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Guest Editorial

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Humanity is playing out the tragedy of the commons on a global scale. At present rates, each individual added to the global human population will annually consume about 0.5 tonnes of cereal grain, 0.05 tonnes of meat or fish, 1 million litres of water, 0.3 tonnes of wood, 4.5 barrels of oil, 0.3 tonnes of copper, and 0.2 tonnes of phosphate fertilizer, and each one will release about 5 tonnes of CO_2 and 4 tonnes of solid and liquid waste into the environment. If these numbers seem large, multiply each of them by 2,000,000,000 to estimate the additional consumption by 2050 when the global population has grown from its current 7.1 billion to over 9 billion (UN 2010). The resulting numbers are almost incomprehensible.

The bottom line is that enormous quantities of natural resources will need to be extracted from the earth to support projected population growth (e.g., Brown et al. 2011). Additional quantities, especially of energy and metals, will be required to increase overall standards of living and to reduce poverty and disease, especially in developing countries. How can these resources be obtained, and at what cost to the environment and biodiversity of the planet (e.g., Wackernagel and Rees 1998, IPCC 2007)? Several approaches have addressed these issues: limits to food supplies (e.g., Pauly et al. 2005, Godfray et al. 2010, Foley et al. 2011, Tilman et al. 2012), supply and distribution of fresh water (Gleick and Palaniappan 2010), availability of alternative sources of energy (e.g., Hall and Klitgaard 2011), and threats from chronic and pandemic diseases (Heymann 2003, Osterholm 2005). A few efforts been made to provide more comprehensive analyses of multiple limiting factors, perhaps most notably the ecological footprint approach of the group at the University of British Columbia (http://www.footprintnetwork.org/en/index.php/GFN/) and the planetary boundaries analyses of Stockholm Resilience Center (Rockström et al. 2009). Nevertheless, most of the attention has been piece-meal—focused on specific problems such as greenhouse gas emissions, climate change, and the outbreak of the H1N1 influenza.

What is needed

We need a comprehensive global assessment of the capacity of the Earth to sustainably support current and projected levels of human population and economic activity. What quantities of resources, levels of pollution, and impacts on biodiversity will likely accompany different scenarios of growth and development? To what extent have we depleted the stocks of non-renewable resources (oil, gas, coal, phosphate, metal ores, rare earths, radio-nucleotides), and what are the energy and economic costs of finding and extracting the remaining, increasingly remote and dispersed reserves? To what extent are we overexploiting potentially renewable resources (arable land, fresh water, fisheries, wood), and what changes, including recycling, will be required to insure sustainable yields? In addition to CO_2 and other greenhouse gasses, what other pollutants most threaten human wellbeing locally, regionally, and globally?

What is also largely missing is a rigorous, quantitative, complex systems "big picture" synthesis of the

multiple inter-connected, non-linear ways that humans are impacting the planet by depleting resources, discharging pollutants, and altering biodiversity, and of the implications of these activities for the future of humankind (Pereira et al. 2010, Milanović 2011, Barnosky et al. 2012). Increasing subsidies of water, fertilizer, and fossil fuels will be required to increase the productivity of limited arable land and rural farmers to feed a growing global population. Vast quantities of energy will be required to power the industrial-technological-informational economies of the most developed nations. The products of developed nations—farm machinery, solar panels, irrigation pumps, drugs, vaccines, cell phones, and the internet—will be required to fight poverty, malnutrition, and diseases in the developing world. A natural disaster, disease epidemic, or regional unrest could trigger acute shortages in supplies of fossil fuel, spreading warfare, or an economic crash. And even modest, sustained economic stagnation will result in substantial cutbacks in social services and research and development, leading in turn to curtailed investment in extracting scarce resources and reduced capacity to respond to natural disasters and regional conflagrations.

There are signs that these kinds of interacting limits and feedbacks are already occurring—witness the effect of unrest in the Middle East and changes in the strategic actions of a number of major actors on volatility in the price of oil, food shortages and political instability in the Horn of Africa, and the global spread and anemic delayed recovery of the economic downturn triggered by the housing bubble in the U.S. Such impacts can be expected to become more frequent and severe in the future as the human population and economy puts more strain on the Earth's life support systems. The probability of a "global tipping point"—a catastrophic collapse—is increasing (Barnoski et al. 2012). So far, however, the public is largely unaware of the complexity of these problems, and the press, policymakers, and politicians do not encourage enlightenment and discussion. There is little appreciation of the global scale of human-environment interactions and the interconnectedness of the modern world that will determine the future of humankind.

