

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

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21 **Abstract**

22 Earth system tipping points pose existential threats to current and future generations, both  
23 human and non-human, with those **least responsible for causing them** being **at greatest risk**.  
24 **Positive social** tipping points **(which we shorten to positive tipping points, or PTPs), are often**  
25 deliberate interventions into **human** systems with the potential to **rapidly** address some of these  
26 challenges. However, the **desire to intervene should neither** increase risks nor perpetuate unjust  
27 or inequitable outcomes through the creation of sacrifice zones. In this paper, we argue that  
28 considerations of what needs to change, who is being asked to change and where the change  
29 or its impacts will be felt and by whom, are fundamental questions that require a level of  
30 reflexivity and systemic understanding in decision-making. All actors have a role to play in  
31 ensuring that justice, equity and ethics are **carefully considered before any** intervention.  
32 Enabling **positive** tipping points **for** radical transformations could benefit from more diverse  
33 perspectives to open up **solutions**, with a particular emphasis on the inclusion of marginalised  
34 voices. We conclude that taking a cautious **approach to positive tipping interventions and**  
35 **stepping** back to explore all options, not just those **appearing** to offer a quick fix, could **lead to**  
36 more equitable **and** sustainable **outcomes**.

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39 Earth system tipping points pose existential threats requiring urgent action. However, this  
40 imperative should neither increase risks nor perpetuate injustices. We argue that considerations  
41 of what needs to change, who is asked to change and where the impacts will be felt and by  
42 whom, are fundamental questions that need to be addressed in decision-making. Everyone has  
43 a role to play in ensuring that justice and equity are incorporated into actions towards a more  
44 sustainable future.

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## 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 interventions are proposed as potentially normative 'positive' social tipping points, which we shorten to positive tipping points \(PTPs\). PTPs are defined as changes to a system which 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: not all the changes associated with PTPs are universally welcome; difficult decisions and trade-offs need to be made as we weigh up anticipated harms versus benefits. Nevertheless, we argue that we have 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 and attempting to orient complex systems onto more sustainable and socially just trajectories, is messy and complicated \(Pereira et al., 2020\). 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 \(Blythe et al., 2018\). It is necessary to be cautious when approaching the idea of using PTPs and to be very clear what transformations are intended, whom they benefit, and whom they may harm.](#)

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 change potentially needs to be both rapid and radical. Indeed, in this context, the language of positive tipping needs to be exercised with caution since the very definition of a PTP, as a point towards an 'idealised' future, is likely to be experienced by many as a polarising event and can have differential welfare impacts on different subsets of the population \(Ehret et al., 2022\). For example, while some welcome a tipping point in the new renewable energy economy \(IEA, 2022; Systemiq, 2023; IRENA, 2022\), others working in the 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, driven by rapidly increasing production of electric vehicles, may create problems as well as opportunities for a different set of communities.](#)

An approach to 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 broadly, but rather focuses on the very specific governance issue of equity and justice. When identifying or](#)

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172 [triggering a tipping point through an intervention](#), it is necessary to ask: What kind of trade-offs  
173 are necessary and what sacrifice zones are being created? Who ends up occupying these  
174 sacrifice zones? What forms of vulnerability are exposed by change? Who is left behind? [And](#)  
175 [how](#) can a comprehensive understanding of [justice](#) be included in a rigorous way when  
176 examining [PTPs](#). Here, we understand sacrifice zones as extractive zones created by the  
177 advancement of coordinated forms of capitalism that see those territories and the communities  
178 inhabiting them as commodifiable ([Gómez-Barris, 2017](#)).

### 179 1.1. Climate Justice in Light of Tipping Points

180  
181 Recent UNFCCC climate summits have seen increasing calls from climate justice campaigners  
182 and representatives of the Global South for [a recognition of uneven historical and ongoing](#)  
183 [responsibility](#) for climate change, currently articulated in calls for 'loss and damage' and  
184 elsewhere for reparations ([Huq et al., 2013; Constantino et al., 2023](#)). These calls are supported  
185 by the work of climate historians, decolonial critics and authors who assert that we cannot hope  
186 to [advance](#) climate action if we do not address [systems of capitalism](#) and colonialism that have  
187 created the current crisis and still shape intergovernmental responses to it ([Bhambra and](#)  
188 [Newell, 2022; Ghosh, 2022; Yusoff, 2018; Sultana, 2022](#)). The future-focus of much scientific,  
189 political and popular [discourse](#) around climate change can create a disconnect with the past,  
190 occluding the fact that climate change and its associated crises 'are deeply rooted in history'  
191 (Ghosh 2022, 158). In this context, there is a danger that the language of tipping points – small  
192 perturbations that trigger large, irreversible responses ([Lenton, 2011](#)) – could reinforce a  
193 discourse that abstracts climate change from past inequities. The notion of tipping points that  
194 are rooted in a biophysical framing, which assumes some 'threshold' and 'set of shocks' that tips  
195 a system over, ignores the grinding every-day realities of life that many of the poor and most  
196 vulnerable endure as an interconnected set of social, economic and environmental crises,  
197 ([Nixon, 2013](#)). These vulnerabilities will only be compounded with the increased risks given  
198 climate change and other changing biophysical pressures ([O'Brien and Leichenko, 2000](#)).

