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DISCUSSION



Rethinking Planetary Boundaries: Accounting for Ecological Limits

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ABSTRACT



The concept of planetary boundaries offers a framework for understanding and managing humanity's impact on Earth's ecological systems. These boundaries mean to delineate a safe operating space in which human activities must remain to ensure the stability of critical Earth processes. Notwithstanding its potential, the planetary boundaries framework faces criticism for its reductionist nature, technocratic approach, and the lack of consideration given to social issues. This commentary explores current accounting research relating to planetary boundaries and emphasises the need for a broader range of interdisciplinary, inclusive, and holistic approaches towards accounting for ecological limits. Drawing from fields such as political ecology, ecofeminism, and environmental justice, we highlight the importance of considering social, economic, and political forces in shaping planetary boundaries. We also recognise the potential challenges in reconciling different forms of accounting for ecological limits and the varieties of knowledge involved. We thus propose maintaining a pluralism of approaches in fostering open communication between the diverse senses and meanings of planetary boundaries and the ecological limits which they articulate. An accounting for planetary boundaries in which diverse ways of knowing, sensing, modelling, and narrating can coexist will encourage, we hope, a more holistic, open, and congenial understanding of our planetary situation.

KEYWORDS

Planetary boundaries;
environmental accounting;
ecological limits;
environmental humanities;
pluralism

Understanding Planetary Boundaries' Fundamental Principles

The concept of planetary boundaries has emerged as a vital framework for comprehending and, ideally, remaining within Earth's ecological limits in the context of human-induced environmental changes. At the core of this concept lies a fundamental principle: the recognition that human activities have increasingly imposed pressures on Earth's ecosystems, resulting in disruptions. Coined by Johan Rockström and colleagues in 2009, the concept of planetary boundaries aims to define a safe operational zone within which humanity can thrive while preserving the stability of critical earth system processes (Rockström et al. 2009a). Adhering to these boundaries is noted as essential to safeguarding the

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resilience of Earth's ecosystems and ensuring the long-term well-being of both humanity and the planet's biodiversity.

The underlying scientific research has played a pivotal role in identifying nine key Earth system processes, including climate change, biodiversity loss, land-use change, and pollution. These processes, if surpassed, could lead to irreversible environmental changes and pose significant risks to ecological integrity, human societies, and the future habitability of the planet. As such, the planetary boundaries framework attempts to define Earth's ecological limits as frontiers that are not to be crossed. However, the latest assessment (Richardson et al. 2023) revealed that six out of nine boundaries are currently transgressed, with increasing pressure observed across all boundary processes except for ozone depletion. For instance, the alarming rate of biological diversity loss is a grave concern and represents a key planetary boundary. The proposed threshold is set at less than 10 extinctions per million species per year, yet current extinction rates have surged into the hundreds (Ceballos et al. 2015), profoundly impacting ecosystem functionality. The significance of planetary boundaries is most evident in these intricate interconnections which highlight the potential for interactions and feedback loops among these Earth system processes. The breach of one boundary can intensify pressure on others, triggering cascading effects and the potential crossing of tipping points that result in abrupt and irreversible changes in Earth's systems. By identifying these boundaries, the framework seeks to provide guidance to policymakers, researchers, and society at large, facilitating informed decision-making and actions aimed at maintaining human activities within a safe operating space. In particular, this offers a foundation for establishing targets, policies, and strategies to mitigate environmental impacts and steer transitions towards sustainable pathways.

In this commentary, we wish to encourage a broader and more critical engagement with the concept of planetary boundaries. We aim to reveal pathways for accounting research to contribute significantly to a better understanding of planetary boundaries by drawing attention to diverse articulations of ecological limits. With this objective in mind, we reflect on the future of accounting research and practice in articulating planetary boundaries and sensing the ecological limits of our shared existence.

