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Introduction to the Climate Change Boundary

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As a phenomenon, climate change is hard to capture. While its science is mostly uncontested, its politics is not. What we do know is that climate change is warming the atmosphere, with direct and indirect impacts on people, societies, and the natural environment. Like humans, flora and fauna physically suffer from rising temperatures, which also dry out soils and increase the risk of forest and bush fires. Meanwhile, warmer air absorbs more water vapour, leading to extreme weather events with heavy rainfall. Droughts and heavy rains both contribute to human suffering by negatively affecting agriculture (and thus food security) or by challenging and destroying existing infrastructure. The negative impacts of climate change are thus many and varied.

The main cause of global warming is the massive burning of fossil energy sources such as coal, oil, and gas since the start of the Industrial Revolution in the 1750s. Such burning produces gases (mainly CO_2) that accumulate in the atmosphere (and also in the oceans). There, they create the same effect as in a greenhouse: short-wave solar radiation can pass through these gases and reach the Earth's surface, where it is converted into long-wave thermal radiation. These longer waves, however, cannot radiate through greenhouse gases back out to space and so remain in the atmosphere as heat. In addition to burning fossil fuels, also other activities cause greenhouse gases (GHGs), for instance, ploughing up green land, which releases soil-bound GHGs, such as CO_2 or nitrous oxide (N_2O), or animal husbandry as cattle emit methane (CH_4).

The planetary boundaries framework has two control variables related to climate change. The first is the amount of CO_2 in the atmosphere, measured in parts per million (ppm). With the 2015 update of the planetary boundaries concept, the second is the amount of energy remaining in the Earth's greenhouse (Steffen et al. 2015). This effect is called radiative forcing and is measured in watt per square metre (W/m^2). Until the industrial revolution, the thermal balance between the energy received from the sun and the energy radiated by the earth was roughly

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equal. The greenhouse effect means that much more energy is being retained in the atmosphere. The values of the two control variables are well above their pre-industrial reference values. The boundary value for the CO_2 concentration is 350 ppm, while the latest update of the concept puts the current value at 417 ppm. The radiative forcing boundary value is 1 W/m^2, with an actual value of 2.91 (Richardson et al. 2023).

It is clear from what has been said that climate change is a moral wrong, the causes of which must be mitigated and to which both individuals and societies must adapt to avoid unacceptable harms. Now, GHG emissions are largely the result of the ways humans produce and use energy and food, and as such are deeply embedded in the daily lives of all people. What is needed are 'forms of life' (Jaeggi 2018) that emit as little GHGs as possible. This is already a huge ethical challenge, as it involves intense and controversial social deliberations about what constitutes a good human life in such radically different circumstances. Then there are the costs and burdens of climate change, a challenge exacerbated by the fact those causing climate change and those most severely affected often belong to different groups. This leads to debates about restorative and distributive justice (Kalfagianni & Meisch 2020). Current climate change is caused by GHGs emitted in previous decades by people in the Global North and now harming people, often the most vulnerable social groups, in the Global South. So, people today need to correct past social choices while ensuring that future people can live good lives. Moreover, climate change interacts with most of the other challenges addressed in the planetary boundaries framework (Richardson et al. 2023). For this reason, the philosopher Stephen Gardiner (2011) calls it the 'perfect moral storm'. The STS scholar Reiner Grundmann (2016: 562) describes climate change as a 'wicked social problem', that is, 'one that cannot be solved, but must instead be re-solved and renegotiated, over and over again'.

Both chapters on climate change in this volume address the ethical challenge of such a constant renegotiation of climate change, and more specifically, how we know about climate change and whose knowledge contributions count in policy responses to (the causes as well as the effects of) climate change. Both raise ethical questions of epistemic justice, that is, dealing with the unjust aspects of knowledge production processes (Kidd et al. 2017). Gay-Antaki's and Sandré and Gheradi's texts challenge the specific understanding of Western science as objective and universal, when, in fact, it is culturally embedded and as such carries specific value judgements, for example, about the social role of science, forms of acceptable harm, or human–nature relations. While cultural embeddedness is not in itself a problem, it can become one if the underlying normativity remains unquestioned. Such a problem is the question of which knowledge contributions are considered relevant for describing the challenges of climate change or how to respond to them.

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As both chapters argue, Western climate science unduly values some forms of knowledge over others, thereby silencing relevant knowledge holders and producing morally problematic knowledge for action.

Consequently, in their own ways, both chapters address the role of scholars as co-producers of knowledge. In her conceptual chapter, Gay-Antaki argues from a feminist decolonial perspective for 'world travelling' as a different mode of knowledge production that engages deeply with other ways of knowing about the world. For their part, Sandré and Gheradi draw on their experience of working on a project in the Arctic and ask how, as researchers, they have developed an epistemic virtuousness that allows them to amplify plural voices within science.

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