199  
200 Moreover, a focus on preventing tipping points can distract attention from the deep structural  
201 imbalances of capital and [asymmetric](#) power that drive precarity and lead to increased  
202 vulnerability to the impacts of tipping events in poorer nations, ([Roberts and Parks, 2006](#)). The  
203 urgency that accompanies the notion of tipping points can overshadow the slow process of  
204 rebuilding trust and relationships that have been broken through past harms, referred to by Kyle  
205 Whyte as "relational tipping points" ([Whyte, 2020](#)). For many Indigenous peoples and local  
206 communities who have faced the existential crisis of colonialism and who are now at the  
207 forefront of the climate crisis ([Gillio-Whitaker, 2019](#)), relational tipping points may have already  
208 been breached ([Whyte, 2021, 2020](#)). The process of rebuilding consent, trust, accountability,  
209 and reciprocity—qualities of relationships necessary to avoid further injustices—require time  
210 and commitment ([Whyte, 2020](#)). Attempts to avoid tipping points through geoengineering, for  
211 example, could merely pass on costs and irreversible effects onto future generations, ([Biermann](#)  
212 [et al., 2022](#)), while contemporary drives to reach technological tipping points, such as the push  
213 towards electric vehicles, can produce new vulnerabilities for communities with homes rich in

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243 rare earth minerals (Calvão et al., 2021). Hence without due care, attempts to address tipping  
244 points can perpetuate spatial and temporal injustices (Sovacool et al., 2022).

246 In this paper we discuss considerations of ethics, equity and justice in relation to the complex  
247 interconnection of biophysical and social, 'positive' and 'negative' tipping points. The  
248 destabilizing of critical Earth systems is already contributing to adverse effects on human well-  
249 being and global ecosystems on which it depends, and will continue to worsen (Rockström et  
250 al., 2009). Crossing biophysical and social tipping points will exacerbate current injustices and  
251 inequities as access to water, food, energy and infrastructure will be uneven, strained, and  
252 increasingly politicised (Rammelt et al., 2023), leading to greater potential harms on future  
253 generations by triggering potentially irreversible processes. It is thus necessary to approach  
254 PTPs with due precaution and humility in our understanding of how complex social-ecological  
255 processes unfold- as such we refer to the need for an ethics of intervention that centres  
256 considerations of equity and justice as central tenets.

## 257 1.2. Discourse matters

259 Within the framework of tipping points, it is crucial to remember that all human and more than  
260 human 'actors' are, in Donna Haraway's words, 'situated... in complicated histories' (Haraway,  
261 2016), which inform complex and plural visions for the future. The IPCC AR6 report urges  
262 immediate action and deep emissions reductions in this decade whilst also calling for climate  
263 resilient development that prioritises risk reduction, equity and justice (IPCC, 2023). In seeking  
264 to build a majority of people in favour of stronger, faster action, it is vital that values-inclusive  
265 forms of discourse are identified to 'create a sense of collective responsibility and action'  
266 (Wiedmann et al., 2020) and which avoid alienating the actors needed to form this coalition.  
267 Even processes to decolonise understandings of time, including seeing it as linear, must be  
268 fostered so that we do not exacerbate problems as we act with urgency to find near-term  
269 solutions to the climate emergency like large-scale renewable energy infrastructures that can  
270 sometimes infringe on human and nature's rights (Whyte, 2021).

272 At the same time, the extreme difficulty and tradeoffs inherent in achieving a safe and just  
273 operating space for life on Earth need to be understood (Gupta et al., 2023a). A discourse that  
274 reconciles the need to meet the internationally agreed +1.5°C rise in average global  
275 atmospheric temperature, alongside the need to address over-consumption and inequalities  
276 within and between nations, can no longer rely on the dominant narratives of efficiency gains  
277 and gradual decoupling (Hickel and Kallis, 2019; Wiedmann et al., 2020; Steinberger et al.,  
278 2020; Constantino and Weber, 2021; Lamb et al., 2020). A growing understanding of tipping  
279 points in the Anthropocene 'cancels the peaceful and reassuring project of sustainable  
280 development' (Bonneuil and Fressoz, 2016: 29). We have entered what Bruno Latour calls 'the  
281 new climatic regime' (Latour, 2018) in which the geophysical framework that we have always  
282 taken for granted, the ground on which our history, politics and economics have played out, has  
283 become destabilized. An ethical community of nations that respects the Earth's biophysical  
284 limits and minimum social foundations for human flourishing must recognise that the only viable  
285 solutions are ones that prioritise strong sustainability and sufficiency for all (Haberl, 2015;

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306 [Trebeck and Williams, 2019](#)) informed, for example, by the principles of 'doughnut economics'  
307 ([Raworth, 2017](#)) and notions of safe and just boundaries ([Gupta et al., 2023a](#)). This places  
308 differential responsibilities on different groups of people as we seek to navigate towards more  
309 just, equitable and sustainable futures.

### 311 1.3. What do we mean by equity and justice?

312  
313 When considering climate justice, it is useful to be precise about which area or domain is  
314 investigated: climate impacts, mitigation efforts, adaptation or decent living standards. There  
315 are dilemmas and trade-offs across attempts to address recognition, procedural, distributional,  
316 reparative, and inter- and intragenerational aspects of justice simultaneously; clarity on the  
317 scope, both in terms of space and time, is important. Additionally, many different terms and  
318 concepts used interchangeably across disciplines, cultures and individuals, create a risk for  
319 misunderstandings and also misinterpretation of research findings ([Newell et al., 2021](#)). As we  
320 go about shaping just transitions, it is important to find a common ground ([Steviss and Felli,](#)  
321 [2020; Zimm et al., in press](#)).

