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Research paper

A methodology for evaluating transdisciplinary research on coupled socio-ecological systems

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ABSTRACT

Socio-ecological research, as conducted within the Long Term Ecological Research network in Europe (eLTER), is a relatively young field that studies coupled ecological and social systems to advance solutions for contemporary challenges in human-nature interactions. While many research and applied projects have been launched using a socio-ecological conceptual framework, there are few tested protocols to evaluate the effectiveness of such efforts at meeting their goals, e.g., goals relating to knowledge integration and influence on policy and practice, which distinguish this type of research. We suggest that such socio-ecological research may be conceptualized as an expression of the broader trend in science favoring transdisciplinarity, an approach that calls for research that fuses knowledge and methods from academia, practice, and broader society, with the goal of addressing shared public problems.

We conducted a literature review of definitions of transdisciplinarity, and used these definitions to distill the core characteristics of transdisciplinary research. From these characteristics, we developed a list of guiding questions for conducting a second literature review, this time to select evaluation frameworks deemed suitable for assessing transdisciplinary research whose content was socio-ecological in nature.

The resulting evaluative approaches were categorized into five groups: questionnaire models; mixed methods; staged environmental policymaking process review; the Research Embedment and Performance Profile approach; and case studies. Selected elements from these approaches were compiled and synthesized to create a six-stage framework for the assessment of interdisciplinary and transdisciplinary socio-ecological research projects and programs. The framework begins with qualitative analysis, followed by: quantitative analysis; data synthesis and visualization; the use of focus groups to reflect on interim conclusions, and, culmination with a final data synthesis and conclusions customized to the intended audience(s) of the evaluation. We provide an example of testing the first two stages of this framework using two Romanian Long-Term Socio-Ecological Research (LTSER) platforms.

1. Introduction

1.1. Ecology broadens its scope and mission

In response to growing regional and global ecological crises and the perceived inability of policy and management to adequately address them, an increasing number of ecologists and others have called for the integration of social sciences with ecological research (Singh et al., 2013; Balmford and Cowling 2006; Redman et al., 2004). These calls suggest that effective conservation policy and management require multiple and integrated forms of knowledge, including knowledge of ecosystems and their function, and the understanding of human societies, which interact with and depend on those systems (Vihervaara et al., 2010; Haberl et al., 2006; Hooper et al., 2005). In addition, effective communication and translation of knowledge across the science-policy interface (Perrings et al., 2011) and an understanding of how knowledge and policy play out to create social and ecological facts on the ground (*sensu* Grove et al., 2015) are needed.

Socio-ecological research, which encompasses the study of the human-environment system and society-nature interactions, is a multifaceted field. We use the term "socio-ecological research" to refer to research that studies aspects of coupled socio-ecological systems, integrated systems in which humans and nature interact (Liu et al., 2007). The term 'social ecology,' refers to several related – but distinct – lines of study. According to Fischer-Kowalski and Weisz (2016), social ecology draws from several disciplines, including political economics, geography, human ecology, and environmental history. They categorize the field into three core research areas: 1) society's biophysical

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structures, 2) biohistory and society-nature coevolution, and 3) regulation, governance, and sustainability transitions (Fischer-Kowalski and Weisz, 2016). Examples of distinct threads of socio-ecological research include the Vienna Social Ecology School, which was founded to study 'social causation of burdens on the environment,' the American tradition focusing on environmental ethics and eco-activism, and the International Long-Term Ecological Research (ILTER) network's adoption of long-term socio-ecological research (LTSER), which extended that network's traditional focus to encompass the study of social processes as well as ecological ones (Fischer-Kowalski and Weisz, 2016). The present study focuses specifically on socio-ecological research that originated among ecologists and other biological scientists who gradually sought to integrate social research, as is today practiced within the ILTER network.

While the distinct threads within social ecology have diverse origins and foci, they are all representative of Mode 2 science, which is characterized as socially distributed, transdisciplinary, cross-sector work that aims to address real-world problems and is accountable to multiple actors (Gibbons, 2000). Mode 2 science represents a shift from Mode 1 knowledge production, which is characterized by the dominance of conventional, experimental science, driven by scientists and academics (Nowotny, 2003). The newer paradigm – Mode 2–does not replace Mode 1; rather, it co-exists with it (Nowotny, 2003). A Mode 2 society means that context should be considered as an influence on all topics of scientific inquiry; for the field of ecology, this has meant acknowledging the fundamental interconnectedness of the ecological and social systems, and advancing frameworks for studying them.

