Planetary boundaries, the Anthropocene and global governance: the challenge of negotiating a safe and just space for humanity

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In an extraordinary era defined by the unprecedented impact of human behaviour on Earth's systems. the ideas of planetary boundaries and the Anthropocene have become central to discussions on sustainability and environmental management. Derived from the Greek words for human ('anthropo') and new ('cene'), the Anthropocene represents a geological epoch in which humans are the dominant force on the planet with planetary boundaries representing a kind of ‘planetary dashboard’, a global aggregation of humanity’s performance on environmental issues which have undermined the capacity of Earths systems and within which a safe operating space has been clearly defined. While science has provided the framework to help understand these complex issues and find solutions, addressing the challenges of the Anthropocene requires effective global governance with a focus on inclusivity, equity, and sustainability to support an effective and just response. This paper will explore the concepts of planetary boundaries and the Anthropocene, discuss the problem with transgressions, explain the need for inclusive global governance and the challenges of implementation and finally propose solutions from the perspective of sustainable development.

As we enter a period in which humans are the dominant influence on the environment, understanding the meaning of planetary boundaries and the Anthropocene is important. Initially proposed by Johan Rockström in 2009 as a novel concept, the boundaries concept includes nine planetary boundaries within which humanity can continue to develop and thrive. Boundaries are an interesting concept as unlike thresholds defined as non-linear transitions in the functioning of coupled human-environmental systems (Schellnhuber 2002), they represent human-determined values of control variables for processes without known thresholds set at distances evaluated as safe. While this can raise questions around the credibility of a deterministic framework which also incorporates human value systems, and despite uncertainty given the initial lack of scientific knowledge about biophysical thresholds, feedback mechanisms and threshold timeframes, these boundaries were scientifically quantified in 2023 and have broadly been accepted. As the era in which this framework defines a safe operating system the Anthropocene is an informal unit of geological time, (Crutzen and Stoermer, 2000), however, it's impact can be measured through pollutant concentrations. It presents an unparalleled degree of danger for life on Earth (Keys et al, 2018), a call to action on environmental sustainability (Ruddiman et al, 2015).and a fundamental shift in the relationship between humans and the environment. The Anthropocene raises important questions and although hallmarked by ideas about human impact and control, it ca be understood as a responsibility and the unprecedented human ability to steward the planet in a positive direction.

According to the planetary boundaries framework update in 2022, six boundaries have now been transgressed with enormous environmental and socio-economic implications. These transgressions include biosphere integrity, biogeochemical flows, novel entities as well as climate, freshwater and land system change with ocean acidification approaching its boundary. Furthermore, the biosphere-related planetary boundary processes which contribute to the resilience of the Earth's system and its ability to regulate are now also at a high-risk of transgression (Richardson et al, 2023) with studies indicating that multiple regional climate tipping points intrinsic to global stability are also nearing critical levels (McKay et al, 2022). Leading to regime shifts in ecosystems marked by large-scale, abrupt, and persistent structural changes, the effects of exceeding planetary boundaries are well documented and include biodiversity loss, ecosystem degradation, disruptions to carbon and nitrogen cycles, an increase in the frequency and intensity of extreme weather events as well as diminished land resources which exacerbate the risk of social instability and conflict. From a socio-economic perspective, regime shifts in ecosystems have significant impacts on society with direct implications for human well-being and livelihoods such as a loss of productivity, decline in yields, and damage to infrastructure. In the renowned Limits to Growth 1972 study of the patterns and dynamics of human presence on earth, Meadows et al discussed the possibility of economic collapse within a century if "business as usual" continued. Regime shifts are particularly important as they disrupt the ecosystem services essential for societies to function as well as societal structures themselves.