322  
323 Gupta et al. (2023) propose an integrated "Earth system justice" framework to approach these  
324 questions and understand how to reduce risks from crossing tipping points while ensuring well-  
325 being for all and an equitable distribution of nature's benefits, risks and related responsibilities.  
326 Earth system justice is conceptualised through multiple approaches and understandings of  
327 justice including, but not limited to, intragenerational, intergenerational justice and interspecies  
328 justice. Intragenerational justice refers to the relationships between humans right now and  
329 includes justice between states and among people across scales. Intergenerational justice  
330 examines relationships across generations, such as the legacy of greenhouse gas emissions or  
331 ecosystem destruction by current and past generations on youth and future people, and  
332 assumes that natural resources and environmental quality should be shared across generations  
333 ([Tremmel, 2009](#)). In this context, interspecies justice refers to considering the rights of nature  
334 and other species to coexist on the planet. It draws on a rights of nature discourse ([Harden-](#)  
335 [Davies et al., 2020](#)) that also counters the idea of human exceptionalism as a lens for thinking  
336 through development impacts ([Srinivasan and Kasturirangan, 2016](#)). Drawing on these  
337 frameworks can help us to assess the uneven impacts of nearing earth system tipping points,  
338 but also the differential responsibility for efforts to avoid tipping points and the distributional and  
339 procedural aspects of positive tipping dynamics.

340  
341 Within the domains mentioned above, one can discriminate between different forms (or  
342 dimensions) of justice, i.e., distributive (or equity across different populations), procedural (how  
343 decision or research processes are designed, who is involved), or reparative (e.g. recognition of  
344 wrongs, restoration where possible, and compensation for negative impacts and past injustices)  
345 ([Byskov and Hyams, 2022](#)). Such justice approaches also include recognition and epistemic  
346 justice, which consider the value of multiple knowledge systems, especially local, Indigenous,  
347 and unrecognised, misrecognized or marginalised groups ([de Sousa Santos, 2008](#)). Finally,  
348 'intersectional' justice that includes multiple and overlapping social identities and categories  
349 underpinning inequality, underrepresentation, marginalisation, and the capacity to respond (i.e.

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gender, race, age, class, health) must be considered in the context of earth system justice (Gupta et al., 2023b). 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 Earth and social system tipping can be analysed with reference to all these justice considerations, to design forward looking actions that avoid negative impacts. Especially in cross-disciplinary discussions and exchanges between different actors, having shared understanding of the nuance and need for contextual framing of challenges will enable and speed up implementation. It is key to highlight that what is perceived as fair is subjective and highly context specific and may change over time (Caney, 2012). In the context of addressing negative biophysical tipping points by attempting to enable positive tipping, an Earth system justice approach is critical to ensure past injustices are not perpetuated in the name of staying within planetary boundaries.

## 2. Blind Spots of intervention

Treaty negotiators have sometimes ignored or dismissed normative dimensions of climate policy and the possibility of unintended social consequences (Okereke and Dooley, 2010; Klinsky et al., 2017). However, all actors in the process – from scientists to world leaders – must avoid today's solutions becoming 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). An equally exponential increase in unintended negative consequences is also possible. It is thus imperative that all actors take responsibility to acknowledge potential risks and centre questions of justice, when referencing PTPs as solutions to the ongoing climate and other social-ecological crises.

### 2.1. Risks and Unintended consequences of interventions for climate impact mitigation and adaptation.

Interventions for climate impact mitigation and adaptation can have unintended consequences, broadly addressed as maladaptation. "Aside from wasting time and money, maladaptation is a process through which people become even more vulnerable to climate change," Schipper, suggests (Schipper, 2020: 409). A good example of risks associated with the quest for PTPs for climate impact mitigation is the transformation to a renewable energy economy that is driving the growing demand for batteries, solar panels, and other digital devices, all of which require mining of 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, the authors also find that 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

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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 (ETs), designed to encourage domestic carbon-intensive sectors to invest in carbon-neutral production, may raise costs and contribute to the decision to relocate to a region enjoying equal access to the same markets, but which has fewer, less stringent policies/regulations (Prellezo et al., 2023). Further intervention in the form of carbon border adjustment mechanisms (CBAMs), carbon content labelling/mandates and other measures may then be introduced to adjust for these climate policy asymmetries.

Relatedly, significant policy research is being devoted to the concept of a 'just transition' (Wang and Lo, 2021; Newell and Mulvaney, 2013), which originated from labour market impacts of decarbonization strategies in coal-intensive regions the Global North (Abraham, 2017). Unless sufficient government investment, regional regeneration, support and retraining are provided to those workers and communities most at risk in the transition away from fossil fuels, severe economic, social and cultural hardships may predictably (though unintentionally) follow. Furthermore, trust in government will fall even lower, and counter-narratives on grounds of fairness/justice voiced by actors for climate policy delay will be strengthened (Patterson et al., 2018; Lamb et al., 2020) potentially further undermining efforts to strengthen governance and make it more inclusive. 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 transition by building political will and legitimacy, and negotiating effective compromises for more just outcomes (Fesenfeld et al., 2022). More generally, 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 mandates/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

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519 and increase poverty, inequality, hunger and other health impacts, popular protest and political  
520 instability (Newell et al., 2021; Davies and Oreszczyn, 2012).

