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Review

Climate change and transdisciplinary science: Problematizing the integration imperative

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ABSTRACT

In this article we critically examine the 'integration imperative' in transdisciplinary environmental science and build on social constructivist and political theories to suggest alternative approaches of knowledge co-production in transdisciplinary settings. Our argument builds upon a body of literature in social studies of science to cull insights about knowledge co-production, social learning, and the ecology of team science, particularly as it relates to climate change adaptation. Couched in this transdisciplinary literature, we demonstrate, is the assumption that integration necessarily can and should be a regulative ideal. We critique this assumption by examining the 'messy' politics of achieving consensus among radically different, and sometimes irreconcilable, ways of knowing. We argue that the integration imperative conceals the friction, antagonism, and power inherent in knowledge co-production, which in turn can exclude innovative and experimental ways of understanding and adapting to climate change. By way of conclusion, the final section explores three alternative models of knowledge co-production – triangulation, the multiple evidence-based approach, and scenario building – and illustrates their application in the context of transdisciplinary research in climate change adaptation in the arctic, focusing on alternative means of cross-boundary engagement with indigenous ways of knowing.

1. Introduction

To address complex societal and environmental issues such as climate change adaptation, new knowledge production models have been proposed to transcend disciplinary and institutional boundaries. Foremost among these is the notion of 'transdisciplinarity,' which has come to represent an idealization of how scientists 'should work' with the diversity of actors\stakeholders affected by environmental issues (Boon et al., 2014; Hadorn et al., 2006; Lynch et al., 2008; Romero-Lankao et al., 2013). By definition, transdisciplinarity is understood as a reflexive, integrative, method-driven approach aimed at producing normative knowledge and policy-relevant solutions for societal problems like climate change (Hadorn et al., 2006; Lang et al., 2012). At the core of transdisciplinarity lies *integration*: the desire to assimilate heterogeneous knowledge (via data, analysis, or claims) through processes of co-production. Ideally, integration occurs on several levels: framing the problem, managing the project, including team members and stakeholders, wrangling data, synthesizing results, and applying insights (Groß and Stauffacher, 2014; Lang et al., 2012). Because climate science projects are often positioned at the confluence of science, policy, and practice, inclusion of different stakeholders and disciplines in knowledge production is often a high priority (Boon et al., 2014). As the argument goes, effective adaptation to climate change requires informed policy making, which in turn will require research paradigms to evolve toward an integration of natural and social science approaches and local knowledge (Ayre and Nettle, 2015; Lynch et al., 2008).

At the same time, this blurring of disciplinary lines and the involvement of non-scientists in processes of societal problem-solving raises important questions about the politics of knowledge production, which may ultimately place limits on the degree to which transdisciplinarity effectively empowers society to confront these issues. If climate change science is the work of composition (Latour, 2014), which involves mobilizing and translating different

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knowledge systems which do not necessarily share the same ontology of Western science (Descola, 2013), then what does it mean to 'integrate' different knowledges in transdisciplinary settings? Drawing together three specific theories—Latour's (2005, 2010) compositionalist theory of science, Mouffe's (2005) notion of the 'political', and Law (2004) and Mol's (1999, 2002) 'ontological politics'—we critically examine the 'integration imperative' in transdisciplinary environmental science and then suggest alternative approaches of knowledge co-production in transdisciplinary settings.

Our argument builds upon a body of literature in social studies of science to cull insights about knowledge co-production, social learning, and the ecology of team science, particularly as it relates to climate change adaptation. Couched in the transdisciplinary literature, we demonstrate, is the assumption that integration necessarily can and should be a regulative ideal. Next, we critique this assumption by drawing upon social constructivist and political theories that examine the 'messy' politics of achieving consensus among radically different, and sometimes irreconcilable, ways of knowing. We argue that the integration imperative conceals the friction, antagonism, and power inherent in knowledge co-production, which in turn can exclude innovative and experimental ways of understanding and adapting to climate change (see also Castree et al., 2014). By way of conclusion, the final section explores three alternative models of knowledge co-production – triangulation, the multiple evidence-based approach, and scenario building – and illustrate their potential use and implications for transdisciplinary environmental science.

