Planetary boundaries—a systems approach to the environmental crisis

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According to two studies recently published in Science and The Anthropocene Review, the rate of human-induced environmental degradation has crossed multiple thresholds that fundamentally destabilize Earth's ecosystem. The papers argue that human society must ensure that these "planetary boundaries" are never crossed and that urgent, scientific planning of future economic and social development is required to draw back from those thresholds already exceeded.

Both papers were led by Will Steffen of the Stockholm Resilience Centre at Stockholm University and the Australian National University, Canberra. They were international efforts, with scientists contributing from Australia, Canada, Denmark, Germany, India, Kenya, the Netherlands, South Africa, Sweden and the United States. The reports are a compilation of data collected from dozens of institutions and hundreds of researchers over the past five years.

Unlike most environmental studies, which focus solely on a single topic (i.e., global warming or ocean pollution), Steffen's team takes a broader look at how human activity impacts the global environment, using the concept of "planetary boundaries," first introduced in 2009. These are nine processes and systems that that maintain the stability and integrity of what the authors term the "Earth System," the connections between terrestrial, oceanic and atmospheric mechanisms that combine to provide the material conditions within which human civilization develops.

Throughout both studies, the baseline for what is considered a stable environment is the average condition of the climate and other geological processes over the past 11,700 years (the Holocene Epoch in geological terms).

Using this schema, it is also possible to prioritize each process, an acknowledgment that certain changes in the global environment are more critical than others. In order of importance, the most recent renditions of the nine planetary boundaries are climate change, biosphere integrity (loss of genetic diversity and species extinction), stratospheric ozone depletion, ocean acidification, biogeochemical flows (the nitrogen and phosphorus cycles), land-system change (such as deforestation), freshwater use, atmospheric aerosol loading (air pollution), and the introduction of novel entities (radioactive materials, plastics).

The research done since the method was first introduced shows that of the nine planetary boundaries, four have now been crossed as a result of human activity: climate change, biosphere integrity, land-system change and biogeochemical flows. That any of these have been crossed indicates the high potential for large-scale disruptions of both environmental and social life.

Currently, the concentrations of carbon dioxide in the atmosphere hover around 400 parts per million, well above the 350 ppm mark virtually all climate scientists agree is the upper end of safe values. The average global temperatures are the highest since records began in 1880 and, according to Antarctic ice core measurements, are possibly the highest temperatures of the entire Holocene Epoch. The levels of ocean acidification have increased 30 percent in the past 200 years, leaving every organism that uses calcium carbonate to live—including coral and plankton—at risk of dying off. Only 62 percent of global forests exist as compared to pre-industrial levels. Seventy-five percent is considered necessary for stability.

In a comment to the Scripps Institution of Oceanography, Steffen noted, "[t]ransgressing a boundary increases the risk that human activities could inadvertently drive the earth system into a much less

hospitable state, damaging efforts to reduce poverty and leading to a deterioration of human well-being in many parts of the world, including wealthy countries. In this new analysis, we have improved our quantification of where these risks lie."

The various parts of the studies are confirmed by outside research. Starting near the end of 2014, reports have indicated that climate change is directly responsible for the slew of high temperatures experienced in the past decade. The high temperatures have led to increasingly powerful weather systems causing increasing property damage, injury and death. An article in *Science* published the day after Steffen's indicates that as a result of human activity, marine life is poised for a mass extinction both as a result of direct human activity in water (harvesting wildlife, pollution) and increased ocean acidification, a secondary effect of global warming.

Significantly, the studies explicitly note that as long it is simultaneously possible to generate wealth at the expense of the environment and as long as this wealth—and the control of resources that comes with it—is distributed so unequally, it will be impossible to maintain Earth's environmental stability.

In an interview with the *Guardian*, Steffen notes that because the current economic system is not geared toward sustaining global life support systems it is "fundamentally flawed."

"It's clear the economic system is driving us towards an unsustainable future and people of my daughter's generation will find it increasingly hard to survive," he said. "History has shown that civilisations have risen, stuck to their core values and then collapsed because they didn't change. That's where we are today."

To address this, the authors will present their findings this week at the World Economic Forum in Davos. No doubt there will be an appeal to world leaders to come to an agreement to halt the accelerating collapse of the ability of Earth to sustain human life. Perhaps this will take the form of drawing parallels with the success of banning CFCs worldwide to heal the ozone layer to what should happen now.

Such attempts will fall on deaf ears. Though Steffen does not explicitly say it in his interview, the "fundamentally flawed" economic system is capitalism. The current economic and social system is not concerned with human need, such as a stable global ecosystem, but the personal enrichment of a tiny minority, even at the expense of the health of the planet. It is therefore up to the working class therefore to fight against the exploitation and plunder of capitalism and to set up a society in which the use of Earth's natural resources can be scientifically and rationally planned—a socialist society.