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521 In the Global South, the transition to net-zero carbon emissions faces multiple challenges, such  
522 as addressing energy security, poverty, multidimensional vulnerabilities, and ensuring decent  
523 living standards for all. These countries are confronted with a toxic mix of shrinking carbon  
524 budget, growing inequalities, heightened climate-related risks, and limited capabilities for  
525 mitigation and adaptation due to increasing debt burdens (Steele and Patel, 2020), but the  
526 debate on historic responsibilities, development rights, and net-zero efforts is gaining renewed  
527 attention (Mishra, 2021). From the perspective of the Global South, achieving just transitions  
528 requires addressing the double inequality of the climate crisis where developing countries bear  
529 a disproportionate share of the risks associated with emissions, while industrialised nations are  
530 primarily responsible for historical emissions (Gardiner, 2004). Therefore, developing countries  
531 are demanding fair procedures for distributing the costs and benefits of mitigation and  
532 adaptation. Such financing commitments from rich countries remained absent in the decisions  
533 taken at COP28 in Dubai in 2023 (Jessop et al., 2023).

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534 Unpopular climate policies can sometimes trigger a widespread 'backlash' that can be defined  
535 as:

537 'An abrupt and forceful negative reaction by a significant number of actors seeking to  
538 reverse a policy, often through extraordinary means that transgress established  
539 procedures and norms' (Patterson, 2023, 68).

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Deleted: (Kinniburgh, 2019).

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541 Examples of climate policy backlash include the ill-fated Australian carbon pricing scheme  
542 (Crowley, 2017), and the fuel tax increase that gave rise to the Gilets Jaunes or Yellow Jackets  
543 protest movement in France in 2018-2019 (Kinniburgh, 2019). Other well-researched forms of  
544 unintended impacts of policy measures include rebound effects and moral licensing  
545 (Chakravarty et al., 2013). Rebound effects generally refer to behavioural responses in which  
546 people consume more of something that costs less due to an environmental improvement, such  
547 as energy efficiency, which can perversely lead to an overall net increase in pollution and  
548 resource use. For example, people may choose to drive further or buy larger cars as cars  
549 become more fuel efficient (Sorrell et al., 2009). Although rebound effects have so far shown  
550 negligible impact, these kinds of dynamics highlight the complexities and uncertainties  
551 surrounding human-nature systems, and the potential for unintended consequences in our  
552 efforts to induce 'positive' tipping points (Constantino et al., 2022).

554 In the field of climate communications, there are unintended consequences associated with a  
555 failure to build broad coalitions based on values-inclusive narratives and norms (Evans, 2017;  
556 Klein, 2015; Constantino and Weber, 2021; Rowson and Corner, 2014; Sloterdijk, 2012;  
557 Meadowcroft, 2011). Research shows that politically progressive actors tend to believe in the  
558 inseparability of climate, (re)distributional and social justice issues as a moral imperative.  
559 Procedural justice is also key as small producers and/or vulnerable people are often excluded  
560 from political mechanisms which determine climate actions (Villasante et al., 2022). 'Climate  
561 justice' can then include colonial, gender and racial injustices and future generations (Jafry,



2018; Perkins, 2018), particularly in its more transformative form which seeks to address the drivers of climate injustice (Newell et al., 2021). 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 have the unintended effect of increasing political polarisation rather than building broader coalitions (Patterson et al., 2018; Smith, 2022). Political progressives tend to frame climate change risk in terms of 'individualising' values of equality, care and fairness, while political conservatives prefer to use 'binding' values based on loyalty, authority, and purity (Adger et al., 2017; Haidt, 2013; Graham et al., 2009). Conservatives are not necessarily against stronger climate governance, but reject progressive framings that challenge their values and identities (Feinberg and Willer, 2013; Feygina et al., 2010; Kidwell et al., 2013). Research has also shown that some actors recognise the need for greater urgency in climate policy, but are reluctant to champion it due to a lack of support and to avoid being labelled as 'extremists' (Willis, 2020). As a result, some climate policymakers and other actors prefer to focus on the more technocratic, less politically risky aspects of transition governance (Patterson et al., 2018).

If decarbonisation is left 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 subsystems along more efficient, ethical, sustainable, and equitable lines may be lost where speed 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 (Stone et al., 2022; Hoffman and High-Pippert, 2005). 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 or social 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 on 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

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risks (Schneider et al., 2020; Stephens et al., 2021; Kravitz and MacMartin, 2020; McLaren, 2018). 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 at the planetary level is not only pushing local tipping points through resource dispossession, but is also exacerbating the drivers leading to transgressing planetary boundaries (Richardson et al., 2023). Resource extraction, be it for fossil fuels or green energy sources, creates sacrifice zones mainly in the Global South to sustain unlimited economic growth in the Global North while it contributes to transgressing the planetary boundaries further (Sultana, 2023b). The tendency of PTPs to benefit some while (intentionally or unintentionally) excluding others, exacerbates sacrifice zones. Winners and losers from transitions are relational in a highly unequal global economy stratified by power, race, class and gender (Newell, 2021). Well-intentioned interventions therefore have the potential to put severe 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 just transitions (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). They go on to define Green sacrifice zones as “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).

