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Introduction to the Biosphere Integrity Boundary

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In 2019, Robert Watson, the Chair of the Intergovernmental Science-Policy Platform on Biodiversity and Ecosystem Services (IPBES), warned that '[t]he loss of species, ecosystems and genetic diversity is already a global and generational threat to human well-being. Protecting the invaluable contributions of nature to people will be the defining challenge of decades to come' (IPBES 2019). This statement highlights the importance of biodiversity to humanity, for example, in terms of crop security. Such warnings are already the backdrop to blockbuster films such as Christopher Nolan's *Interstellar* (2014), in which humanity in a not-too-distant future depends on a few crops and comparatively thin genetic diversity. Reliance on those few crops, increasingly affected by blight in that film, threatens human survival on Earth. The basic idea is not an alternate reality but a foreseeable future. In times of massive environmental change, a wide range of crops would provide fallback options for food security. In its 2019 Global Assessment Report, IPBES also warned that around one in four species is at risk of extinction (Kolbert 2014). At the current rate, this would be one of the worst extinctions in Earth's history, with many mammals used for food and agriculture also at risk (IPBES 2019).

The perspective of the planetary boundaries framework is that the loss of biodiversity has multiple negative impacts on the functioning of the Earth system and thus the preservation of a safe operating space for humanity. In the framework's 2023 update, the boundary on biosphere integrity is 'markedly exceeded', and conditions are moving into a zone of high risk (Richardson et al. 2023: 3). Currently, the boundary on biosphere integrity has two control variables: *genetic diversity* and *functional diversity*.

Genetic diversity refers to the 'maximum extinction rate compatible with preserving the genetic basis of the biosphere's ecological complexity'. The boundary value is set at less than 10 extinctions per million species-years (E/MSY), but with the aspiration of reducing it to one E/MSY. The current value is

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at more than 100 E/MSY (Richardson et al. 2023: 3). Since the 2023 update to the planetary boundaries framework, *functional diversity* has referred to the energy and material flows into the biosphere, also known as net primary production (NPP). NPP can be explained using photosynthesis as an example. Plants (primary producers) use abiotic components (e.g., CO_2 or nitrogen) and energy (i.e., solar light) to produce energy stored in complex organic compounds (e.g., carbohydrates, fats, and proteins). Plants need some of this energy for their own metabolism. So, the energy difference between what they produce and what they need is the NPP, or the net gain over a period. Almost all other organisms depend on the energy sources provided by NPP (Andersen & Quinn 2020). The boundary value sets a limit to the human appropriation of NPP (HANPP) to ensure the functioning of the biosphere. The boundary value is set at less than 10 per cent human appropriation of pre-industrial Holocene NPP, meaning that more than 90 per cent of NPP remains in the biosphere. With 30 per cent HANPP, the current value is already in a zone of high risk, that is, beyond 20 per cent HANPP (Richardson et al. 2023: 3–6).

From an ethical and epistemological perspective, 'biodiversity' is an interesting term. Scientifically speaking, it is about '[t]he variability among living organisms from all sources including terrestrial, marine and other aquatic ecosystems and the ecological complexes of which they are a part. This includes variation in genetic, phenotypic, phylogenetic, and functional attributes, as well as changes in abundance and distribution over time and space within and among species, biological communities and ecosystems' (Díaz et al. 2015: 12). This definition, however, does not fully capture the meaning of the term, which is not only about a quantifiable diversity of species, biological communities, and ecosystems. It also implies that such a diversity is something morally good and in need of political protection. As such, it is a concept composed of scientific forms of knowledge as well as value judgements – something Thomas Potthast (2015) called an 'epistemic-moral hybrid'.

In Chapter 9, Uta Eser traces precisely this specific conceptual history of the term 'biodiversity', which emerged in the borderland between biology, ethics, and politics. She takes a critical look at the planetary boundary itself and how it has developed since 2009. Eser focuses on what value judgements are embedded in the framework's conceptualization of biodiversity, which she finds too reductionist. In Section 9.4, she suggests more inclusive ways of framing biodiversity that recognize the many different human–nature relationships.

Makere Stewart-Harawira's Chapter 10 uses the case of Aotearoa New Zealand to discuss how ontologically distinct human–nature relationships are socially and politically negotiated. Three key points emerge from her text. First, most biodiversity hotspots are located on the lands of Indigenous communities, whose

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understandings of thriving human–nature relationships are often ontologically different from those of an international political community whose knowledge is inspired by Western scientific concepts. Second, there is a need for more inclusive framings of biodiversity that recognize the onto-cosmologies of Indigenous communities and support interspecies justice and the right of more-than-human species to thrive. Third, her case illustrates the fragility of governance approaches and how political achievements are threatened by a movement of extreme right-wing political parties.

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