Background and Limits of Planetary Boundaries and Similar Frameworks

The concept of planetary boundaries, as introduced and defined by Rockström et al. (2009a), can be viewed as an evolution of earlier concepts such as 'guardrails' and 'tolerable windows' which were developed in the late 1990s by the German Advisory Council on Global Change in collaboration, among others, with the Potsdam Institute for Climate Impact Research. The concept of tolerable windows involved establishing normative guidelines, referred to as guardrails, to prevent the climate system from approaching potentially unstable states and to mitigate the risk of dramatic climatic hazards (German Advisory Council on Global Change, 2000). One specific guardrail that emerged from this concept was the target of limiting the average global temperature increase to a maximum of 2°C, which is now widely recognised and accepted by most governments as a critical threshold for avoiding dangerous climate change.

Furthermore, the notion of planetary boundaries, as well as guardrails, aligns closely with the broader field of research on critical transitions, tipping points, and tipping

elements within the earth system. Tipping elements are defined as parts of the earth system that can undergo qualitative shifts into different states due to small perturbations under specific circumstances (Lenton et al. 2008). Tipping points can be seen as critical values at which these shifts occur, fundamentally altering the state of the system. While our understanding of tipping points in the earth system remains limited, ongoing research aims to identify early-warning signals and indicators for these critical transitions (Scheffer et al. 2009).

Notwithstanding the variations in approach, perspective, and research trajectory, the notions of planetary boundaries, guardrails, tipping points, and critical transitions all converge on a shared objective: the quantified identification of the boundaries that delineate the safe operating space for humankind on planet Earth. These notions highlight the need to set limits and thresholds to prevent the earth system from entering potentially irreversible and hazardous states, ensuring the long-term sustainability of both human societies and the natural environment.

However, while planetary boundaries offer a useful way towards understanding what is needed to keep the earth system within the limits of the safe operating space for humanity, these boundaries are subject to criticism related to the challenge of precisely quantifying and measuring complex earth system processes. On the one hand, such boundaries lack clear scientific consensus and oversimplify the interconnectedness and cumulative effects of breaching multiple boundaries. Moreover, there are concerns about the subjective and arbitrary nature of threshold levels set for each boundary (Cornell 2012). And while the authors of the planetary boundaries stated that the selection of these boundaries was shaped by scientifically pinpointing established boundary conditions within the earth system (Rockström et al. 2009b), critiques argued that the selection of these boundaries was inherently influenced by a normative judgement about the level of risk acceptable to society (Biermann 2012; Biermann and Kim 2020) as 'the idea of a limit involves setting a maximum level of damage to a natural resource system that we are prepared to tolerate or accept' (Haines-Young et al. 2006). However, what's considered acceptable varies based on the risk appetites of different societies. Critics also emphasize that these decisions should not be solely in the hands of natural science experts (Pickering and Perrson 2020), especially when many hail from affluent industrialized nations (Schmidt 2013).

At the same time, the articulation of planetary boundaries often appears to prioritise scientific and ecological considerations over social, cultural, and political dimensions. It has been argued that the concept overlooks the power dynamics, inequalities, and social justice issues inherent in environmental challenges (Brand et al. 2021). The crux of the contention also lies in the fact that these boundaries were suggested without input from stakeholders or the general public. Thus, for some scholars, the concept of planetary boundaries reinforces a top-down, technocratic approach to global environmental governance, potentially overshadowing the importance of local knowledge, community engagement, and participatory decision-making processes. Addressing planetary boundaries requires not only technical solutions but also transformative social and political changes (Biermann 2012). As a result, critiques have expressed concerns about this seeming shift towards an expert-led, technocratic world, likening it to a 'global expertocracy' (Biermann and Kim 2020). These criticisms highlight the need for a more interdisciplinary, inclusive, and not one-sidedly technoscientific approach that incorporates social, cultural, and political perspectives into the understanding and management of planetary boundaries.