Some queer decolonial critique puts it, sacrifice zones are not random, but carefully chosen: “the colonial paradigm, worldview, and technologies [...] mark out regions of “high biodiversity” in order to reduce life to capitalist resource conversion” (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. Decolonial ecocritical thinker Rob Nixon, describes the “slow violence” that unfolds in marginalised communities, over a long period of time and which are almost imperceptible (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 parcel affects the rest of the entities and breaks the spiritual heritage in a region (Gómez-Barris, 2017). This slow violence has delayed effects and requires justice to take new forms to secure effective legal measures for prevention, restitution, and redress (Nixon, 2013: 8,9). To include justice and equity in climate mitigation actions, Latin American countries, for example, have developed the first agreement Acuerdo de Escazú in 2018 (CEPAL, 2018). This regional agreement proposes three concrete objectives to include climate justice in environmental policies and transition actions: (1) access to environmental information, (ii) public participation in

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environmental decision-making processes, and (iii) access to justice in environmental matters. These three points involving communities in discussions of climate justice stand out as crucial for a theory on positive tipping points that aims to include equity and justice frameworks.

A theory of tipping points should not only recognise the way in which the military-industrial complex through powerful non-state actors, and even well-intentioned government policies, disguise and disregard the toxicity and contamination that poor and disadvantaged communities of the world suffer (Bullard, 2005), but also where the “disposable” populations are rising in resistance to demand a climate justice attuned to local social-ecological realities (Gilio-Whitaker, 2019). Discussions of tipping points similarly need to be aware of the technologies of governance (race-making, even the processes for identifying ‘indebted countries’ or Least Developed Countries - LDCs) that enable access to and appropriation of stocks for capitalist resource conversion. For the concept of sustainability and just sustainable futures to help improve the situation of those 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, these cannot neglect how racial capitalism contributes to inequalities and environmental degradation (Sze, 2018; Newell, 2005).

### 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 (Newell, 2021; Kenner, 2019; Wiedmann et al., 2020; Rammelt et al., 2023) and the infrastructures of high-impact sectors such as food (reducing 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.

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## 2.4 Positive financial tipping points: actors and mechanisms

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), including changing the mandates of multilateral development banks, reforming central banks and regulating private company law and disclosure policies.

For example, higher costs of accessing finance in the Global South 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 600million people in Sub-Saharan Africa alone) (IEA, 2023). 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 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.

Furthermore, the public sector should ringfence funding to support the need to respond to unintended consequences. 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).

A framework for guiding sustainable and equitable investments, and a taxonomy of these investments are 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<sup>1</sup> 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

<sup>1</sup> [www.unpri.org/about-pri/the-six-principles](http://www.unpri.org/about-pri/the-six-principles)

Finance Principles whereby UNEP works with financial institutions to incorporate environmental, social, and governance issues into business principles and financial market practices (UNEP, 2020).

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 of the serious proposals 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 Dufo, 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).

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. (Costello et al., 2016) recently

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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.

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). Financial actors are key players in the global economy and affect 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).

### 3. Illustrative case study on 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 oceans 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 recently agreed Kunming-Montreal Global Biodiversity Framework seeks to protect 30% of the ocean by 2030 to halt biodiversity loss (30x30 target 3 (CBD, 2022). Through the global CBD negotiations, conserving 30% of the ocean (and land) is seen as an important threshold for halting biodiversity loss and maintaining ecosystem function as previous levels of protection were insufficient (Dinerstein et al., 2019; Baillie and Zhang, 2018). 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 positive tipping point 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

