

# Nearly half the systems crucial to stability of planet compromised

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Almost half of the processes that are crucial to maintaining the stability of the planet have become dangerously compromised by human activity. That is the view of an international team of 18 researchers who provide new evidence of significant changes in four of the nine systems which regulate the resilience of the Earth. One of the systems which has been seriously affected is the nitrogen-phosphorus cycle which is essential to all life, and is particularly important to both food production and the maintenance of clean water.

"People depend on food, and food production depends on [clean water](#)," says Prof. Elena Bennett from McGill's School of the Environment who

contributed the research on the nitrogen-phosphorus cycle to the study. "This new data shows that our ability both to produce sufficient food in the future and to have clean [water](#) to drink and to swim in are at risk."

The research fixing new [planetary boundaries](#) (which represent thresholds or tipping points beyond which there will be irreversible and abrupt [environmental change](#)) was published today in the journal *Science*. It suggests that changes to the Earth's climate, biosphere integrity (a concept covering loss of biodiversity and [species extinction](#)), and land-system (through deforestation for example) represent a risk for current and future societies. The fourth process which has become significantly compromised is the nitrogen-phosphorus cycle, which affects both the water we drink and our ability to produce food.

There are two issues relating to the state of the phosphorus-nitrogen cycle. Both elements are essential to plant and animal life. But one of the problems is that phosphorus, which is used as a fertilizer for fields and lawns is in limited supply, and that supply is geopolitically concentrated. Nearly 90% of all known phosphorus reserves are found in just three countries - the vast majority is in Morocco, with China, Algeria coming in next.

The second issue is that the excess of phosphorus-based fertilisers that drain from fields and lawns into neighbouring lakes can have disastrous effects on the surrounding water. It can lead to the sudden growth of algae that can cause the decline or death of other lake organisms and produce toxins that are dangerous to people or animals that swim in the lake or get drinking water from it.

"About half a million residents of the city of Toledo found out that their tap water had been contaminated with a toxin called microcystin last summer. And in 2007 the Quebec government declared that more than 75 lakes were affected by toxins produced by blue-green algae, says

Prof. Bennett. "This kind of problem is likely to become much more common. We will see more lakes closed, will have to pay more to clean our water, and we will face temporary situations where our water is not cleanable or drinkable more and more frequently. That's what it means to have crossed this planetary boundary. It's not a good thing for any of us."

Prof. Elena Bennett, of McGill University's School of the Environment, participated in developing the new assessments on the phosphorus and nitrogen cycles - one of the four core planetary boundaries that scientists believe to have been crossed.

## **Key points:**

- The concept of planetary boundaries has been updated with new assessments and quantifications.
- Climate change and biosphere integrity identified as core planetary boundaries. Significantly altering either of these "core boundaries" would "drive the Earth System into a new state".
- Four boundaries are assessed to have been crossed, placing humanity in a danger zone: climate change, loss of biosphere integrity (biodiversity loss and species extinction), land-system change, altered biogeochemical cycles (fertiliser use - phosphorus and nitrogen).
- Crossing boundaries raises the risks to current and future societies of destabilising the Earth System – the complex interactions of land, ocean, atmosphere, ice sheets, life and people.
- Internationally agreed upper climate limit of 2 degrees lies beyond the [climate change](#) boundary: which makes 2 degrees a risky target for humanity, and therefore an absolute minimum target for the global climate negotiations.

## Nine planetary boundaries:

- Climate change
- Change in biosphere integrity (biodiversity loss and species extinction)
- Stratospheric ozone depletion
- Ocean acidification
- Biogeochemical flows (phosphorus and nitrogen cycles)
- Land-system change (for example deforestation)
- Freshwater use
- Atmospheric aerosol loading (microscopic particles in the atmosphere that affect climate and living organisms)
- Introduction of novel entities (e.g. organic pollutants, radioactive materials, nanomaterials, and micro-plastics).

**More information:** *Science*, [www.sciencemag.org/lookup/doi/...  
1126/science.1259855](http://www.sciencemag.org/lookup/doi/10.1126/science.1259855)

Provided by McGill University

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