

A measure for environmental justice

The concept of ‘planetary boundaries’ has been updated to incorporate the crucial requirement to protect the world’s most vulnerable people from environmental harm.

How many biophysical boundaries does our planet have? What are the limits of, say, carbon dioxide emissions, ocean acidification, chemicals and air pollution beyond which existence becomes unsafe for Earth and its inhabitants?

Back in 2009, a team of researchers led by environmental scientist Johan Rockström grappled with these questions in an article published in *Nature* (J. Rockström *et al.* *Nature* 461, 472–475; 2009). In the researchers’ view, planet-altering human activities could be assembled into nine groups. Thresholds were calculated for most of them, beyond which the result could spell danger for the planet and its people. The scientists concluded that humanity has crossed three of these nine ‘planetary boundaries’, and that the remaining six would also be crossed unless remedial action was taken.

That article, called ‘A safe operating space for humanity’, has been extraordinarily influential in a relatively short time. Cities around the world have been experimenting with how to apply the findings, and researchers (including many in the original 2009 team) have continued to refine the planetary boundaries in response to feedback and new data.

A gap in the original concept was that it lacked environmental justice and equity – it needed to take into account the fact that everyone, especially the most vulnerable, has an absolute right to water, food, energy and health, alongside the right to a clean environment.

This week, Rockström, together with sustainability scientist Steven Lade and a team of researchers, have modified their original concept to incorporate justice alongside the biophysical boundaries. The resulting findings, which build on a study published in March in *Nature Sustainability* (J. Gupta *et al.* *Nature Sustain.* <https://doi.org/grwfbk>; 2023), show that seven out of eight thresholds have been crossed: the eight are climate, natural ecosystem area, ecosystem functional integrity, surface water, groundwater, nitrogen, phosphorus and aerosols.

Stark warning

The findings are an even starker warning than were those reported in 2009. Arguably, the most striking change since 2009 is that the authors advocate that global warming should be limited to 1 °C above pre-industrial levels. This is lower than the 1.5 °C target agreed at the 2015 Paris climate

conference. It is also a stricter constraint than the recommendation in the 2009 study to keep carbon emissions to 350 parts per million by volume (the pre-industrial value was 280 parts per million by volume).

The authors reason that keeping to 1.5 °C might well enable the world’s more-affluent people to protect themselves, but it would create significant harm for the most vulnerable. The researchers estimate that some 200 million people would be exposed to unprecedented temperature increases and that 500 million people would be exposed to long-term sea-level rise.


In incorporating ideas of justice into their research, Rockström and colleagues build on a body of recent work. Not long after the 2009 paper was published, justice and equity were included in discussions that led to the United Nations Sustainable Development Goals (SDGs), announced in 2015. Environmental justice is also at the core of an innovative idea called doughnut economics. In 2012, economist Kate Raworth, then working for the aid agency Oxfam, and colleagues adapted the 2009 study’s findings to include what Raworth called a “safe and just space”. This space was represented by an area enclosed by a double circle, the ‘doughnut’, whose boundaries could not be crossed. Such a threshold would be measured using the indicators and methodology underpinning the SDGs.

The latest study shows how members of the 2009 team, working with a new generation of scientists and a more multinational team, have risen to the challenge of triangulating their original work with doughnut economics and the SDGs. This has not been easy, and the new work is very much an initial step. In an accompanying News & Views article, Stephen Humphreys, who studies law and social justice at the London School of Economics, acknowledges the difficulty of setting numerical values when integrating ideas from the natural and social sciences. Readers can see how this process worked: alongside the paper, we are publishing the full discussion between authors and reviewers (J. Rockström *et al.* *Nature* <https://doi.org/10.1038/s41586-023-06083-8>; 2023). It underscores where there is agreement and disagreement, and where more data and further refinement will be needed.

This is a wonderful example of how well science functions when different teams study and refine each others’ work. But there is a troubling aspect to the new findings, too. If seven of the eight thresholds have been crossed, what does that mean for our still-feeble efforts to move to a more sustainable path?

Researchers vary widely in their views on how this question should be addressed – from those who advocate working within the current economic system (known as green growth) to those arguing that the present economic system was itself a factor (if not the defining factor) in bringing about the present situation and requires transformation (known as post-growth or degrowth). Some months ago, we urged scientists representing these different approaches to forge more channels of communication between them.

The paper we are publishing represents one such opportunity. If the findings are anything to go by, there is no time to lose.

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