New planetary boundary to measure effects of human activity

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Credit: NASA

(Phys.org)—A US scientist has proposed that a new planetary boundary be used to analyze the effects of human activities on the planet. He warns that there are definite biophysical limits to growth in human population, economies and consumption, and that limits in some variables might already have been reached.

In a *Perspective* article in the journal *Science*, Professor Steven W. Running, Director of the Numerical Terradynamic Simulation Group (NTSG) at the University of Montana, proposes that adopting a new planetary boundary—annual net primary production (NPP) of all terrestrial plants—might help researchers to more effectively monitor the effects of humans on climate, land use and biodiversity and their limits.

Net primary production is the basis of the carbon cycle and is closely linked to other planetary boundaries such as climate and freshwater use. Planetary boundaries are limits to variables vital to human habitation of Earth, such as changes in climate, biodiversity, land use, ocean pH, and so on. Prof. Running suggests in his article that some planetary boundaries, such as freshwater use for crop irrigation, may already have been breached.

The first systematic analysis of the global limits was published in 1972 in the book *Limits to Growth*, but the analysis was done using computers that are rather primitive by today's standards, and the modeling it used has faced some criticism. Even so, its predictions, including that limits to some resources would be reached by early this century, were found to be reasonably accurate when compared in 2008 with actual data on depletion of resources.

One problem with the concept of planetary boundaries is that some variables are difficult to measure on a global scale, and critical limits can be hard to quantify. To overcome these difficulties, Running suggests adopting NPP as a new planetary boundary because of its links to many other variables and because humans need plants for many reasons, including food, food for animals raised for food, oxygen (via photosynthesis), building materials, and fire wood.

Satellite data enables scientists to calculate how much vegetation is produced each year, and data is available for more than 30 years. Over this period the amount of vegetation produced has been extremely stable at 53.6 trillion kilograms per year. Humans use 40 percent of this each year, but around 50 percent is unavailable for human use either because it's inaccessible, unharvestable, or in vital conservation areas. This leaves only around 10 percent remaining for a growing human population.

Vegetation growth can be increased with fertilizers and irrigation, but these also have limits and are unlikely to provide a significant boost. Even if they could, Running questioned whether a world in

which every available acre of ground is taken for human use is the kind of world we want. He warned that "endless" economic and consumptive growth are not possible, and we should revise expectations for the future in the light of this.

Prof. Running also pointed out that even if the entire further 10 percent of vegetation growth available was turned over to growth of crops for biofuels, it could produce only 40 percent of current needs.

More information: A Measurable Planetary Boundary for the Biosphere, *Science* 21 September 2012: Vol. 337 no. 6101 pp. 1458-1459. DOI: 10.1126/science.1227620

Abstract
Forty years ago, Meadows et al. published a landmark first analysis of global limits to human activity (1). Based on a primitive computer model of the Earth system, they concluded that by the early decades of the 21st century, tangible limits to key global resources would begin to emerge. A reanalysis of the original results in 2008 found that the original global resource depletion projections were remarkably accurate (2). Since then, Rockström et al. (3) have defined a new term—planetary boundaries—to describe nine variables of high importance to habitability of Earth, including climate change, ocean acidification, land-use change, and biodiversity loss. These metrics are compelling conceptually, but many are not easily measured globally; explicitly defining a critical boundary is even more challenging. I suggest a new planetary boundary, terrestrial net primary (plant) production (NPP), that may be as compelling conceptually, integrates many of the currently defined variables, and is supported by an existing global data set for defining boundaries.