Environmental Research 144 (2016) 1–7

Contents lists available at ScienceDirect

Environmental Research

journal homepage: www.elsevier.com/locate/envres

Future directions in human-environment research

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ARTICLE INFO

Article history:
Received 1 May 2015
Received in revised form
13 September 2015
Accepted 16 September 2015
Available online 1 October 2015

Keywords:
Sustainability
Transdisciplinarity
Consumption
Institutions
Social ecological systems

ABSTRACT

Human-environment research in the 21st century will need to change in major ways. It will need to integrate the natural and the social sciences; it will need to engage stakeholders and citizens in the design of research and in the delivery of science for the benefit of society; it will need to address ethical and democratic goals; and it will need to address a myriad of important theoretical and methodological challenges that continue to impede progress in the advance of sustainability science.

1. Introduction

Sustainability encompasses social sustainability, environmental sustainability, economic sustainability, as well as institutional[1] sustainability (Charles, 1994; Goodland, 1994; NRC, 1999b). The expansion of research on sustainability from the environmental dimension to the social, economic, and institutional is one of the important changes taking place in human-environment research. It began during the past decade and will be more fully implemented in the next ten years. This is a major task, from both research and policy considerations, and one that needs to question business-as-usual and find new paradigms unencumbered by assumptions about unfettered growth and development (e.g., D'Alisa et al., 2015). Neither *sustainability* nor *sustainable development* are straightforward terms and there is much to question in them, which makes the definition of and search for sustainability very much local and regional processes, rather than a national or global one, if one is to address these different pressing problems from the stakeholders' perspectives. Sustainability science is fundamental research, but it will also have to be concerned with how to implement science for the benefit of local people. The goal ultimately is to improve society's capacity to use the earth in ways that simultaneously meet the needs of the human population today and in the future. It must do so while sustaining the environmental foundations of our life support systems, and substantially reducing poverty, hunger, and inequities in access to resources (Clark, 2007; Moran, 2010; NRC, 1999a).

According to Levin (2006), socioeconomic systems are, in fact, ecological systems characterized by familiar processes such as exploitation, cooperation, and parasitism, and ecological systems are economic systems in which competition for resources are central and in which individuals seek what is best for them, but which have emergent properties that have evolutionary and systemic consequences. Thus, they are complex, adaptive systems in which patterns at the macrolevel emerge from interactions and selection processes at many lower levels of organization. Complexity theory can shed light on the interactions of these human-environment systems, by focusing not only on its structurally complex characteristics but also on the management of the use of resources in such systems. Such management needs to be adaptive in its goals and approaches, seeking system sustainability and system self-organization—since without the latter, the former is simply unattainable (Norberg and Cumming, 2008).

Human-environment research is at its foundation about sustainability science and sustainability research, and progress has been made in how such work ought to go forward. It is a good time to reflect upon some of the new directions of human-environment research, and assess which future directions are most needed. What we see is a growing convergence between the natural and social sciences, and stakeholder engagement in the production of the science that can ensure that the investments result in public

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[1] Institutions in this context are understood as rules and norms that govern society.

http://dx.doi.org/10.1016/j.envres.2015.09.019
0013-9351/

benefit. This fundamentally changes the scientific enterprise, and scientists need to be trained in new ways, and learn to practice their science in a way that the public understands and supports.

2. Toward transdisciplinarity and integrative science

2.1. Training of researchers needs to change

There is an urgent need to develop theories and methods for a science of sustainability based on the fundamental interactions between people and the biophysical environment. This call for new research implies a profound level of transdisciplinarity (Brown et al., 2010), and a multiscale, multinational, and multi-temporal integrative science that brings together the physical, biological, and social sciences, including institutional analysis and governance (Kaneshiro et al., 2005; Orr, 2002). Transdisciplinarity is a challenging process, characterized by the tackling of complexity, non-linearity, reflexivity, context-specific negotiation of knowledge, and a fusion of knowledge beyond disciplines. Because such research runs counter to traditional disciplinary-based approaches that have shaped the education and training of citizens, including scholars, the first order of business is to develop the capacity to speak across the disciplinary divides, understand the assumptions of others across the table, have a systems' perspective, and work to comprehend the complexity of human-environment systems rather than seek to simplify them. Scholars studying sustainability need to work together to formulate questions, propose innovative approaches, collect data, develop data analyses that are not disciplinary but transdisciplinary in nature, and interpret the results in ways that are truly integrative and democratic—a call for citizen-engaged science. From many quarters, from the Millennium Ecosystem Assessment to Future Earth, there is a call for engagement of the non-academic community into all stages of research from identifying problems to defining methods, gathering data, analyzing, interpreting and disseminating the data. Citizen science (Boyd, 2014) is a way to encourage participation, empower citizens and democratize knowledge. It is a new way to do science, as it presumes a degree of engagement of different stakeholders in the design of the goals of the science—rarely done until now—in environmental research. It is a new, challengine frontier and one that we must embrace as we go forward in the 21st century.