As a progression of the planetary boundaries' framework, the Doughnut Economics framework developed by the economist Kate Raworth (2017) provides a new and arguably broader approach that considers both social foundations and ecological limits in the articulation of planetary boundaries. The outer boundary, the ecological ceiling, describes the planetary boundaries above which humanity cannot go without risking its global ecosystem's carrying capacity. The aim is to ensure that human activities stay within this ecological ceiling, avoiding overshoot and protecting Earth's vital systems. Within the outer ring lies the inner circle of the doughnut, which represents the social foundation. This foundation encompasses the minimum social requirements necessary for human well-being, including access to basic needs such as food, clean water, health-care, education, and social equity. As such, the doughnut economics framework seeks to find a balance between the outer ecological limits and the inner social foundations. This model requires us to think more holistically about our ecological, social, and economic systems and the connections between them (Laine et al. 2020). Given these connections, transformative changes may face resistance from powerful vested interests and encounter political and economic barriers that hinder their adoption.

Raworth's Doughnut Economics framework is arguably more reflexive than other articulations of planetary boundaries by making the discipline of economics both a stepping stone for and a recipient of thoroughgoing critique from a consideration of ecological limits. However, much like in other articulations of planetary boundaries, the role of the specific types of knowledge and the apparatuses, technologies and disciplines articulating ecological limits is not given much consideration. Most notably, the social construction of the scientific knowledge underwriting the understanding of these limits remains latent, and the epistemological and technoscientific basis of articulating planetary boundaries is being taken for granted. This lack of reflexivity risks inadvertently universalising a one-world view of planetary boundaries that is in fact culturally and technologically unique and might marginalise if not obscure any sense of ecological limits that exists outside of its apparatus (see also Ehrnström-Fuentes and Böhm 2023). Where Raworth uses her understanding of ecological ceilings to question the knowledge base of the scientific discipline of economics, such reflexivity is lacking where the technoscientific apparatus articulating planetary boundaries is concerned.

Accounting and Accountability for Planetary Boundaries

We believe that closer attention with the accounting practices informing the articulation of planetary boundaries as well as the articulation of ecological ceilings and limits more generally considered can contribute to overcoming this lack of reflection and reflexivity. Although notions of planetary boundaries have primarily been developed outside of accounting scholarship and practice, accounting represents a domain in which these concepts can be applied (Schaltegger 2018). Translating the concept of planetary boundaries into specific sustainability limits necessitates a closer examination of the science of sustainable development (Bebbington and Larrinaga 2014; Schaltegger et al. 2013). Given the escalating challenges in social and ecological domains, accounting plays a pivotal role in exploring the intricate connections between organisations and the dynamics of the Anthropocene era (Bebbington et al. 2020). It becomes imperative to evaluate the role accounting can play, not only in collecting information about ecological limits but

also in raising awareness regarding planetary boundaries (Bebbington et al. 2020). Drawing on Robson (1991), Jabot (2023) critically argues that, in the process of translation, the following four dimensions – including social debates, normative debates, narrative debates and control debates¹ – arise at the intersection of the discourse surrounding the need to operationalise the framework of planetary boundaries and the impact of accounting techniques.

Within the accounting literature, several environmental issues have been explored independently of the planetary boundaries framework, often aimed at quantifying and managing the impacts of human activities on the planet (e.g. Bebbington and Larrinaga-González 2008; Andrew and Cortese 2011; Ascui and Lovell 2011; Bowen and Wittneben 2011; Jones 2003; Jones and Solomon 2013; Samkin, Schneider, and Tappin 2014; Cuckston 2017, 2018a, 2018b; Atkins et al. 2018; Weir 2018; Gray and Milne 2018; Gibassier and Alcouffe 2018; Sobkowiak, Cuckston, and Thomson 2020). Additionally, some studies have considered how to integrate planetary boundaries specifically into accounting practices (e.g. Linnenluecke et al. 2015 for asset impairment; Veldman and Jansson 2020 and Antonini and Larrinaga 2017 for corporate reporting and indicators; and Wu et al. 2021; Xian et al. 2023 for environmental footprints). This led Schaltegger (2018) to suggest that the notion of planetary boundaries holds significant heuristic potential for translation into practical innovations in accounting and management, making it relevant and tangible for individual actors.

