Planetary Boundaries and Global Catastrophic Risk

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Published by the Institute for Ethics and Emerging Technologies, 21 February 2014.
Archival version produced 2 June 2024.

Back in 2012, I was invited to spend a few weeks visiting at the Research Institute for Humanity and Nature (RIHN), a federally funded Japanese research institute based in the beautiful city of Kyoto. I was invited by my colleague Itsuki Handoh of RIHN. During my visit, Handoh and I came up with an idea for how to fuse two important lines of research on major global threats. The resulting paper has just been published: Integrating the planetary boundaries and global catastrophic risk paradigms, in the journal *Ecological Economics*.

Handoh and I share an interest in taking a big-picture perspective on human-environment interactions. I first learned of his work from his paper On the timescales of sustainability and futurability, which criticizes traditional sustainability research for focusing on the next 100 years and falls for research using time scales of at least several centuries and possibly much longer. I completely agree with this. Indeed, I also emphasize very long time scales for sustainability, for example in my paper Adaptation to and recovery from global catastrophe.

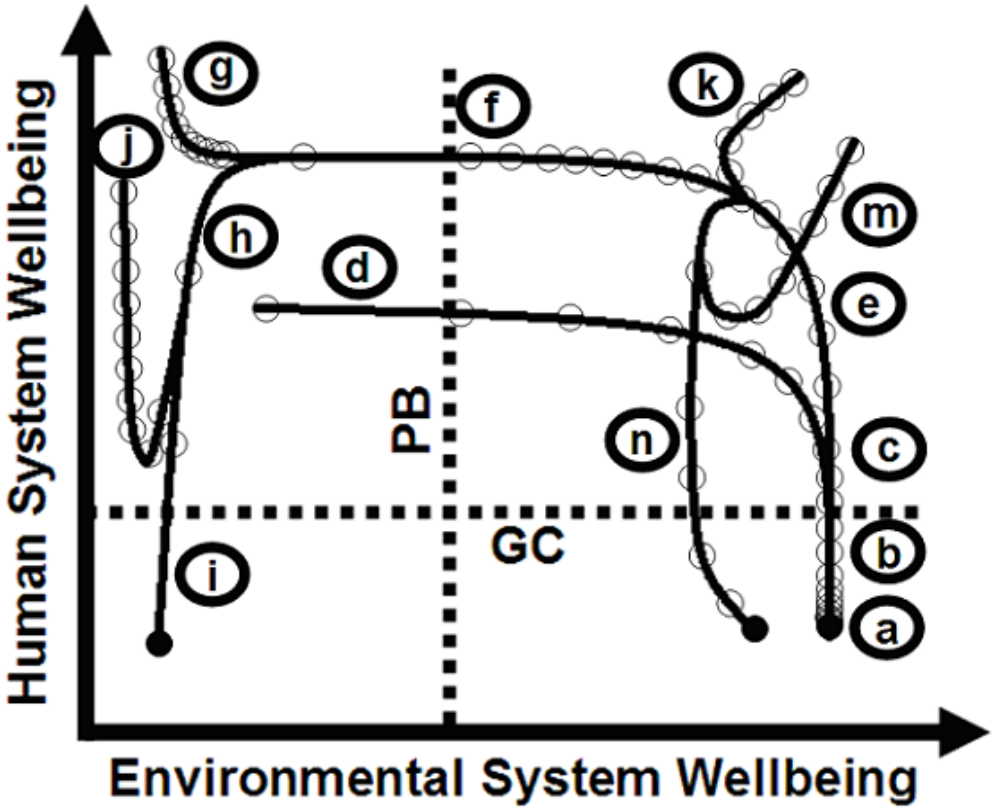
It was with this big-picture perspective that led Handoh and I to discuss the planetary boundaries (PBs) and global catastrophic risk (GCR) paradigms. PBs research comes from the Earth system science research community and follows in the tradition of global-scale human-environment research like that in *The Limits to Growth*. GCR research comes from a mix of economics, ethics, risk analysis, and a few assorted other fields. Handoh and I saw that PBs and GCR were different but complementary conceptual frameworks. So, we set about integrating them into a new framework, which we now call Boundary Risk for Humanity and Nature, or BRIHN, which is in part in honor of Handoh's group RIHN where we did the preliminary work.

A core innovation in BRIHN is to take the use of boundaries and thresholds from PBs and the use of probabilistic analysis from GCR and put them together into what we call probabilistic thresholds. PBs research posits that society should set safe policy boundaries to make sure that dangerous environmental thresholds aren't crossed. For example, society should set a policy boundary of 350 parts per million (ppm) of carbon dioxide in the atmosphere, in order to avoid crossing dangerous environmental thresholds from climate change—thresholds like ice sheet collapses. But there is no guarantee that 350 ppm will avoid crossing the threshold. Instead there is just a probability that it will. So BRIHN calls for policy to set an acceptable probability of crossing the threshold and calculate the boundary accordingly.

Another innovation in BRIHN is to consider thresholds for both environmental and human systems. PBs only looks at environmental thresholds, like ice sheet collapses. But there is also concern about human system collapses—see for example Robin Hanson's paper Catastrophe, social collapse, and human extinction. The same concept of policy boundaries can also be applied to human system collapses. The BRIHN framework makes it easy to analyze thresholds and set boundaries for human and environmental systems simultaneously.

Our paper uses the case of the phosphorous biogeochemical cycle, which is one of Handoh's research specialties. The phosphorous biogeochemical cycle is a great example of a threat that has been analyzed as an environmental threat and a PB but not as a human threat and a GCR. The environmental threat comes from phosphorous from fertilizer accumulating in waterways. This lowers the oxygen content in the water down to danger levels for aquatic life. The worst case is an oceanic anoxic event, which would lead to mass death of ocean life. This would clearly be a major environmental harm, but it's less clear what the human impacts would be. Human civilization might be able to get by even with the complete loss of seafood. It's important here that an oceanic anoxic event probably can't occur for thousands of years. A lot can change between now and then.

The paper uses BRIHN to tell the story of humanity and nature co-evolving from ancient times to the distant future. Here is the graphic the story of the phosphorous biogeochemical cycle. The circles show time passing. They are closer together when time passes more slowly. It might take a little while to figure out how to read the graphic but if you can get it then it's a nice little way of seeing the big picture.



Looking ahead, I hope that our paper will help research in the PBs and GCR traditions benefit each others' work and perhaps even collaborate. My own work is mainly on the GCR side, and I see a lot that PBs has to offer. I'm especially excited about the concept of human systems boundaries and thresholds, which can help us understand what sorts of events can cause what sorts of catastrophes. Likewise I hope that PBs and other environmental research will become more attentive to the human impacts of environmental changes, in particular whether there could be global catastrophes to humanity. But most of all I hope that this can help policy makers and other actors keep both humanity and nature safe.

For more details please see our paper.