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926 a more nuanced and equitable discourse on positive tipping points in ocean governance and  
927 conservation and the role of Marine Protected Areas (MPAs) in achieving them.  
928  
929 Although the positive ecological impacts of MPAs are relatively well understood (i.e. large, old,  
930 well-enforced and 'no-take' MPAs would provide greater ecological benefits within the area  
931 effectively protected (Sala and Giakoumi, 2018), less attention is paid to the negative socio-  
932 economic impacts that MPA establishment can have on dependent and marginalised  
933 communities (Bennett and Dearden, 2014; Rasheed, 2020). Past research has shown that the  
934 MPAs can exacerbate equity issues currently present in the Global South, by further  
935 marginalising already vulnerable coastal communities (Sowman and Sunde, 2018; Hill et al.,  
936 2016). MPAs establishment and management may exclude local and Indigenous participation,  
937 which in turn can also lead to reduced conservation and management gains (Hill et al., 2016). A  
938 heightened focus on increasing MPAs may entail undesirable consequences for social well-  
939 being of vulnerable communities in a variety of ways, including forced removals and  
940 displacement of Indigenous peoples from traditional lands and waters, loss or restricted access  
941 rights, as well as negative impacts on food security, health, livelihoods, identity and culture  
942 (Bennett and Dearden, 2014; Hill et al., 2016). As an example, (Sowman and Sunde, 2018)  
943 explored the social dimensions of five MPAs in South Africa, finding that they led to the  
944 weakening of local governance rights and processes, loss of tenure rights and access to  
945 resources, loss of livelihoods, negative impacts on culture and way of life, and increased conflict  
946 in already marginalised coastal communities. Similarly, Oracion et al. (2005) documented how in  
947 some MPAs in the Philippines, the tourism sector marginalised small-scale fisheries in terms of  
948 access and control, jeopardising the economic and socio-cultural viability of fishing-dependent  
949 communities.  
950  
951 A strong global focus on increasing MPAs as a 'tipping point' towards conserving marine  
952 biodiversity, may fail to carefully and comprehensively address historical impacts and ongoing  
953 equity issues experienced by coastal communities in the Global South. In addition, measuring  
954 conservation success based solely on a coverage metric can incentivize the establishment of  
955 large centrally-governed MPAs (often situated in former colonies) (O'Leary et al., 2018), at the  
956 expense of relatively small, but locally managed MPAs (Smallhorn-West et al., 2020). A looming  
957 time horizon for 30x30 may also discourage participatory and collaborative processes that may  
958 take longer to achieve but are more efficient in the long term (O'Leary et al., 2018). Concerning  
959 global planning of MPAs expansion, maps are not apolitical. Global conservation planning  
960 exercises informed by biophysical variables and cumulative human impacts placed a significant  
961 fraction of priority areas within the Global South (e.g. Coral Triangle, Southwest Indian Ocean,  
962 Caribbean Sea) (Zhao et al., 2020; Selig et al., 2014; Jenkins and Van Houtan, 2016),  
963 occupying the entire Exclusive Economic Zones (EEZs) of some Global South countries (e.g.  
964 Indonesia) and thereby perpetuating a form of green sacrifice zone. While providing important  
965 foundations, this literature hardly discusses the ethical and governance considerations of such  
966 "conservation planning exercises" and local socio-economics needs are either conceptualised  
967 as an extra map layer that competes with wildlife or something to consider in future analyses.  
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985 The 30x30 initiative and the revitalization and empowerment of local communities may be  
986 reconciled by: (1) balancing both biodiversity and well-being outcomes of local communities  
987 when enhancing existing MPAs and designing new ones; (2) seriously considering the wide  
988 range of “other effective area-based conservation measures”, including those where small-scale  
989 actors are empowered; (3) involving coastal communities from the very beginning of decision-  
990 making processes to enhance procedural justice, increasing the likelihood of equitable  
991 outcomes; (4) acknowledging customary, traditional and local practices of Indigenous peoples  
992 when protecting coastal areas; and (5) considering ongoing sustainable Indigenous  
993 management systems within the 30x30 target (e.g. [Atlas et al., 2021](#)). Importantly, the  
994 expansion of MPAs, across both large and small areas, should not be seen as a single strategy  
995 to balance marine biodiversity and socio-economic needs; it must be part of a broader and more  
996 diverse management and governance portfolio to govern our oceans in a sustainable and  
997 equitable manner ([O’Leary et al., 2018](#)).

#### 999 4. [Implications for practice](#)

1000  
1001 Above we have laid out a series of risks and potential injustices associated with the need to act  
1002 to address the existential threat that is climate change and related sustainability concerns like  
1003 biodiversity loss. We argue that interventions, especially concerning narratives of positive  
1004 tipping points, cannot be divorced from current injustices and inequities in the global earth  
1005 system. Below, we set out some specific key messages for different actor groups to internalise  
1006 as we all seek to act to shift the planet onto a more environmentally sustainable and equitable  
1007 trajectory.

#### 1009 4.1. [Researchers](#)

##### 1011 4.1.1. [Employ participatory and plural/inclusive approaches.](#)

1012 Biophysical and social system tipping points are interconnected, and do not exist in isolation  
1013 ([Sultana, 2023a](#)). Avoiding an increase of harms requires a broad set of expertise, approaches,  
1014 and acknowledgment that we may need multiple and plural approaches not only within  
1015 academic disciplines, but also of diverse knowledge systems beyond academia and that these  
1016 need to be taken seriously ([Tàbara et al., 2022](#)). Interactions with other knowledge systems are  
1017 only slowly developing, but participatory approaches that involve stakeholders in science, can  
1018 still be very superficial and not go beyond consultation into more embedded modes of  
1019 knowledge co-production ([Osinski, 2021](#); [Chambers et al., 2021](#)). By being more mindful about  
1020 inclusiveness, we can bring about more procedural justice in research through participatory co-  
1021 design, action research and humility on the part of researchers ([Huybrechts et al., 2017](#)).

##### 1023 4.1.2. [Diversify the research space.](#)

1024 Diversity is a key principle of resilience and should also be a core framing when thinking through  
1025 equity, so that diverse groups, perspectives, knowledge systems and research methods are not  
1026 side-lined in the quest for addressing global tipping points. Greater diversity in research is  
1027 therefore needed - in terms of cultural, religious, ethnic, gender or background of the  
1028 researcher, but also in the disciplines that are engaged. For example, considering social

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sciences in the intentions, 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).

4.1.3. Have more heterogeneity in research contributions.

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. Place-specific information and experience is often lacking as a lot of traditional research is concentrated in high-income countries. A more inclusive global research project 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. Diversity and inclusivity of research teams within and beyond academia are needed to help find solutions to tipping points that do not exacerbate existing inequities and inequalities (de Souza, 2021; Latulippe and Klenk, 2020).

4.2. Business and finance

4.2.1. Transformed financial systems

Recognise that finance and business as part of social and ecological systems and not somehow apart from them; that active steering and regulation are required to divest, de-finance and divert financial resources to where positive tipping points can be found. This means reconfiguring currently highly uneven access to credit, education and capital in order to bring about more transformative change and creating mechanisms that redirect finance away from activities pushing us past planetary boundaries and towards sectors and regions where they are most required (Newell, 2021).

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. Furthermore, the public sector should ring-fence funding to provide a cushion against unintended consequences.