1.2. Transdisciplinarity in socio-ecological research

While the term 'transdisciplinarity' can be traced to the early 1970s (Klein, 2004), it is a 1992 article by Patricia Rosenfield, writing about large-scale public health studies, that proposed a taxonomy of cross-disciplinary research that has been widely cited when scholars define transdisciplinarity (see, e.g., Stokols, 2010; Pohl and Hirsch Hadorn, 2008; Klein, 2006). In this taxonomy, *multidisciplinarity* refers to projects that involve several disciplines working in parallel to address a problem, defined by a coordinated or sequential work process. *Interdisciplinarity* is defined by a higher level of interaction and integration. *Transdisciplinarity* transcends disciplinary boundaries to create something new that becomes greater than the sum of its parts; it raises new questions and possibilities that could not have been raised by a single discipline, nor by a cross-disciplinary effort lacking coordination, integration, and close communication in a problem-solving context (Klein, 2010). Some scholars suggest that a transdisciplinary approach is necessary to carry out most complex, interdisciplinary team research projects, since, from their perspective, transdisciplinarity connotes a more inclusive team, higher standards for knowledge integration, and cooperation with non-academic stakeholders, thereby requiring sophisticated team communication and knowledge-sharing (Angelstam et al., 2013; Jahn et al., 2012; Klein, 2008; Pohl and Hirsch Hadorn, 2008).

Different scholars continue to debate the meaning of transdisciplinarity and to use the term in various ways (Zscheischler and Rogga, 2015). In this paper, we use the term to emphasize the core aspects of transdisciplinary research – an aim to address complex, real-world problems; meaningful collaborations, particularly between academic researchers and non-academics; and an openness to adapting methodologies as projects proceed (Zscheischler and Rogga, 2015; Roux et al., 2010; Polk and Knutsson, 2008). We conducted a literature review of definitions of transdisciplinarity, which is explained in more detail below, but since it is important to define transdisciplinarity for the purposes of this study, we present our own definition, which is particularly inspired by LTSER:

> A reflexive, collaborative approach to knowledge co-production, inclusive of academic and non-academic actors and stakeholders, to integrate diverse types of knowledge, consider risks and consequences, and generate practical solutions to societal problems.

Socio-ecological research, as conducted within European LTER – the regional European network within ILTER, (eLTER) – was conceived to incorporate different knowledge domains from diverse stakeholders to influence policy and ultimately to improve "ecological facts on the ground" (*sensu* Grove et al., 2015). These goals align with the goals of transdisciplinarity in a general sense. This is logical because the theoretical foundation of the socio-ecological research conducted within eLTER explicitly promotes transdisciplinary research across the sciences (Singh et al., 2013; Haberl et al., 2006). Since tools to evaluate transdisciplinary studies on nature-society interactions are so scarce, we deemed it appropriate to borrow approaches designed for the evaluation of interdisciplinary and transdisciplinary nature-society research and apply it to the type of socio-ecological research conducted within the LTSER network.

To this end, this article reviews approaches relevant for evaluating socio-ecological research, synthesizes these approaches into an original framework for the evaluation of socio-ecological research, and implements the first two stages of the approach, demonstrated through a case study of two Romanian LTSER platforms. While we focus our study on LTSER (described in detail below), we believe the evaluation framework we have developed can be applied to other socio-ecological programs and projects (such as those conducted through other projects and networks that have adopted the socio-ecological approach; for example, Future Earth,[1] The Stockholm Resilience Centre,[2] and the Institute for Social-Ecological Research).[3]

2. The emergence of long term socio-ecological research in eLTER

The Long Term Ecological Research (LTER) network was established in the United States by the National Science Foundation (NSF) in the early 1980s, followed in 2003 by the launch of the European LTER (eLTER) network. At its establishment, LTER program goals included the coordination of ecological research at the network level; improvement of comparability of data; delivery of high-quality data to scientists, policy makers, and the public to meet needs for decision-making; and education of the next generation of scientists (Knapp et al., 2012). A thirty-year review of the US LTER program conducted by an expert panel convened by the NSF commended the research network for establishing a functioning network of research sites that enabled research on a continental scale and collected long-term observational data that facilitated cross-site experimental studies (Michaels and Power, 2011). However, reviewers suggested changes for improving the program, particularly by addressing the tension between site-based and network-level research, challenges in data sharing, and for increasing research integrated with the social sciences to produce knowledge more useful for addressing complex environmental challenges such as climate change, sustainable development, biodiversity, ecosystem management, and environmental hazards (Michaels and Power, 2011). Due to these and similar recommendations (e.g. Redman et al., 2004; Singh et al., 2013; Sier and Monteith, 2016), European LTER network members proposed a new research framework – the LTSER platform – with a goal of integrating the social sciences into traditional ecological research. While the establishment of a formal network that put "socio-ecological research" explicitly in its name (Haberl et al., 2006) was specific to Europe, there was also evidence for this shift in the US LTER network (e.g. Phoenix and Baltimore Urban LTER). LTSER platforms have since proliferated across Europe and globally, forming an international network aimed at establishing cross-disciplinary, socio-

[1] See www.futureearth.org.
[2] See http://www.stockholmresilience.org.
[3] See http://www.isoe.de/en/home/.