While the current notion of planetary boundaries can be assessed at the macro level, we argue that existing scholarship in accounting for planetary boundaries discussed above mostly remains constrained by the entity concept and its focus on the organisation (see also Russell, Milne, and Dey 2017). These limitations give rise to recurring concerns that span various dimensions and are inherently interconnected.

Reductionism and Oversimplification

In the context of accounting for the planet and planetary boundaries, there is a proclivity toward reductionism. This involves simplifying intricate ecological systems and processes into numerical values and indicators. However, such simplification can inadvertently overlook the inherent uncertainties, nonlinear dynamics, and complex interdependencies within Earth's systems. Relying predominantly on quantitative metrics may sideline aspects that are not easily quantified, local contextual knowledge, and the holistic understanding of ecologies of life that will often be crucial for effectively addressing sustainability challenges (Nykvist et al. 2013; Keppner et al. 2020; Drees et al. 2021).

Technocratic Approach

Current approaches to accounting for planetary boundaries often adopt a technocratic stance. They prioritise scientific and technical solutions to environmental challenges, which can neglect the broader social, cultural, and political dimensions integral to sustainable development (Lövbrand et al. 2011). Critics argue for a shift towards more participatory and democratic decision-making processes that actively involve a diverse array of stakeholders and would ideally incorporate a wider spectrum of knowledge systems, including indigenous and local wisdom (see also Escobar 2017; Krawec 2022).

Social and Equity Shortcomings

Accounting for the planet and its boundaries sometimes falls short in addressing social justice and equity concerns. The consequences of breaching planetary boundaries disproportionately affect marginalised communities and future generations. To address this imbalance, critics advocate an approach that champions inclusivity and social justice. This involves confronting the underlying power structures, inequalities, and social dimensions that underpin sustainability issues (see further discussion by Brand et al. 2021).

Disaggregation Challenges

Effectively dealing with planetary boundaries necessitates a systemic and collaborative approach that extends beyond individual organisational boundaries. Planetary boundaries are not isolated entities; they are interconnected and interdependent. Actions in one domain can reverberate through others. Fragmenting these boundaries down to the level of individual companies' risks oversimplifying complex interactions and missing the cumulative impacts of numerous actors and activities within the larger system. Planetary boundaries operate at a global or regional scale and encompass the cumulative effects of various sectors, industries, and societal activities. Addressing them at the level of individual organisations might not adequately capture the broader systemic repercussions and can narrow the focus to isolated environmental aspects, disregarding the holistic context. While organisations do disproportionately contribute to overall environmental impacts, assigning responsibility and accountability solely at the organisational level might ignore the broader structural and systemic factors that shape environmental outcomes. Addressing planetary boundaries calls for collective action, policy reforms, and systemic transformations that transcend the actions of individual organisations.

These limitations point to shortcomings of the current articulation of planetary boundaries and call into question the underlying practices of environmental accounting (Tregidga and Laine 2022). Perhaps accounting researchers are uniquely placed to recognise these limits on the back of an interdisciplinary discourse spanning four decades discussing accounting's constitutive and literally world-shaping effects within the social contexts in which it operates (Burchell, Clubb, and Hopwood 1985; Hines 1988). With the recognition of these effects, any accounting that speaks with the voice and authority of a particular type of expertise will prompt questions which other accounts – and with them, which other worldviews, intuitions, cognitions – are being outperformed (see also Yu and Huber 2023).

Can We Broaden our Sense of Ecological Limits?

