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Editorial

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Earth's boundaries?

An attempt to quantify the limits of humanity's load on our planet opens an important debate.

In this issue of *Nature*, a group of renowned Earth-system and environmental scientists led by Johan Rockström of the Stockholm Resilience Centre sets out to define boundaries for the biophysical processes that determine the Earth's capacity for self-regulation (see **page 472**). The framework presented is an attempt to look holistically at how humanity is stressing the entire Earth system. Provocatively, they go beyond the conceptual to suggest numerical boundaries for seven parameters: climate change, ozone depletion, ocean acidification, biodiversity, freshwater use, the global nitrogen and phosphorus cycles, and change in land use. The authors argue that we must stay within all of these boundaries in order to avoid catastrophic environmental change.

The boundaries are based on existing data. For some processes, such as anthropogenic climate change and human modification of the nitrogen cycle, we may already have crossed the line, and need to back-pedal quickly. For others, such as ocean acidification, we are rapidly approaching a threshold beyond which there may be abrupt and nonlinear changes.

The exercise requires many qualifications. For the most part, the exact values chosen as boundaries by Rockström and his colleagues are arbitrary. So too, in some cases, are the indicators of change. There is, as yet, little scientific evidence to suggest that stabilizing long-term concentrations of carbon dioxide at 350 parts per million is the right target for avoiding dangerous interference with the climate system. Focusing on long-term atmospheric concentrations of the greenhouse gas is perhaps an unnecessary distraction from the much more immediate target of keeping warming to within 2 °C above pre-industrial levels. Nor is there a consensus on the need to cap species extinctions at ten times the background rate, as is being advised.

Furthermore, boundaries don't always apply globally, even for processes that regulate the entire planet. Local circumstances can ultimately determine how soon water shortages or biodiversity loss reach a critical threshold.

Assigning 'acceptable' limits to processes that ultimately determine our own survival is risky in other ways, too. After all, some of the suggested limits may be easier to balance with ethical and economic issues than others. Human interference in the nitrogen cycle may well have damaging long-term consequences, but the production of nitrogen for agriculture has also fed large parts of humanity.

But even if the science is preliminary, this is a creditable attempt to quantify the limitations of our existence on Earth, and provides a good basis for discussion and future refinement. To facilitate that discussion, *Nature* is simultaneously publishing seven commentaries from leading experts that can be freely accessed at *Nature Reports Climate Change* (see **http://tinyurl.com/planetboundaries**).

Defining the limits to our growth and existence on this planet is not only a grand intellectual challenge, it is also a potential source of badly needed information for policy-makers. Such numerical values, however, should not be seen as targets. If the history of environmental negotiations has taught us anything, it is that targets are there to be broken. Setting limits that are well within the bounds of linear behaviour might therefore be a wiser, if somewhat less dramatic, approach. That would still give policy-makers a clear indication of the magnitude and direction of change, without risking the possibility that boundaries will be used to justify prolonged degradation of the environment up to the point of no return.

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