



We must set planetary boundaries wisely

The concept of environmental thresholds is compelling, but it has the potential to shift political focus to the wrong areas, says **Simon L. Lewis**.

As pressure on resources increases, pollution accumulates and humanity's impact on Earth escalates, global-scale governance of the environment is increasingly necessary. In June, the United Nations' Rio+20 Earth Summit in Rio de Janeiro, Brazil, will grapple with these difficult political issues. Up for discussion is a relatively new scientific concept: planetary boundaries.

Formulated in 2009 by Johan Rockström, director of the Stockholm Environment Institute, and his colleagues, the concept is based on the idea that humanity flourished under the conditions on Earth in the 10,000 years leading up to the industrial revolution — the Holocene epoch. So, to maintain human progress, we should keep the planet under similar biophysical conditions. The researchers set out nine key environmental measures and thresholds that should not be breached for fear of pushing Earth out of the Holocene-like 'safe operating space for humanity'. The boundaries include thresholds for climate change and biodiversity loss that have already been crossed.

The idea is conceptually brilliant and politically seductive: clear, quantitative measurements with no obvious judgements on what is 'right' or 'wrong' to include. It is also liberating. Here is humanity's safe space: within it, do what you want.

In Rio, there will be a push to convert the concept into meaningful action. It has support from UN secretary-general Ban Ki-moon, and is included in the conference's draft negotiating text. Yet the boundaries concept has two important flaws, and using it uncritically could unwittingly undermine Rio's twin goals of environmental stewardship and ensuring a good life for everyone.

The first flaw, from a human-welfare perspective, is that not all of the identified parameters are true thresholds that, once passed, can be recovered to move back to Holocene-like conditions. Some parameters are fixed limits, not boundaries. Take disruption of the phosphorus cycle: this is represented in the planetary boundaries concept as the quantity of phosphates flowing into the oceans from crop-fertilizer run-off, which can cause algal blooms and an oxygen deficit for marine life. Framed in this way — 'don't destroy the marine environment' — the boundary makes sense. But more serious for humanity is that phosphorus is a key plant nutrient. Fertilizer is produced from rock phosphate, which forms on geological time scales. When it is gone, it is gone. This does not represent a threshold boundary: it is a depletion-limit. Humanity cannot use more rock phosphate than there is.

This distinction between thresholds (which we can breach), and fixed limits (which we cannot) may seem academic, but it has important policy implications. To highlight a boundary on phosphate pollution, for example, would drive investment in technology to combat the impact on marine

environments, but do nothing to stop the running down of rock-phosphate supplies. To emphasize the depletion limit would shift the focus to technology to use and re-use phosphorus to safeguard stocks.

Similarly, at the Planet Under Pressure conference in London in March, US scientist Steven Running proposed a new planetary boundary: terrestrial net primary productivity (NPP), or more simply, plant growth. Despite massive agricultural expansion in the past century, global NPP has not dramatically increased. It is a ceiling limit. Thus, the allocation of NPP to benefit biodiversity or food, fibre, fodder and fuel for humans is essentially a zero-sum activity. Yet Rockström's published planetary boundary suggests that we could expand croplands by 400 million hectares before reaching the threshold — something that would seriously harm biodiversity.

The second weakness relates to scale. True threshold boundaries come in two types. Some are unambiguously global, such as climate change, which is driven by well-mixed greenhouse gases in the atmosphere. Others, such as nitrogen pollution, are global only if local problems are widely replicated. Even if nitrogen-fertilizer run-off is cleaned up in China's Yangtze River, it has no direct impact on nitrogen pollution in Nigeria's Niger Delta. These are regional problems, but in aggregate can be of global significance. The planetary boundaries concept does note that whereas climate change, ocean acidification and stratospheric ozone depletion are 'systemic processes', the rest are 'aggregate processes'. However, each published safe threshold is based on a single global number, and will probably be treated accordingly.

A global focus on nine boundaries could spread political will thinly — and it is already weak. There is no need for all the world's countries to enter protracted legal discussions on aggregate boundaries: those affected by regional problems should work among themselves to solve them. Global negotiations should focus on managing the clear global planetary boundaries of climate change and ocean acidification, as well as biodiversity loss, which has global drivers.

The concept of planetary boundaries and avoiding dangerous thresholds is important but limited. Furthermore, a narrow focus on maintaining Holocene-like conditions risks side-lining key problems such as the 'plastic soup' of particulate waste that stretches across the Pacific Ocean. This does not fit the boundaries model, because there was no plastic during the pre-industrial Holocene. A simple transfer of a neat scientific idea into the policy arena could cause as many problems for policy-makers as it solves. ■

Simon L. Lewis is reader in global change science at University College London and the University of Leeds, UK.
e-mail: s.l.lewis@leeds.ac.uk

**BOUNDARIES COULD
SPREAD
POLITICAL
WILL
THINLY — AND IT IS
ALREADY
WEAK.**

➔ **NATURE.COM**
Discuss this article
online at:
go.nature.com/4ukvxx