Given the discussion above, we suggest rethinking the concept of planetary boundaries in a more pluralistic and open-ended manner, without giving up the original ambition of finding a safe operating space for life on Earth. This entails recognising the global nature of most critical ecological and social challenges. In pursuit of this, we wish to encourage collective reflection on the diversity of approaches to understanding and articulating planetary boundaries. For instance, how far need we think beyond securing a safe place for humanity, at the possible expense of other forms of life? How can we settle on any planetary boundary? Who should have a say in defining our affordances

and limits? How should we account for these operating spaces, ecological affordances and limits? Considering the array of issues currently at play, how can we reconceptualise the idea of planetary boundaries? We wish to suggest several avenues of exploration.

Firstly, critical social science perspectives (Löwbrand et al. 2015), such as political ecology, postcolonial studies, science and technology studies, and critical geography, can enrich our understanding of ecological limits. These perspectives shed light on the social, economic, political, epistemological and ontological forces that shape environmental change and resource distribution (e.g. Arboleda 2020; Asdal, Druglittø, and Hinchliffe 2017; Bresnihan and Millner 2023; Chandler 2017; Liboiron 2021; Tsing 2015). By critically examining power dynamics, structural inequalities, and dominant discourses, they provide insights into how accounts of planetary boundaries as well as the boundaries themselves are constructed, contested, and experienced.

Secondly, ecofeminism (e.g. Cooper 1992; Cooper and Senkl 2016; Mellor 1997) emerges as another area for research on accounting for planetary boundaries to explore. Accounting is seen as a system that regulates and dictates, prioritizing legal frameworks over natural ones and fostering a hierarchical structure where the dominant groups take precedence over subordinates (Shearer and Arrington 1993). At its core, conventional accounting operates on the assumption that there's an objective external world that can be measured and quantified (Hines 1992). According to Hines (1992), traditional form of accounting suppresses attributes often associated with the feminine or 'Yin' dimension, such as intuition, feelings, and inner experiences (314). Ecofeminism could be used as sound guidance for a more holistic understanding of the power dynamics involved in the process of articulating, quantifying and measuring planetary boundaries. It would also allow reflection on diverse forms of knowledge (e.g. through multiplicity, interconnectedness and connection to the earth) and how they could be integrated into accounts of planetary boundaries. Ecofeminism also emphasises the importance of recognising how human actions within broader ecological systems are intertwined with issues of gender and societal boundaries (e.g. Powell and McGuigan 2023). As such, exploring relationships between planetary and societal boundaries is another potentially interesting area for further research.

Thirdly, ecofeminism has strong links to the concept of environmental justice, especially through their shared recognition of the interconnectedness of social and environmental inequalities. By highlighting the disproportionate impacts of environmental degradation on marginalised communities, environmental justice frameworks (e.g. Ensor and Hoddy 2020) could play a crucial role in understanding and articulating planetary boundaries. In particular, we believe addressing the social, economic, and political factors in planetary boundaries could help acknowledging environmental injustices and advocates for addressing underlying power structures, inequalities, and questions of equity and justice (Ensor and Hoddy 2020). Moreover, this would open up questions around what types of 'safe operating spaces' the current planetary boundaries are creating and for whom (and whom not). In doing so, further research might want to renew discussions around accounting for planetary boundaries highlighting or obscuring mechanisms and relations that contribute to the marginalisation of the poorest and the structures enabling inequality and ecological degradation as part of the setting and implementation of planetary boundaries.

These efforts should include approaches that are *participatory*. Engaging diverse stakeholders, including local communities, indigenous groups, and marginalised populations, in the process of sensing and articulating Earth limits can provide valuable insights.

