Available online at www.sciencedirect.com

ScienceDirect

Current Opinion in Environmental Sustainability

# Understanding ourselves and the environment in which we live

Yongping Wei [1], Ray Ison [2], Andrew W Western [3] and Zhixiang Lu [1,4]

This paper calls for a new methodological paradigm for understanding the adaptive human–nature relationship to achieve a sustainable global environment. It proposes three future research directions: theoretically framing societal processes in natural resources management; establishing a new methodological paradigm for understanding co-evolving human–nature systems; and developing system-scale experimental research.

**Addresses**
[1] School of Earth and Environmental Sciences, The University of Queensland, Brisbane 4067, Australia
[2] School of Engineering & Innovation, The Open University, Milton Keynes MK7 6AA, UK
[3] Department of Infrastructure Engineering, The University of Melbourne, Melbourne 3010, Australia
[4] Key Laboratory of Ecohydrology of Inland River Basin, Northwest Institute of Eco-Environment and Resources, Chinese Academy of Sciences, Lanzhou 730000, China

Corresponding author: Yongping, Wei (yongping.wei@uq.edu.au)

**Current Opinion in Environmental Sustainability** 2018, **33**:161–166

This review comes from a themed issue on **System dynamics and sustainability**

Edited by **Bojie Fu** and **Yongping Wei**

Received: 23 May 2018; Accepted: 07 June 2018

https://doi.org/10.1016/j.cosust.2018.06.002



## Expressing the need: for further understanding the dynamics of the human–nature system for a sustainable global environment

The sun, earth, moon, plants, animals, other biota and ourselves all together form a splendid world. For a long time human society has been at one end of this spectrum and the natural world at the other end. The harmonious interaction between humans and nature presents a beautiful picture. From ancient philosophy, to scientific philosophy, then to modern science, natural systems and societal systems have belonged to two different domains of understanding and practice in the sciences. The natural and social sciences have developed with different objects, methods and paradigms [1].[5] The object of natural science is considered to be context-independent; it is therefore possible that problems can be structured with mathematical equations. By contrast, the object of social science is to abstract context-free features from context-dependent human activities [2]. Many, if not most, situations of concern can be characterized as unstructured or wicked problems that are difficult to formalize.

Generally speaking, quantitative approaches and qualitative approaches are used by natural science and social science respectively. The underlying idea, or prejudice, is that the former is objective, whereas the latter is subjective [3••]. Finally, natural scientists are mainly interested in, with numerical models, predicting or projecting what happens in future populations. By contrast, social scientists, using descriptive models, analyse the relationships in past populations, providing 'postdictive' statements [4,5]. It is commonly held that there is an insurmountable gap between natural science and social science.

Recently, humans have begun to notice that their activities have significantly modified the earth's biosphere and thus disturbed the environment in which they live. This has led to calls for the proclamation of a new geological age — the Anthropocene [6,7]. Land desertification, drying of rivers, disappearance of wetlands, climate change, pollution and biodiversity loss have contributed to a loss of the 'emergent splendor' arising from the interactions between humans and nature. The learning that emerges from understanding the 'Anthropocene phenomena', learning that both global society and science struggle to come to terms with, is that human society and the natural world are best understood as a 'coupled, co-evolving system'. The practices of natural science and social science have to be integrated to understand and govern this co-evolving human–nature system.

Many multiple-disciplinary, cross-disciplinary and inter-disciplinary studies on environmental science and management have been contributing to bridging the gulf

[5] Formulated in 1959, the two cultures have not gone away — see https://www.telegraph.co.uk/technology/5273453/Fifty-years-on-CP-Snows-Two-Cultures-are-united-in-desperation.html.

between natural science and social science for the last several decades. This issue, entitled '*System Dynamics and Sustainability*' contributes to furthering our understanding of the challenges that arise when attempting integration of natural science and social science in the field of global environmental change. It particularly focuses on advances in understanding of the interactions between the change in biophysical processes and change in the societal processes over a long timeframe.

