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Transition towards a new global change science: Requirements for methodologies, methods, data and knowledge

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ABSTRACT

Dealing with the challenges of global change requires a transition not only in society but also in the scientific community. Despite continued claims for more inter-disciplinary approaches, progress to date has been slow. This paper elaborates on the need for innovation in methodologies and knowledge, on the one hand, and methods and data, on the other, to build the foundations for dealing with the challenges from global change. Three questions related to the nature of global change, the dynamics of sustainability transitions and the role of human agency guide analyses on the state of the art, barriers for innovation and need for action. The analyses build on literature reviews, expert workshops and surveys which were conducted under the umbrella of RESCUE, a foresight activity funded by the European Science Foundation. The major recommendations focus on integrating environmental and human dimensions, bridging scales, data and knowledge for global change research and overcoming structural constraints to make global change research more policy relevant.

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1. Introduction

Global change poses unprecedented challenges to scientific and policy communities, of the kind that cannot be tackled using existing conceptual frameworks and disciplinary

approaches and methods. Two challenges seem to be particularly relevant and persistent: the integration of natural and social sciences¹ and the production of societally relevant knowledge.

Both the natural and the social sciences have sought to address global change challenges, the former through the

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¹ Social sciences is used here as an umbrella term to refer to all fields of academic scholarship that deal with human society, such as philosophy, anthropology, economics, political science, and sociology.

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development of Earth System Science (Schellnhuber, 1999) and the latter mainly through critical analysis of globalisation processes (e.g. Amin and Thrift, 1994). However, these alternative conceptualisations have not been integrated, despite recognition that new forms of inter-disciplinary knowledge creation, and new forms of inquiry, are needed. In fact, although the Amsterdam Declaration² of the Global Change Programmes (2001) expressed the need to move towards a more integrated perspective, the research agenda of these programmes continues to be framed and dominated by the natural sciences (Reid et al., 2009). A survey conducted in 2011 by the International Human Dimension Programme (IHDP), in collaboration with UNESCO and the International Social Science Council (ISSC), explored the current status of engagement of social science scholars in Global Environmental Change (GEC) research, and collected more than 1200 questionnaires from multi-disciplinary experts around the world.³ There was general agreement on the need to address human dimensions of GEC more in the future, with priority consideration of issues such as equity, governance, economic policies, and social and cultural transitions.⁴

However, an effective integration of societal concerns into scientific practice may require more fundamental changes in the nature of scientific enquiry, and a move towards truly inter-disciplinary research, and also involving external stakeholders in the research process. Gibbons et al. (1994) distinguish conventional, “Mode 1” forms of science from a “Mode 2” form in which knowledge production is guided by using values mutually and reflexively constructed by a heterogeneous set of practitioners and experts working together (see also Irwin’s “citizen science”; 1995). Kates et al. (2001), following the Amsterdam declaration² outlined a research programme for sustainability science that would focus on the dynamic interactions between nature and society, analyse the resilience of social-ecological systems, and bridge science and practice to support societal transitions toward sustainability. These developments can all be interpreted as the first steps towards a transition in scientific research. However, cross-cutting initiatives in research and capacity building promoted at the Amsterdam conference, including joint projects on carbon, food, health and water, have taken time to get under way, suggesting that there continue to be difficulties in conducting inter-disciplinary research. Funding challenges have contributed to this delay, but as Webster (2007) notes, the critical social sciences may be suspicious of co-option and capture by natural science agendas, and unwilling simply to act as a medium through which science can be rendered more acceptable to various publics. Instead, social scientists want to have their understanding integrated at the earliest stages of project formula-

tion, so that more radical transformations of knowledge production can be envisaged (Hackmann and St. Clair, 2012).

These difficulties can be interpreted using the concept of different levels, or stages, of social learning process that describe both intellectual and societal transitions (Pahl-Wostl, 2009). Here, “single-loop learning” refers to incremental improvement of action strategies, without questioning underlying assumptions; “double-loop learning” then refers to a revisiting of assumptions (e.g. about cause-effect relationships) within a value-normative framework. However, it is only through “triple-loop learning” that underlying values, beliefs and world views begin to be reconsidered, and assumptions and world views are challenged. From this perspective, one can argue that the global change research community has entered the phase of double-loop learning, in which there is a reframing of the dominant research paradigm, to which the “human dimensions” community has made a significant contribution. The first signs of triple-loop learning, which requires structural change, are now emerging. Such structural change includes the adoption of new, shared norms, together with changes in actor-network structures, and in the roles of actor groups (Pahl-Wostl, 2009). This is an emergent process where emphasis needs to be given to methodologies, modes of inquiry and sharing of knowledge.

Much has been written on the problems and research questions to be addressed in global change research, but far less attention has been devoted to the requirements for methodologies, methods, knowledge and data to address these challenges. Given the recognition that barriers for innovation reside in deeply entrenched procedures and practices, we explicitly chose to broaden our concern to include “methodologies and knowledge” as well as “methods and data”. Sometimes these terms are used synonymously, but we consider it important to expand the terminology, and to be precise about the different meanings of the terms.

Thus, a “methodology” sets the framework for combining modes of inquiry and methods, and forms a set of organizing principles, following the logic underlying a particular area of study (or science). A “method”, however, is a specific information generation practice; measuring devices generate data, methods generate information, and methodologies generate knowledge. These distinctions largely follow the DIKW (Data-Information-Knowledge-Wisdom) model (Rowley, 2007). “Data” are symbols, such as the numbers produced by a temperature-measuring device, whereas “information” places data in relation to some meaning that makes them useful (e.g., impacts of July temperature on the yield of a certain crop). “Knowledge” is information embedded in a context of interpretation (e.g., the ability to make temperature-sensitive crop choices based on experience or expert knowledge). Knowledge embraces framed experience, contextual information and grounded intuition (Davenport and Prusack, 1998; Wallace, 2007), and is embedded in routines, practices and norms that may not always be explicit. These definitions indicate that simply to address “methods and data” is to assume a particular mode of knowledge production, and accordingly, constrains our enquiry and our interest in exploring how science can support transitions towards sustainable development in a changing world.

² The Amsterdam Declaration on Global Change was adopted during the first joint congress of the four global change programmes “Challenges of a Changing Earth: Global Change Open Science Conference Amsterdam, The Netherlands (www.essp.org/index.php?id=41).

³ The survey report can be downloaded at <http://www.ihdp.unu.edu/file/get/9091>.

⁴ In accordance with Rotmans et al. (2001), we define transitions as transformation processes in which society – or part of it – changes in a fundamental way.

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