Addressing the challenges associated with transgressing planetary boundaries requires a global approach which combines systemic reforms with grassroots initiatives that empower communities while integrating principles of equity and sustainability into governance frameworks based. Environmental issues were viewed as peripheral issues under the jurisdiction of state actors and subject to a weak notion of sovereignty McCormick, (1991), however, with mounting scientific evidence, the international community began to cooperate on environmental issues through scientific organisations, bodies of political dialogue and universal legally binding regulatory mechanisms. Although a global consensus has been reached on a safe operating space, multilateral and regional cooperative efforts have proven inadequate to maintain Earth system equilibrium and new levels of cooperation are necessary in global governance. This requires a radical transformation of existing institutional frameworks for cooperation from a focus on international regimes in environmental politics to a more comprehensive concept of global governance which is inclusive and representative (Franchini et al 2017). Imagining a richer conception of inclusion, Heikkurinen et al (2021) expand on the ideas of agency and draw attention to power imbalance across regions, communities, and socio-economic divides and even across life-forms. Humans have disproportionate control over the fate of all living organisms and while this can seem uncontroversial or taken as a given, Gibson and Graham (2011) suggest a more nuanced understanding is necessary to support the transformative solutions for sustainable development. A world view that prioritises human agency and separates humans literally and conceptually from nature has become institutionalised and a holistic approach is required to tackle ecological crises of which we all are a part.

While quantifying boundaries is crucial, addressing environmental problems at the planetary level poses serious challenges not only because of the scale but because of the complex interlinkages and the implications for global governance. These challenges include the relationship between Earth system science and global policy, the ability of international organisations to address individual boundaries as well as role of global governance in shaping socio-ecological innovations (Galaz et al (2012). A key issue relates to the complicated intersection between economic interests and perceptions of risk which can lead to failure in governance in rapidly changing environments. According to Rockström et al (2023) exceeding boundaries will not only impact on the structure and functioning of the eco-systems but also the socio-economic and political systems that co-evolved and are reliant on the stable Holocene conditions. With a significant impact on policy debates, the boundary framework has faced some resistance in policy sectors and raised issues about the compatibility of ecological democracy and planetary limits. According to Pickering and Persson (2020) this points to key problems in terms of democracy which is to understand to what degree are democratic processes and environmental protection reinforced or in conflict. Arguably framework is in contradiction with democratic principles given its reliance on sectoral expertise and evaluation which fails to include a whole-of-society response and cultural values in terms of environmental issues (Pielke, 2013 and restricts opportunities for economic growth for developing countries (Linnér and Selin, 2013). Nevertheless, while state actors will safeguard development opportunities, many have agreed to targets which place constraints on economic interests to protect the environment.

Despite the complexity of addressing global environmental challenges, there are pathways to support solutions including increased citizen participation. Pickering and Persson (2020) argue that democratic principles can inform the interface between policy and science to manage Earth system governance and advocate for dialogical deliberation over planetary boundaries and targets with regard to policy. While Galaz et al. (2016) also agree on the importance of engaging in debate and discussion concerning environmental crises, they advise against the dangers of demanding exact measurements of boundaries which can impede progress and argue for institutional reform at the international level with a focus on biosphere economics. Given the rapid rate of environmental, social, and technological change, urgent reforms are required since incremental institutional reform is no longer adequate as boundaries are transgressed. Reforms must strengthen treaties that integrate values into global trade and democratic values that support the legitimacy of environmental policymaking. Integrating local and indigenous knowledge with global insights through community-based monitoring and information systems is equally as important for sustainable ecosystem management. A mobilising narrative is also crucial to achieve sustainable development at the global level to help shape policies as well as societal norms. How issues are framed is important with opportunities to lean into ideas of collective responsibilities rather than a reliance on top-down solutions with a focus on learning, innovation, and the utility of a creative and imaginative response.

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The concepts of planetary boundaries and the Anthropocene offer important frameworks for understanding and addressing the unprecedented challenges posed by human impacts on Earth's systems and emphasise the urgent need for global governance that prioritises inclusivity, equity, and sustainability to navigate towards a safe and just future for humanity and the planet. While science provides valuable insights into complex issues, effective solutions require transformative thinking and reforms that strengthen international cooperation, prioritise resilience and integrate diverse perspectives. There are potential challenges in terms of understanding environmental issues across diverse actors at various developmental levels and with varying development needs. This suggests a need for an approach that acknowledges the importance of local contexts and supports agency through a future-oriented goal approach which focuses on risks and opportunities within a safe operating space. Mobilising collective action is key to a sustainable future within a safe operating space and ensuring the well-being of present and future generations.

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