As we move forward, and project a future for human-environment research, we need to ensure that, regardless of discipline, the training we offer students is inclusive of expertise in both natural and social sciences, with an emphasis on the constraints of disciplines to find solutions to human-environment problems, and the capacity to work with different temporal and spatial scales. Business-as-usual in education and training is one of the obstacles that stands in the way of making major advances in human-environment research, since environmental problems do not belong to or respect disciplines but rather need to be addressed with comprehensive and inclusive approaches. Then, one must transform the educational enterprise by changing the structures within which people learn. How to do so will not be easy, as departments have a strong hold on the behavior of its members, and universities very often do not incentivize work across departments except rhetorically. Some departments and disciplines are more resistant than others to this need. The rise of bioengineering and biomedicine is a start, as are programs in sustainability science, and it is only a matter of time before serious integration of sciences will take place. Innovative leadership is needed to make this happen. Fortunately, we already see signs of organizations and networks breaking with tradition. Arizona State University, for one, did away with traditional disciplinary boundaries, and created new programs such as the School of Sustainability and the School of Human Evolution that bring together a variety of disciplines to address major concerns of our times. Michigan State University (MSU), through the Environmental Science and Policy Program is providing faculties and students the opportunity to work together without a whiff of disciplinarity. In Europe, important efforts are advancing in this regard: the Integrative Research Institute on Transitions in human-environment Interactions at Humboldt University in Berlin; the Institute of Social Ecology in Vienna; and several departments at Swiss universities are advancing integration outside disciplinary boundaries. The Vienna School of Social Ecology has proposed a robust approach to society-nature interactions as another useful new paradigm (e.g., Fischer-Kowalski and Haberl, 2007; Haberl et al., 2007; Krausmann et al., 2012; Singh et al., 2013). Worldwide, there are networks of academics and practitioners such as the Resilience Alliance studying resilience, adaptability, and transformability of social-ecological systems. More efforts such as these are needed to redefine the boundaries of education.

It is also crucial to develop theoretical frameworks to study complex human-environment relations. Ostrom (2009: 419) recognized that "ecological and social science have developed independently and do not combine easily," and that each discipline uses its own terminology and its own set of concepts to describe human-nature relations. She recognized the need to establish a common framework for human and environmental interactions—what she describes as the social-ecological framework (SES)—aiming to facilitate a dialogue across disciplines, organize findings, do comparisons among social-ecological systems, and study the same systems over time. The SES framework is continually updated by Ostrom's colleagues and others who have recognized its usefulness (e.g., McGinnis and Ostrom, 2014) and used for different settings that go from water and irrigation systems (Meinzen-Dick, 2007) to protected areas (Dumyahn and Pijanowski, 2011). Researchers are adapting the SES framework to include more environmental variables (Epstein et al., 2013; Vogt et al., 2015), give more attention to the context in which the SES is embedded (Torres et al., 2015; personal communication) and apply it to large ecosystems (Cox, 2014).

2.2. The scope of the research is now broader

Part of the challenge of citizen science and integrative science is that there are important differences and unequal relations between stakeholders—for example, between North and South, urban and rural areas, big industries/infrastructure projects and citizens—in defining what are the most pressing problems of sustainability (Clark, 2003; Martínez-Alier, 2002). In other words, stakeholders vary in what they want from scientists, and it will be a challenge to listen to the various stakeholders, and not just the ones who are louder or better funded to be present at the table. Environmental quality is linked to human equality and human health. As shown by Torras and Boyce (1998), countries with more civil and political rights, higher levels of literacy, and better income distribution have higher environmental quality than countries with more unequal income distribution and fewer rights. These findings have been replicated across U.S. states and their counties (Agyeman et al., 2002).

The Global South has a very different point of view from the North. They are countries with medium human development indicators or low human development. Until very recently they have been agrarian based, and dependent on the Global North for access to capital and technology, and the North depends on them as a source of raw materials, including energy. Perhaps most important, the Global South is young compared to the Global North, which is aging rapidly and concerned with immigration flows