Can we prevent the tragedy of the commons that appears to be inevitable?

History teaches us that humans often over-exploited their local environments. Populations survived by migrating to unexploited areas or by importing resources to compensate for local depletion and exporting wastes to avoid local pollution. These strategies worked so long as there were new areas to colonize and new resources to extract from them.

Now, however, the world is full of humans and the remaining stocks of natural resources are being rapidly depleted. The bounty of the Earth is finite and humans are increasingly pressing up against the global limits. To the extent that humans have been able to enforce regulations to prevent the tragedy of the commons, these successes have mostly been local and temporary. Because they limit individual freedom, regulations must either be enforced autocratically from above, like China's one-child policy, or be accepted democratically because people recognize that public good outweighs self-interest, like collecting taxes to pay for parks and social services. But the capacity to sacrifice for other humans and for the well-being of the planet is jeopardized because global resource scarcity brings out narrow self-interests—of individuals, communities, and nations. The kinds of actions that might avert collapse, such as a global one-child policy and strict limits on greenhouse gas emissions, are all but impossible to implement, because the forces of greed and competition will always trump the virtues of thrift and caring and the voices of optimism will always trump the voices of "doom and gloom." If *ultimately* the population must decrease to be sustainable, then the question is whether this will be a consequence of wars, poverty and pandemics, or whether humanity can show collective intelligence and avoid learning from major or catastrophic mistakes.

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References

Barnosky A.D., Hadly, E.A., Bascompte, J., Berlow, E.L., Brown, J.H., Fortelius, M. et al. 2012. Approaching a state shift in Earth's biosphere. Nature 486:52–58. CrossRef

Brown J.H., Burnside, W.R., Davidson, A.D., DeLong, J.P., Dunn, W.C., Hamilton, M.J. et al. 2011. Energetic limits to economic growth. BioScience 61:19–26. CrossRef

Foley J.A., Ramankutty, N., Brauman, K.A., Cassidy, E.S., Gerber, J.S., Johnston, M., et al. 2011. Solutions for a cultivated planet. Nature 478:337–342. CrossRef

Gleick P.H. and M. Palaniappan. 2010. Peak water limits to freshwater withdrawal and use. Proceedings of the National Academy of Science USA 107:11155–11162. CrossRef

Godfray H.C.J., Beddington, J.R., Crute, I.R., Haddad, L., Lawrence, D., Muir, J.F., et al. 2010. Food security: the challenge of feeding 9 billion people. Science 327: 812–818. CrossRef

Hall C.A.S. and K.A. Klitgaard. 2011. Energy and the Wealth of Nations: Understanding the Biophysical Economy. Springer.

Heymann D. 2003. The evolving infectious disease threat: implications for national and global security. J Human Development 4:191–218. CrossRef
IPCC. 2007. Climate Change 2007: Synthesis Report to the Fourth Assessment Report of the Intergovernmental Panel on Climate Change. World Meteorological Organization.
Milanović B. 2011. The Haves and the Have-Nots: A Short and Idiosyncratic History of Global Inequality. Basic Books.
Osterholm M.T. 2005. Preparing for the next pandemic The New England Journal of Medicine 352:1839–1842. CrossRef
Pauly D, Watson R., and J. Alder. 2005. Global trends in world fisheries: impacts on marine ecosystems and food security. Philosophical Transactions of the Royal Society B 360:5–12. CrossRef
Pereira, H.M., Leadley, P.W., Proença, V., Alkemade, R., Scharlemann, J.W., Fernandez-Manjarrés, J.F., et al. 2010. Scenarios for Global Biodiversity in the 21st Century. Science 330: 1496–1501. CrossRef
Rockström J., Steffen, W., Noone, K., Persson, Å., Chapin, F.S., Lambin, E.R., et al. 2009. A safe operating space for humanity. Nature 461:472–475. CrossRef
Tilman D., Balzer, C., Hill, J., and B.L.Befort. 2012. Global food demand and the sustainable intensification of agriculture. Proceedings of the National Academy of Science USA 108:2060–2064.
United Nations. 2010. World Population Prospects: The 2010 Revision. http://esa.un.org/wpp/Excel-Data/population.htm
Wackernagel, M., and W. Rees. 1996. Our Ecological Footprint: Reducing Human Impact on the Earth. Gabriola Island, Canada: New Society Publishers.