

Earth-system science at a crossroads

The Planet Under Pressure conference underscored a rapidly changing landscape of Earth-system science. **Mike Raupach** says that the path ahead should combine the need for wider engagement with a continuing commitment to reason.

The Planet Under Pressure conference in London was the third major gathering of the Earth-system science community, following predecessors in Amsterdam (2001) and Beijing (2006). Each of these meetings has provided a chance to evaluate not only the latest science, but also the state of the Earth-system science community and its relationship with wider societies. The 2012 meeting indicated a community in rapid and sometimes difficult transition. Three major turning points can be discerned: fading optimism, the coupling between environmental and human wellbeing and science as a societal participant. Each of these has a double life, appearing both within the Earth-system science community and also in the wider world.

Increasing urgency, decreasing optimism

Relative to its predecessors, Planet Under Pressure offered a sober-to-bleak assessment of the biophysical state of the planet and its ability to support the demands of a growing and increasingly affluent human population. Climate change, food security and water security were

identified as the three leading pressure points among many.

Bob Watson, who chaired IPCC during its third assessment in 2001, gave an assessment in his opening address that the world now has only a 50 percent chance of limiting warming to 3°C, and that the two-degree target agreed in Copenhagen in 2009 is impossible. His assessment was shared by many (including me¹), both during and before the conference. Calculations suggest that keeping global warming below two degrees requires global emissions reductions at rates from 3 to over 10 percent per year, depending on assumptions about how quickly the trajectory of CO₂ emissions can make the U-turn from its present 3 percent per year growth to sustained reduction. The higher end of this range is probably unachievable technically, let alone politically.

This tone engendered a variety of responses throughout the conference, among different sessions according to focus and among different participants according to personality: desperation, urgency, resignation (as in Bob Watson's assessment) and, occasionally, withdrawal. Planet Under Pressure marked the

end of the era of naïve optimism.

Although climate change is receiving the lion's share of public attention at the moment, other finite planet pressures are also of concern. In particular, food security and water security are immediate needs for human wellbeing. Both are issues with strong local texture, framed by global trends in population, affluence and trade. In the case of food, for example, there is evidence that yield improvements are slowing, global demand is intensifying and pressures from demand for biofuels are increasing prices for staples such as corn.

To an extent greater than for climate change, food and water security are predominant concerns for the geopolitical South. This leads to the second turning point.

Environmental and human wellbeing as coupled issues

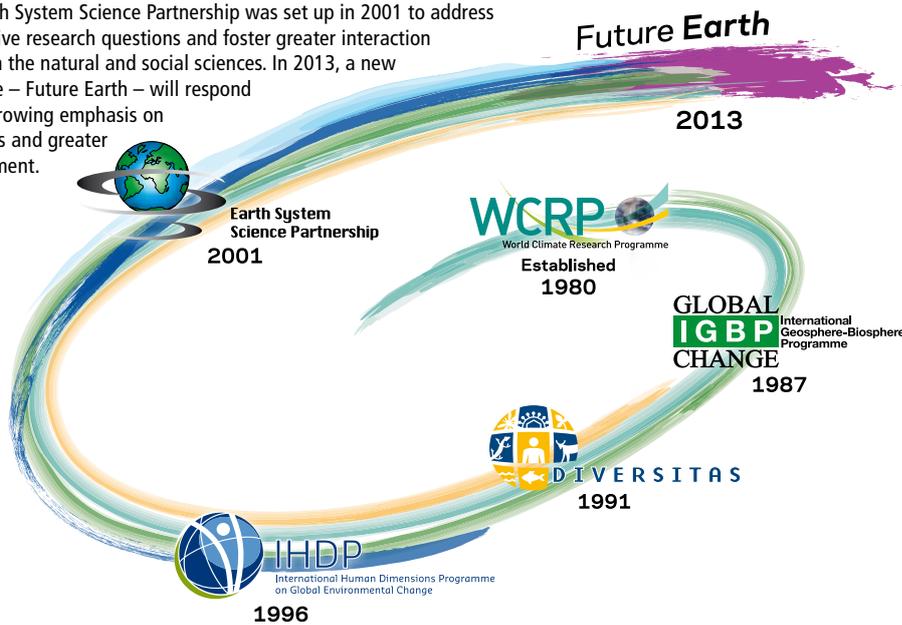
Planet Under Pressure was a more representative meeting than those in Amsterdam (2001) and Beijing (2006), in three ways. It came closer to gender balance than either of these predecessors; the human sciences had equal or greater representation, in both numbers and influence,

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The compact between Earth-system science and society is being reshaped. Hard work lies ahead to ensure that both partners are comfortable with the relationship.

The Earth System Science Partnership was set up in 2001 to address integrative research questions and foster greater interaction between the natural and social sciences. In 2013, a new initiative – Future Earth – will respond to the growing emphasis on solutions and greater engagement.



relative to the natural sciences; and the voices of developing as well as developed nations were prominent. This led to an explicit focus on interactions between the geopolitical North and South.

Under the influence of these trends, environmental issues were framed at the conference both in biophysical terms and also as fundamentally human concerns. What are the consequences for human societies of seeing Earth not only as materially finite and ecologically vulnerable, but also as a fully coupled system with both natural and human components? What new rights and responsibilities flow from such a perception? As biophysical pressures mount, how can the environmental commons be shared so that destructive conflicts are avoided and human wellbeing enhanced?

