration beyond growth and not on extractivism. Identify models where private property is not seen as the only possible solution to the allegation of the tragedy of the commons, and employ real alternatives such as collective ownership that have been in place for generations in many parts of the world. The right to nature and ecocide examples offer existing possibilities, but there is a need for us to be more imaginative in how we can foreground options beyond Western ideologies.

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Disclaimer. All the authors are either from the Global South or, if from the Global North, identify as BIPOC. As such, we have a specific agenda to articulate a reflexive position on the concept of tipping points from this perspective, which is often marginalized due to the dominance of US and European research in this space. We share reflections and insights from our working experience and hope in this way to provide some more nuance and context to the

discussion of tipping points. Our audience is therefore mainly the well-intentioned researchers who are proposing notions of positive tipping points to ensure that the aims of sustainable, equitable and just futures are centred in this research and to emphasize that reflexive caution is needed.

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