

Scientists: Human activity has pushed Earth beyond four of nine ‘planetary boundaries’

At the rate things are going, the Earth in the coming decades could cease to be a “safe operating space” for human beings. That is the conclusion of a [new paper published Thursday in the journal Science](#) by 18 researchers trying to gauge the breaking points in the natural world.

The paper contends that we have already crossed four “planetary boundaries.” They are the extinction rate; deforestation; the level of carbon dioxide in the atmosphere; and the flow of nitrogen and phosphorous (used on land as fertilizer) into the ocean.

“What the science has shown is that human activities — economic growth, technology, consumption — are destabilizing the global environment,” said Will Steffen, who holds appointments at the Australian National University and the Stockholm Resilience Center and is the lead author of the paper.

These are not future problems, but rather urgent matters, according to Steffen, who said that the economic boom since 1950 and the globalized economy have accelerated the transgression of the boundaries. No one knows exactly when push will come to shove, but he said the possible destabilization of the “Earth System” as a whole could occur in a time frame of “decades out to a century.”

The researchers focused on nine separate planetary boundaries first identified by scientists in a 2009 paper. These boundaries set theoretical limits on changes to the environment, and include ozone depletion, freshwater use, ocean acidification, atmospheric aerosol pollution and the introduction of exotic chemicals and modified organisms.

Beyond each planetary boundary is a “zone of uncertainty.” This zone is meant to acknowledge the inherent uncertainties in the calculations, and to offer decision-makers a bit of a buffer, so that they can potentially take action before it’s too late to make a difference. Beyond that zone of uncertainty is the unknown — planetary conditions unfamiliar to us.

“The boundary is not like the edge of the cliff,” said Ray Pierrehumbert, an expert on Earth systems at the University of Chicago. “They’re a little bit more like danger warnings, like high-temperature gauges on your car.”

Pierre Humbert, who was not involved in the paper published in Science, added that a planetary boundary “is like an avalanche warning tape on a ski slope.”

The scientists say there is no certainty that catastrophe will follow the transgression of these boundaries. Rather, the scientists cite the precautionary principle: We know that human civilization has risen and flourished in the past 10,000 years — an epoch known as [the Holocene](#) — under relatively stable environmental conditions.

No one knows what will happen to civilization if planetary conditions continue to change. But the authors of the Science paper write that the planet “is likely to be much less hospitable to the development of human societies.”