This essay is situated in the context of climate change adaptation, a field increasingly characterized by transdisciplinary discourse and methodological experimentation (Ayre and Nettle, 2015; Kerstin and Barth, 2014; Serrao-Neumann et al., 2015; Romero-Lankao et al., 2013). Adaptation takes place at a number of scales, from local to global; thus integrating knowledge and producing policy-relevant solutions are seen as particularly urgent (Adger et al., 2005; Dilling and Lemos, 2011). In theory, the complexities of climate change adaption demand relevant knowledge from a range of disciplines and perspectives, and application that bridges the science-policy gap (Hegger et al., 2012; Serrao-Neumann et al., 2015). As we explain in the next section, research on transdisciplinarity reveals several common factors and patterns that have made it an attractive model for investigating climate change adaptation, despite practical and epistemological challenges.

2. The science of transdisciplinary science

Scientific work is heterogeneous, requiring many different actors and viewpoints; yet it also requires convergence and cooperation in order to produce generalizable findings and a univocal product (Star and Griesemer, 1989). As a research paradigm, transdisciplinarity emerged in the 1970s as a top-down approach to implementing systems thinking, and was later adopted by so-called 'post-normal' scientists as a bottom-up approach to steer science toward expanded epistemic communities of scientists and non-scientists working together to address complex societal problems (Hadorn et al., 2006). Transdisciplinarity is also common to public-private collaborative research networks, funded, mandated and monitored by governments (i.e. university–government–industry research or 'triple-helix' networks), which have become commonplace in regional, national and international systems of innovation and science policy (Etzkowitz and Leydesdorff, 2000). These collaborative arrangements are often characterized by a 'mode-2' approach to knowledge co-production: research conducted with knowledge users and/or stakeholders through applied projects intended to inform and spur socioeconomic development (Gibbons et al., 1994).

While transdisciplinarity is not yet considered 'mainstream' science and struggles to receive long-term support from funding organizations (Lawrence, 2014; Lyall et al., 2011), its allure for climate science lies in its promise of balancing epistemological-disciplinary heterogeneity and broader demands for knowledge convergence around climate action (Boon et al., 2014). For transdisciplinary science to influence policy it must be credible (involving the adequacy of evidence and arguments); salient (relevant to needs of decision makers); and legitimate (production of knowledge is respectful, unbiased, and fair) (Cash et al., 2003).

A review of the transdisciplinarity literature reveals critical procedural and epistemological factors that are thought to facilitate the co-production of such valid, policy-relevant knowledge in methodologically robust ways. Areas of consensus focus on the structural, institutional, behavioral, and relational factors – intrinsic and external – that influence how to effectively build a transdisciplinary team and co-produce rigorous scientific knowledge (Table 1). Several factors stand out. In terms of project structure and team composition, proper mechanisms to foster knowledge integration – such as face-to-face dialogue, frequent interactions, cross-cultural communication, and spatial proximity –are necessary to enable the trust and communication required to

Table 1
Organizational factors shaping transdisciplinary science. Factors were compiled by a comprehensive review of 60 papers on transdisciplinary research. For explication of factors, see Chompalov and Shrum (1999), Huutoniemi et al. (2010), Lang et al. (2012), Jahn et al. (2012), Vanasupa et al. (2014).

Factor	Characteristics
Structural	
Clear expectation of transdisciplinarity	Cooperative policies that facilitate exchange; institutional mandates; catalysts for integration; capacity building, and memory
Appropriate scale and magnitude	Identify the locus of problem and timeline for collaboration
Funding and capital	Continuity of funding; availability of labor, capital, and organizational resources
Spatial proximity	Face-to-face dialogue, interactive research processes
Reward structures	Influence of work policies (e.g. tenure and promotion); compensation for labor; career stage
Problem identification and structuring	Clear common goals; "front loading" of social sciences and humanities, identifying the right object of study
Compositional	
Stakeholder involvement	Early engagement with stakeholders; careful selection of collaborators
Motivations	Individuals with formal experience or training in transdisciplinary research; basic vs. applied science
Active management	Democratic leadership; facilitation and mentorship; fair allocation of responsibilities; conflict resolution
Standardization of methods and data	Appropriate infrastructure, resources, and data support; discussion of intellectual rights and data security
Diversity	Diversity of team members according to ethnicity, gender, discipline, function
Cognitive and relational	
Trust	Credibility, interdependence, faith in others
Frequent and effective communication	Updates, information sharing, shared concepts
Social learning	Recursive research design; flexibility to adapt to new tasks and goals