4.2.2. Introduce investment restrictions for non-compliant companies.

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

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practices. Another area where investments could leverage positive tipping points, for instance, would be an investment 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). Likewise redirecting the \$11 million per minute currently being spent on fossil fuel subsidies towards improved access to renewable energy for poorer communities would represent a major gain (McCulloch, 2023).

#### 4.2.3. Develop more supportive and inclusive investments.

Financial actors, such as international development banks, institutional and private investors, 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, as opposed to unsustainable working conditions and overexploitation of 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. For example, Prellezo et al (2023) highlight the need to build climate resilience, social sustainability, and equity in global fisheries to achieve targets to limit global warming established by the Paris Agreement. By internalising the social cost of carbon, the authors found that if CO2 trading prices reach the 2050 social cost of carbon, around 75% of the landings worldwide would be more valuable as carbon than as foodstuff in the market.

Redirecting public and private money to new innovative tools and instruments can enable new entrants into the new financial architecture while reducing the degradation of biodiversity. For example, the IIX Sustainability Bonds<sup>2</sup> 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<sup>3</sup> that empower communities to create their own financial systems based on local goods and services (Ruddick, 2023).

At the national level, the Netherlands provides, for instance, special green investment funds that are exempt from income tax, thus allowing investors in green projects (e.g. green shipping), to contract loans at reduced interest rates (usually ~2% below commercial rates). Another example is the Raven Indigenous Impact Fund<sup>4</sup>, 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<sup>5</sup> 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<sup>6</sup> and

<sup>2</sup> <https://iixglobal.com/iix-sustainability-bonds/>

<sup>3</sup> <https://grassrootseconomics.org/>

<sup>4</sup> <https://ravencapitalpartners.ca/investments/impact-funds>

<sup>5</sup> [www.climatebonds.net](http://www.climatebonds.net)

<sup>6</sup> <https://bluenaturalcapital.org>

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With this improved finance mechanism, businesses should then be able

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Deleted: resilient. This includes moving money to key areas where it is needed (adaptation, biodiversity, social goods) rather than just for profit.

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1155 [the technical guideline for blue bonds. Mainstreaming these examples as best practice is critical](#)  
1156 [for leveraging the financial system to enable PTPs.](#)

### 1157 **4.3. Decision and Policy-makers**

#### 1160 **4.3.1. Design fiscal policies that are reflective and [cognisant](#) of extant configurations.**

1161 Fiscal policy needs to be designed to subsidise lower-income households for the higher costs  
1162 that may accompany climate policies such as carbon pricing, emissions trading, new  
1163 mandates/standards for energy-efficient buildings, smart energy systems, and the electrification  
1164 of transport. Failure to do so could set off a cascade of unintended consequences and increase  
1165 poverty, inequality, hunger and other health impacts, popular protest and political instability.

1166 [Hypothecation, for example redirecting funds from fossil fuel subsidies to affordable public](#)  
1167 [transport or from windfall taxes on oil companies for home insulation schemes, can build](#)  
1168 [support among poorer groups for measures that might otherwise be opposed. Policy and](#)  
1169 [governance actors attracted to](#) tipping interventions need not only to design targeted, sector-  
1170 and actor-specific approaches, but also to combine disciplines and sectors for a coordinated,  
1171 complex systems thinking approach and capabilities. [Including potential losers in the design](#)  
1172 [process can also reduce opposition and ensure more equitable outcomes.](#) They should also  
1173 maintain the highest commitment to research and policymaking standards that expose hidden  
1174 assumptions, biases and potential for backfires, rebounds and other unwelcome results  
1175 [\(Sterman, 2002\).](#)

### 1177 **4.4. Media/communications**

#### 1179 **4.4.1. Be aware of the politics of language and power dynamics in the science landscape.**

1180 Communicators must be alert to the ideologies, values and systems of power that affect which  
1181 messages are communicated and how they are encoded. For example, how a tipping point is  
1182 identified [\(Juhola et al., 2022\)](#) and what specific language is used to define [and communicate it](#)  
1183 [\(Milkoreit et al., 2018\)](#). This is particularly relevant in relation to the language of 'positive' and  
1184 'negative' tipping points, which can imply a universality of effect that is insensitive to the diverse  
1185 experiences (and responsibilities) of different communities [illustrated above](#).

#### 1187 **4.4.2. Recognize their position in framing key messages in the scientific landscape.**

1188 In an equity and justice context, media and communicators must be alert to the competing  
1189 ideologies and value systems that affect how a message is 'decoded' or interpreted by different  
1190 communities [\(Holmes, 2020\)](#). [It is well established in Communications studies that the](#) meaning  
1191 of a message is not necessarily determined by the messenger or the message, but 'a complex  
1192 interplay of how this meaning is framed through ideological values and beliefs' [\(Hall, 1980\)](#).  
1193 Thus, it is important to view communication not as a neutral process of information  
1194 transmission, but as a complex, non-linear system that is entangled with [competing](#) knowledges  
1195 and [powers](#). Studies have shown that [increased](#) knowledge does not automatically lead to  
1196 enlightened action [\(Norgaard, 2011\)](#) and, indeed, that more factual information may serve to  
1197 further entrench dismissive perceptions of climate change [\(Bain et al., 2012\)](#). There is,  
1198 therefore, a need to go beyond linear 'information deficit' models of communication, moving