These questions lead inevitably to a convergence between issues of the biophysical environment and of human wellbeing. The very concept of human wellbeing is seen by some as value-laden and therefore forbidden territory for the natural sciences, with their stress on objective reasoning. However, the most powerful forces in the contemporary human-Earth system are those

“solutions” to “problems” are neither context-free nor value-neutral.

arising from human actions and desires, founded in a search for individual and collective wellbeing. The central importance of the quest for wellbeing is not diminished by the fact that the goal is perceived in multiple ways by individuals and societies. Therefore, in any holistic study of an Earth system in which nature and humans are fully interactive, environmental and human wellbeing are fundamentally coupled. Planet Under Pressure reinforced the need for the human and natural sciences to enter this difficult terrain together.

Science as a participant in the search for solutions

The third turning point was that the science of the Earth system is evolving to be both an observer and describer of global change, and also a participant in the search for solutions to sustainability dilemmas. Planet Under Pressure was a meeting in the active voice. Contributing factors to this emphasis included the balances noted above – female and male, natural and human sciences, and perspectives from the South and the North.

The Conference Declaration² concluded that: *Interconnected*

issues require interconnected solutions ... technological innovation alone will not be enough. We can transform our values, beliefs and aspirations towards sustainable prosperity.

And further (slightly paraphrased): *Research plays a significant role in monitoring change, determining thresholds, developing new technologies and processes, and providing solutions. The global-change research community proposes a new contract between science and society, to encompass three elements: (1) integrated goals for global sustainability, based on scientific evidence; (2) a new approach to research that is more integrative, international and solutions-oriented; and (3) new mechanisms for interactive dialogue at multiple scales.*

In this spirit, the conference saw the public unveiling of efforts to reshape the international structures governing global Earth-system science research. A new initiative, Future Earth (Figure 1), will succeed the present Earth System Science Partnership (ESSP) (see page 4 of this issue).

The world beyond science

These three turning points in the Earth-system science community have counterparts in wider societies. However, in every case, the central ideas in the wider world are deeply contested.

Many individuals and groups in both the North and the South share a sense of urgency about the challenges of global sustainability, and the difficulties of moving fast enough to avert interlinked crises. There are strong currents of awareness of the developing pressures on fronts such as climate change, water security, food security, biodiversity, nutrient cycling and other human-environment interactions. However, there are also strong counter-currents.

The standout contemporary example is scepticism about the

idea that modern climate change is primarily anthropogenic in origin. Polarisation over climate change is particularly strong in the USA, the UK and Australia. Most evidently but not only in these countries, the climate battle also embroils the broader dialogue around environmental and human wellbeing, turning that dialogue into a contest as well.

One reason for this conflation is revealed by a question stated above: how can the environmental commons be shared successfully? The notion of sharing inevitably involves fairness and equity, both within and between societies and nations. Equity is seen by some as being in tension with other cherished values such as freedom and individual liberty. For these people and groups, sharing the environmental commons can become identified with an attack on liberty, leading them to a position in which climate mitigation and other efforts to share the commons must be opposed by any means³.

Just as deeply contested in some communities is the idea that science, and Earth-system science in particular, should be a participant in the search for solutions. It suffices to say that "solutions" to "problems" are neither context-free nor value-neutral. In an interconnected world, almost any solution to a problem somewhere has ripple effects elsewhere, creating actual or perceived winners and losers. Participation in the search for solutions inevitably entrains issues of fairness, justice and equity, and the balance between these values and those of freedom and individual liberty.

Reshaping the compact

Earth-system science is entering new and difficult territory. Funtowicz and Ravetz⁴ described this terrain 20 years ago as "post-normal science": a mode of scientific enquiry that is

appropriate when "facts are uncertain, values in dispute, stakes high and decisions urgent" – a tailor-made description of the issues central to Earth-system science. This mode of enquiry is one where "problems are set and solutions are evaluated by the criteria of broader communities [in addition to science and engineering]. ... Post-normal science is indeed a type of science, and not merely politics or public participation"⁴.

As with so much else, the concept of post-normal science is itself contested, to the extent that the phrase has become a term of abuse in the climate-sceptic community. The abuse is unwarranted. There is clearly a need to engage in forms of enquiry along the lines defined by Funtowicz and Ravetz, because the leading issues of our time are indeed characterised by uncertain factual knowledge, disputed values, high stakes and an urgent need for decisions. Science, with its commitment to reason and observational evidence, is a critical contributor to these issues, but science is not the only voice in the room, and workable solutions need to account for a plurality of voices.

As Earth-system science enters this new terrain, two points of reference remain critical. First, across the full spectrum of the natural and human sciences, Earth-system science is founded on principles of reason, logic and the primacy of observational evidence over dogma or ideology. The challenge of understanding the Earth system – its climate, water, land, soils, biota, ecosystems, societies, economies and cultures, and their interactions – demands the fullest commitment to these principles.

Second, Earth-system science speaks directly to human values and to policy. Some basic scientific conclusions about the Earth system are now starkly evident from a multitude of observations showing that the finitude of our

planet is an imminent strong constraint on unfettered growth in material consumption. It is necessary to think about sharing finite resources, and therefore about equity, because the sharing needs to be fair and just if it is to work⁵. Such conclusions explicitly contradict broad policy directions, still dominant around the world, that are founded on assumptions of endless growth in material throughput. It is no longer possible for Earth-system science to remain "value-free" and detached from policy.

These two reference points – commitment to reason and logic, and a willingness to engage with human values and policy – are at the heart of a reshaping of the compact between Earth-system science and society. It is still early, and much hard work remains to be done before both partners in the reshaped compact are comfortable with the relationship. ■

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