

# Science for Environment Policy

## Four of nine 'planetary boundaries' exceeded

**Civilisation has crossed four of nine 'planetary boundaries'**, increasing the risk of irreversibly driving the Earth in to a less hospitable state, concludes new research. These are: extinction rate, deforestation, atmospheric CO<sub>2</sub> and the flow of nitrogen and phosphorus.

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**Planetary boundaries** are scientifically based levels of human pressure on critical global processes that could create irreversible and abrupt change to the 'Earth System' — the complex interaction of atmosphere, ice caps, sea, land and biota. These boundaries were first identified and put forward by scientists in 2009. They help decision makers by defining a safe operating space for humanity.

Crossing planetary boundaries increases the risk of moving the Earth System to a state much less hospitable for human civilisation than the one in which we have flourished in over the past 11 000 years (the 'Holocene epoch').

Planetary boundaries represent a precautionary approach, based on maintaining a Holocene-like state of the Earth System. Beyond each boundary is a 'zone of uncertainty', where there is an increased risk of outcomes that are damaging to human wellbeing. Taken together the boundaries define a safe operating space for humanity. Approaching a boundary provides a warning signal to decision makers, indicating that we are approaching a problem while allowing time for corrective action before it is too late.

This new research has updated and revised the planetary boundaries and assessed where the state of the planet is in relation to them. To do this, the researchers conducted an extensive review and assessment of scientific publications on planetary boundaries since 2009.

A total of nine planetary boundaries were previously defined. These were: [climate change](#), loss of [biodiversity](#), ozone depletion, ocean acidification, biogeochemical flows (the flow of nitrogen and phosphorus), land-system change (deforestation), fresh water use, atmospheric aerosol loading and chemical pollution.

The new research refined the names and scopes of two of these. The first, originally called 'loss of biodiversity', has been changed to 'biosphere integrity'. This reflects the effect humans have on the functioning of ecosystems as well as their genetic diversity. The second, originally titled 'chemical pollution', has been broadened to 'introduction of novel entities', to incorporate not just chemical pollution but also the release of radioactive and nanomaterials which could also influence the Earth System.

Of the nine boundaries, the researchers report that four of these have now been crossed: extinction rate (one of two indicators for biosphere integrity), deforestation, atmospheric carbon dioxide (an indicator for climate change), and the flow of nitrogen and phosphorus. Action therefore needs to be taken to return to safe operating space in these processes.

The researchers also analysed the many interactions between the different boundaries. They identified 'climate change' and 'biosphere integrity' as two 'core boundaries' which are connected to all of the other planetary boundaries and either of which, alone, could 'drive the Earth System into a new state'.

Identification of these core boundaries may help decision makers develop policies that help us avoid a less hospitable Earth. It also highlights how concerted political action, in the form of controlling atmospheric release of CFCs, has allowed us to move away from the boundary for ozone depletion.