Participatory approaches involve integrating local knowledge, values, and lived experiences into decision-making processes, ensuring a more inclusive understanding of environmental limits. Participatory research methods, such as participatory mapping (e.g. Chambers 2006; Sletto 2009), citizen science initiatives (e.g. Brown et al. 2018; Kimura and Kinchy 2016), and community-based monitoring (e.g. Fernandez-Gimenez 2008), can help gather data and perspectives from various stakeholders. These approaches might also open up new sources of knowledge for planetary accounts as well as counter accounts of organisational impact on environmental limits (Dey, Russell, and Thomson 2011; Denedo, Thomson, and Yonekura 2017).

Fourthly, accounting for ecological limits will also involve *narrative, storytelling, literary studies and literary criticism*. Incorporating narratives and storytelling can enhance the understanding and articulation of ecological limits and in fact has always been intrinsic to how we make sense of any matter of ecological concern (Galafassi, Daw, et al. 2018). Narratives allow individuals and communities to express their relationships with the environment, their experiences of environmental change, degradation and renewal, and this has been documented widely in ecocriticism and related literary studies (e.g. Stibbe 2021; Cronin 2017; Iovino and Oppermann 2014; Walton 2021). Scientists, natural or social, make use of stories, oral histories, and creative expressions to capture diverse perspectives on environmental limits and have their own stories to add of being in the field and of connecting with communities and ecosystems, their vulnerabilities and affordances (Puig de la Bellacasa 2017; Salazar et al. 2020). The field of Environmental Humanities (www.environmentalhumanities.org; Schaberg 2019) still remains under-recognised in a discourse of planetary boundaries that draws its energy mainly from the technoscientific modelling of ecosystems dynamics.

Finally, integrating *arts-based approaches more broadly considered*, including visual and performance arts can facilitate alternative ways of sensing and articulating ecological limits (Szerszynski, Heim, and Waterton 2003; Galafassi, Tabara, and Heras 2018; Living Earth 2016; Thomson 2022) and encourage a broader and more inclusive dialogue about sustainability and environmental stewardship. Art and the Arts, alongside the Humanities, enable emotional and aesthetic engagements with environmental issues, offering diverse ways of understanding and communicating complex ideas and of connecting with the varieties of life and lived experiences involved in the sensing of ecological limits (see also Arjaliès et al. 2021). These approaches can foster creativity, imagination, and empathy, all of which are in no sense unfamiliar to natural or social scientists but still so often missing in the representation of their work and experience. Considering that this commentary addresses a relatively underexplored issue in accounting, we encourage exploration and questioning of diverse possibilities (or impossibilities) for integrating the concept of planetary boundaries from various perspectives. Can we integrate different accounting methods into ecological models and notions of planetary boundaries? Should we attempt such integration? If we broaden our senses of ecological limits beyond the existing planetary boundaries and include different ways of accounting for them, can we integrate the diverse ways of sensing and knowing that result from this into our models of ecological systems, their responses to disturbances, their resilience, vulnerabilities, or tipping points? Or do we need to accept that modelling ecological systems will remain a technoscientific endeavour, separate from other, less technical, less numerical, less disciplined, and messier ways of relating to the world?

Our collective 'requisite variety' of relating to the world stands to benefit from a multiplicity of senses, technologies, and accountings of the environment, particularly where we strive for a holistic position and can never seem to get there. It might be that we would lose some of this variety by forcing the assimilation of different forms of knowledge into ever-bigger models of the planet and its ecosystems. Any model of the planet that we build in order to sense more broadly, or ever more precisely ecological limits or planetary boundaries will have to contend with other models, and that is a good thing. One way to reassure this position would be to simply maintain and defend the presence of diverse ways of sensing ecological limits, potentially disrupt and annoy the system-builders with this presence and re-assure otherwise side-lined stakeholders that they will find support for their own divergent or peripheral views.