This issue comprises 19 papers, presenting progress reviews, theoretical research and empirical studies in relation to interactive processes of global environment change. It covers several themes including structure, function and services of ecosystems, hydrology and catchment management, and land and soil conservation. Several new frameworks are presented. These offer valuable insights into particular sub-systems (e.g. water, land), processes (e.g. ecological, hydrological), phenomena (e.g. spillover effect) or a management issue (e.g. water allocation, soil conservation); others make the case for the development of more generic frameworks for addressing the general human–nature relationship. The latter are needed for addressing contemporary global environmental problems when answering the question of how things should be, explaining how things are and why things are the way they are. Therefore, we suggest the following three research directions for advancing our understanding of the unfolding human–nature relationship.

## Theoretically framing societal processes

We have recognized that human activities have significantly modified the Earth's surface. However, as there exist lags in the two-way feedbacks between the natural system and human system and there is limited understanding of transitions between multiple equilibrium states of these systems, the mechanisms of influence of human activities on the natural system over long timeframes are not clear. The great challenge is to improve the feedback between changes in critical natural processes and human (re)action, both in terms of reducing lag and ensuring sufficiently strong feedback to stabilize the coupled systems. Science produces scientific explanations for phenomena; but acceptance, or otherwise, of these explanations and processes of interpretation sit squarely within the societal system. With either a lag in scientific understanding and/or a lag in effective human action, natural resources management decisions can never be taken in a timely and wise way. We argue that this is the direct cause of an unsustainable global environment.

We propose a conceptual framework for understanding the mechanism of influence of human activities (a societal system) in relation to natural system (Figure 1). The figure is constructed so as to highlight that the human societal system is central to a co-evolutionary future in which humans play a part. The natural system including other species and physical processes can continue in the absence of humans, although we already know that human impact will continue to shape these dynamics for some time and create 'legacy systems'. The key question is, what will the quality of human life be into the future and what are our ethical responsibilities in relation to other life?

Figure 1 is a heuristic device; a conceptual picture designed to facilitate thinking and conversing about how we humans understand and reshape the environments where we live. This is not a picture of how the world is. But it could be used as part of a process to help us, and the world, do things differently. Figure 1 can be read by starting at the yellow societal sub-system at time $t = n$. Within this subsystem we highlight two sub-subsystems: the first is concerned with human practices — what people do when they do what they do [8,9], for example, natural resources management. The other is concerned with human invention of institutions (norms and rules of the game which operate in all social groups and human invented technologies [10]). There are legacy systems operating now; sometimes we are aware of this, sometimes not [11••,12••,13]. Two legacy sub-systems are presented in Figure 1 (two green parts). The first is the historical human invention of institutions; and the second is the understandings, explanations we accept or reject from experiences and study of the natural world. The societal sub-system and two legacy sub-systems are our understanding of the state of the human–nature system (blue part), which mediate, or facilitate human activities and impact on the natural system (brown part in the right of Figure 1).

There are two important lags in observation, explanation and societal action. The first lag is in understanding; this is due to the current understanding being based on past data. In fact, even when using real-time data, our knowledge must still lag as trends and changes emerge slowly and knowledge takes time to mature — we prefer it to stand the test of time. The second lag is in response due to decision making, which involves debate, and development and implementation of policy and action plans. We try to address the second by using future scenarios but that is only partially effective for many socio-political and economic reasons, as well as the inertia in our physical, human and other capitals. Uncertainty is an important issue in slowing response and future scenarios are of course limited by the lag in knowledge.

As discussed above, the limited scientific understanding of state transitions of these co-evolutionary human–nature systems and, in particular, the poorly developed ability of our institutional arrangements and governing system to interpret and extrapolate from expected patterns and trends and to decide on desired future states [9] have led to the attenuation of feedback (lags) and very slow speed of