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A financial sector tipping point that reconfigures where finance can go, for example towards mitigation, adaptation, loss and damage, biodiversity, addressing vulnerability etc. requires greatly strengthening the governance of public and private finance. This requires changing the mandates of multilateral development banks, reforming central banks and regulating the need to change to company law and disclosure policies. Furthermore, the public sector should ringfence funding to support unintended consequences. ¶

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1222 instead towards 'non-linear' models of communication that prioritise open, reflective dialogue  
1223 between different stakeholders. For example, case studies of communication strategies  
1224 involving Indigenous people and local communities on the front line of climate change have  
1225 found that 'messages rooted in empirical research and using simple language is insufficient and  
1226 that researchers should investigate different stakeholders' understandings of what good  
1227 climate change communication is and thereby determine the needs of different audiences  
1228 from their unique cultural standpoints before developing materials (Gotangco and Leon,  
1229 2017; Barau and Tanko, 2018). With this in mind, it is important that communication strategies  
1230 are co-produced with the communities they are seeking to engage (Moser, 2016).

1231  
1232 **4.4.3. Embrace creative co-production practices.**  
1233 Initiatives arising from the Arizona State University Imagination and and Climate Futures  
1234 Initiative and the University of Exeter-led 'Climate Stories' and 'We Still Have a Chance'  
1235 projects, have shown that the arts and humanities offer models for empowering communities to  
1236 create their own narratives and contextualise climate change in relation to their own systems of  
1237 value, which is an important step towards the design and implementation of just and equitable  
1238 transitions (Woodley et al., 2022; Roberts et al., 2023; Milkoreit et al., 2016). The effectiveness  
1239 of literature, film and art in promoting ethical responses to climate change is increasingly being  
1240 recognised in empirical studies (James, 2015; von Mossner, 2017; Houser, 2014) and, as David  
1241 Holmes states, 'the arts have an ability to communicate the vulnerability and sensitivity of  
1242 climate issues that other channels may lack' (Holmes, 2020). Therefore, in the context of tipping  
1243 points, engaging a wide range of stakeholders in creative co-production would offer an open-  
1244 ended, non-instrumental approach to communication that could be key to achieving ethical  
1245 solutions in this complex field.

1246  
1247  
1248 **5. Conclusion**  
1249

1250 Biophysical tipping points pose existential threats to current and future generations, both human  
1251 and non-human, with those currently underserved being the most vulnerable. It is therefore  
1252 imperative to act. However, this cannot be done in a way that perpetuates past and current  
1253 unjust or inequitable outcomes. Considerations of what needs to change, who is being asked to  
1254 change and where the change or its impacts will be felt and by whom, require a level of  
1255 reflexivity and systemic understanding. All actors have a role to play in ensuring that justice,  
1256 equity and ethics are incorporated to all actions, with a particular emphasis on the inclusion of  
1257 marginalised voices; those most affected by disruptive environmental change and the least  
1258 responsible for causing it. Finally, enabling social tipping points towards radical transformations  
1259 could benefit from more diverse perspectives to open up the solution space, leveraging a shift in  
1260 worldviews and paradigms rather than just reconfiguring materials and feedbacks (Meadows,  
1261 1999). Trying to fix a system using the same tools that created it is not the best way to go about  
1262 solving our planetary crises. Taking a cautious step back to explore all options, not just those  
1263 that seem to offer a quick fix or 'low-hanging' fruit, could offer a more substantial route into  
1264 thinking through tipping points that could create a more equitable as well as sustainable future.

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1291 Author contribution  
1292 LP conceptualised the paper and prepared the initial draft together with SRS, LG, PN, BS and  
1293 SV. TA, AC, SC, AG, CV, TP and CZ edited and reviewed the draft.

1294  
1295 Competing interests  
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Page 1: [4] Style Definition	Admin	18/12/2023 12:45:00
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Caption

Page 1: [5] Style Definition	Admin	18/12/2023 12:45:00
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Equation

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Balloon Text

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Affiliation

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MS title

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Name

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Kontakt

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Header

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Bullets

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Heading 4: Font: (Default) Arial, 12 pt, Not Bold, Font colour: Grey-60%, Left, Space Before: 14 pt, After: 4 pt, Line spacing: Multiple 1,15 li, Keep lines together

Page 1: [16] Style Definition	Admin	18/12/2023 12:45:00
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Heading 3: Font: (Default) Arial, 14 pt, Not Bold, Font colour: Custom Colour (RGB(67,67,67)), Left, Space Before: 16 pt, After: 4 pt, Line spacing: Multiple 1,15 li, Keep lines together

Page 1: [17] Style Definition	Admin	18/12/2023 12:45:00
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Heading 2: Font: (Default) Arial, 16 pt, Not Bold, Left, Space Before: 18 pt, After: 6 pt, Line spacing: Multiple 1,15 li, Keep lines together

Page 1: [18] Style Definition	Admin	18/12/2023 12:45:00
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Heading 1: Font: (Default) Arial, 20 pt, Not Bold, Font colour: Auto, Left, Space Before: 20 pt, After: 6 pt, Line spacing: Multiple 1,15 li, Keep lines together

**Page 1: [19] Style Definition      Admin      18/12/2023 12:45:00**

Normal: Font: (Default) Arial, 11 pt, Left, Line spacing: Multiple 1,15 li

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Font: Bold, Font colour: Custom Colour (RGB(70,70,70))

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