International scientists set boundaries for survival

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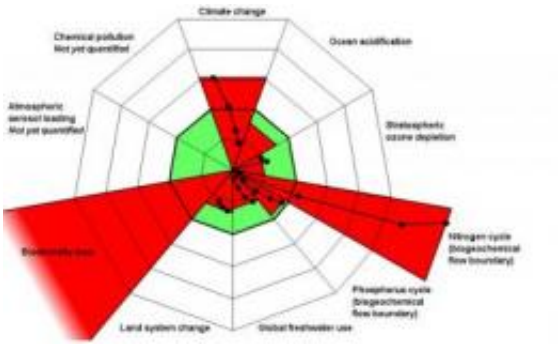

These are estimates of how the different control variables for seven planetary boundaries have changed from 1950 to present. The green shaded polygon represents the safe operating space. Human activities have already pushed the Earth system beyond three of the planet's biophysical thresholds, with consequences that are detrimental or even catastrophic for large parts of the world; six others may well be crossed in the next decades, conclude 29 European, Australian and US scientists in an article in the September 24 issue of the scientific journal *Nature*. Credit: Image courtesy of Courtesy of Stockholm Resilience Centre

Human activities have already pushed the Earth system beyond three of the planet's biophysical thresholds, with consequences that are detrimental or even catastrophic for large parts of the world; six others may well be crossed in the next decades, conclude 29 European, Australian and U.S. scientists in an article in the Sept. 24 issue of the scientific journal *Nature*.

Scientists have been warning for decades that the explosion of human activity since the industrial revolution is pushing the Earth's resources and natural systems to their limits. The data confirm that 6 billion people are capable of generating a global geophysical force the equivalent to some of the great forces of nature - just by going about their daily lives.

This force has given rise to a new era - Anthropocene - in which human actions have become the main driver of global environmental change.

"On a finite planet, at some point, we will tip the vital resources we rely upon into irreversible decline if our consumption is not balanced with regenerative and sustainable activity," says co-author Sander van der Leeuw who directs the School of Human Evolution and Social Change at Arizona State University. Van der Leeuw is an archaeologist and anthropologist specializing in the long term impacts of human activity on the landscape. He also co-directs ASU's Complex Adaptive Systems Initiative that focuses ASU's interdisciplinary strength on large-scale problems where an integrated effort is essential to finding solutions.

Defining planetary boundaries

It started with a fairly simple question: How much pressure can the Earth system take before it begins to crash?

"Until now, the scientific community has not attempted to determine the limits of the Earth system's stability in so many dimensions and make a proposal such as this. We are sending these ideas out through the *Nature* article to be vetted by the scientific community at large," explains van der Leeuw, whose experience includes leading interdisciplinary initiatives in ASU's College of Liberal Arts and Sciences.

"We expect the debate on global warming to shift as a result, because it is not only greenhouse gas emissions that threaten our planet's

equilibrium. There are many other systems and they all interact, so that crossing one boundary may make others even more destabilized," he warns.

Nine boundaries were identified, including climate change, stratospheric ozone, land use change, freshwater use, biological diversity, ocean acidification, nitrogen and phosphorus inputs to the biosphere and oceans, aerosol loading and chemical pollution. The study suggests that three of these boundaries -climate change, biological diversity and nitrogen input to the biosphere - may already have been transgressed.

"We must make these complicated ideas clear in such a way that they can be widely applied. The threats are so enormous that it is too late to be a pessimist," says van der Leeuw.

"A safe operating space for humanity"

Using an interdisciplinary approach, the researchers looked at the data for each of the nine vital processes in the Earth system and identified a critical control variable. Take biodiversity loss, for example, the control variable is the species extinction rate, which is expressed in extinctions per million species per year.

They then explored how the boundaries interact. Here, loss of biodiversity impacts carbon storage (climate change), freshwater, nitrogen and phosphorous cycles, and land systems.

In the *Nature* report titled "A safe operating space for humanity," the scientists propose bold move: A limit for each boundary that would maintain the conditions for a livable world. For biodiversity, that would be less than 10 extinctions per million species per year. The current status is greater than 100 species per million lost per year, whereas the pre-industrial value was 0.1-1.

The researchers stress that their approach does not offer a complete roadmap for sustainable development, but does provide an important element by identifying critical planetary boundaries.

"Human pressure on the Earth system has reached a scale where abrupt global environmental change can no longer be excluded. To continue to live and operate safely, humanity has to stay away from critical 'hard-wired' thresholds in Earth's environment, and respect the nature of planet's climatic, geophysical, atmospheric and ecological processes," says lead author Professor Johan Rockström, director of the Stockholm Resilience Centre at Stockholm University. "Transgressing planetary boundaries may be devastating for humanity, but if we respect them we have a bright future for centuries ahead," he continues.

Alarm bells for Arizona

"Our attempt to identify planetary boundaries that, if crossed, could have serious environmental and social consequences has a special resonance in the southwest where pressures on biodiversity, land use, and water are likely to intersect with climate change to create tremendous challenges for landscapes and livelihoods," explains co-author Diana Liverman, a professor of geography and development at the University of Arizona.

Liverman, who also is professor of environmental science and a senior fellow of Oxford University's Environmental Change Institute, is currently attending an international climate conference at Oxford, United Kingdom. Participants are discussing the implications for humans and Earth ecosystems of a 4 degree Centigrade global temperature rise.

She adds: "Three of the boundaries we identify - 350 parts per million of atmospheric carbon dioxide, biodiversity extinction rates more than 10 times the background rate, and no more than 35 million tons of nitrogen pollution per year - have already been exceeded with fossil fuel use, land

use change, and agricultural pollution, driving us to unsustainable levels that are producing real risks to our survival."

Source: Arizona State University (news : web)