However, even where we are sceptical about the desirability or overall likelihood of modelling ecological limits in a way that would be able to embrace the full diversity of our accounts and accounting, we still desire mutual exchange and interconnectivity between different senses of ecological limits. The risks of one model of ecological limits dominating another, whether in the name of science or in the name of industry (a profession, a faith, and so on), might be low where the lines of communication remain open and well attended. But there are also power dynamics that play out between different accountings and their different languages that we need to be aware of (Laaksonen 2022; Venuti 2018; Cronin 2017). So, what are appropriate modes of engagement between and across the different accountings for ecological limits? How far can they bleed into one another without diluting or even spoiling what each of them can tell us about our planetary situation, respectively?

Modernity's response to such questions has been to separate science from politics, treating the first as a matter of producing robust knowledge and the latter as a matter of agreeing on collective action. In such a settlement, the best politics could do would be to follow the science, and we would treat anything that is possibly political about scientific practice as a matter of contamination. However, our current planetary situation has brought us to the point where we see that the very separation of science and politics has become – and has possibly been for quite a while – an illusion (Latour 2004, 2017). The copresence of multiple accountings for ecological limits and planetary boundaries force us to reconsider how different ways of seeing and sensing the world can interact in meaningful and mutually beneficial ways (Escobar 2017; Cadena and Blaser 2018). Bringing them into conversation cannot be but a scientific and a political practice at the same time: a question of how can we ensure the inclusion of a relevant and diverse set of accounts and accountings in understanding where we are and what to do about it.

Concluding Comments

In this commentary, we have offered a brief critical appraisal of the original concept of planetary boundaries and the so far limited role of accounting research in realising the transformative potential of accounting for ecological limits. While planetary boundaries offer a valuable lens through which to view ecological limits, limitations and criticisms include concerns about oversimplification, the dominance of technocratic perspectives, insufficient attention to social and cultural issues or considerations of social justice and

equity, and the challenge of accounting's own preoccupation with organisations as units of analysis. We have suggested several pathways for accounting research and practice into a broader understanding of planetary boundaries to enable more diverse ways of sensing and articulating ecological limits. Incorporating critical social science perspectives, political ecology and postcolonial studies, science and technology studies, literary criticism, environmental arts and humanities can shed light on environmental change, ecological degradation and renewal, the forces shaping it as well as the underlying power and justice dynamics, and the ways of life that suffer, prevail, or disappear as a result. Ecofeminism offers insights into the interplay between human-nature interactions, gender relationships and different forms of knowledge, while environmental justice frameworks highlight the intersectionality of social and environmental inequalities and the role of accounting in potentially perpetuating structures enabling inequality and ecological degradation. We highlighted narrative and storytelling, participatory and arts-based approaches that help enrich this comprehension of ecological limits by integrating local knowledge and experiences, cultural values and emotions, creativity, empathy, and diverse ways of sensing and knowing, all encouraging transformative actions toward a more sustainable way of life on their own terms, respectively.

These considerations raise fundamental questions about the integration of different accounting methods, models, and perspectives into our understanding of ecological limits. They highlight the importance of maintaining a diversity of approaches and of fostering open communication and interconnectivity between different senses of ecological limits. In the face of our current planetary challenges, the separation of science and politics appears increasingly illusory. The coexistence of multiple accounts and accountings for ecological limits compels us to reconsider how these diverse ways of sensing and understanding the world can interact meaningfully and reshape our collective response to the urgent environmental issues we face. This requires not only scientific but also political and cultural practice in unpacking and reshaping the accounts and accountings that will in turn help us unpick and reshape how we understand our shared planetary situation and do something about it.

Note

1. In detail, the social dimension includes discussion around the missing social debate in planetary boundaries, the vision of the world they propose, their undemocratic development process, their relationship to economic growth. The normative dimension links to risk positioning, downscaling needs, and the allocation of global resources. The narrative debate explores issues around the language of the framework, the lack of guidance on how to achieve them or how they link to corporations, the lack of comprehensive description of the consequences of overshooting, the lack of prioritisation and the assumption of a uniform humanity. The last dimension – control – debates the need for indicators, dashboard, earth stewardship, reporting and assurance, appropriate visualisation and boundary setting.

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