RIHN-RISTEX Project Working Paper #1

When is a Transdisciplinary Approach to Research Needed?

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Summary

This short background paper of the JST-RISTEX-supported project implemented by RIHN is a first step in the development of criteria to help assess the need for research projects to adopt a transdisciplinary approach in the context of Future Earth. The paper provides a brief discussion of main arguments in the general conceptual literature on transdisciplinary approaches to environmental and sustainability research in English. This literature has grown rapidly in recent decades, but no great variations in justification for transdisciplinary approaches were found. The predominant argument for transdisciplinarity is the nature of the complex (or wicked) problems currently facing the earth and human society, where "facts are uncertain, values in dispute, stakes high and decisions urgent" (Funtowicz & Ravetz 1992). The paper concludes by suggesting two sets of dimensions, focusing on (1) decision stakes and system uncertainties and (2) agreement on knowledge and values, respectively, as possible starting points for developing criteria for the need for transdisciplinarity.

As the Future Earth initiative was developed, two arguments were prominently put forward to justify a new approach to Global Environmental Change (GEC) research. The first was the need for greater integration of different disciplinary perspectives in order to overcome the fragmentation of science -- interdisciplinarity. Previously, GEC research had been organized in the form of separate global core projects (in effect, networks of researchers and research activities), which were grouped under four Programs (WCRP, IGBP, DIVERSITAS, and IHDP). In Future Earth, interdisciplinarity is primarily embodied in a new organization of GEC research, where the existing GEC research projects are brought together under a single Future Earth umbrella and the

programs are dissolved.[1] A strong push is also underway to bring the social sciences and humanities more into Future Earth (Hulme 2011, Hartman 2015, Mann 2015).

The second argument is that in order to contribute to the solution of GEC problems, research needs to engage in partnerships with actors beyond the science community (often referred to as societal stakeholders or, simply, society). In the Future Earth context, this is usually described as the co-design, co-production and co-delivery of research (e.g. Mauser *et al* 2013). The term transdisciplinarity is also commonly used, suggesting something of a sequence from disciplinary research, through interdisciplinarity, to transdisciplinarity (Pohl and Hirsch Hadorn 2007, Jahn *et al* 2012), countering the tendency of specialization and fragmentation of science (Funtowicz and Ravetz 1993). This report briefly summarizes some of the main arguments in the transdisciplinarity literature for why, under what circumstances, a transdisciplinary approach is deemed necessary. It is not an exhaustive review of the literature, but is confined to general works, mostly in GEC research, environmental research, and sustainability science.

The literature on transdisciplinarity spans a range of fields and perspectives, but a few contributions stand out. The work of Silvio O. Funtowicz and Jerome R. Ravetz (among others 1993, 2003, and 2008) on "post-normal science" has been particularly influential in paving the way for the broad acceptance of the need for transdisciplinary research. Similarly, writings by Gibbons and colleagues (Gibbons *et al* 1994, Nowotny *et al* 2001) on "Mode 2" knowledge production that traces the evolving relationship of science with society have been important. The *td-net for transdisciplinary research*, initiated by the Swiss Academies of Arts and Sciences, is a network that has made a range of key theoretical contributions, including a *Handbook of Transdisciplinary Research* (Hirsch-Hadorn *et al* 2008).

Conceptual research about transdisciplinarity and studies applying transdisciplinary approaches have mushroomed in recent years, in particular the last ten years, as shown in Figure 1 below.

[1] WCRP will continue to exist as a separate entity and collaborate with Future Earth.

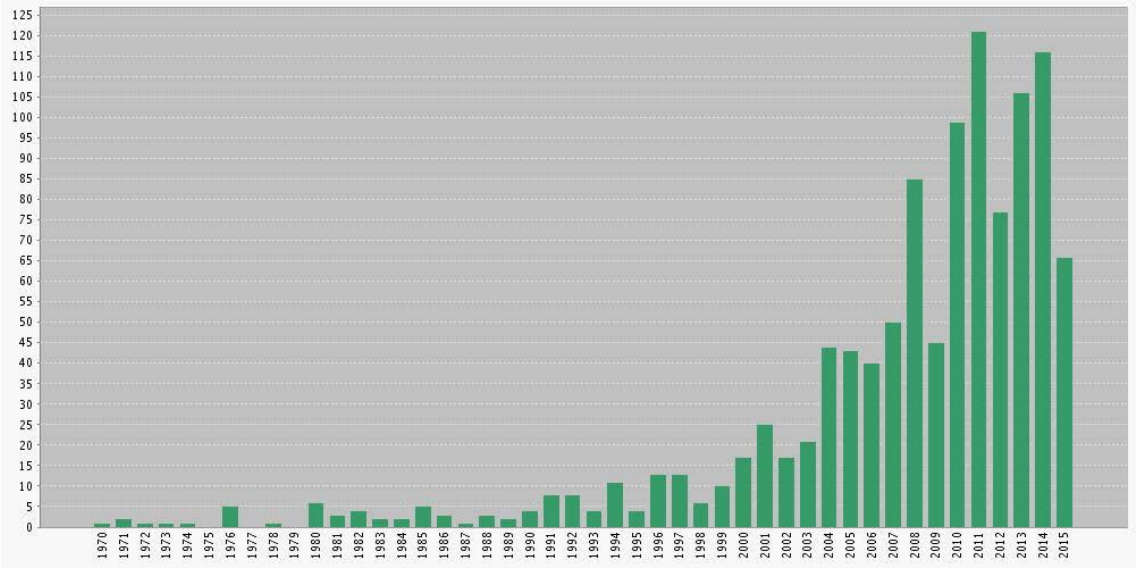

Figure 1: Growth of publications on Transdisciplinarity, 1970-2015

Source: Web of Science search, key= "transdisciplinary*", by title of publication.

What is Transdisciplinarity?

There are many different definitions and understandings of "transdisciplinarity," but two elements appear in most. The first is that transdiciplinary research not only integrates different scientific disciplines – the domains of the researchers -- but that it also incorporates other types of "non-scientific" knowledge held by other groups in society. Thus, transdisciplinarity has the function of bridging different knowledge systems (or knowledge *cultures*). The second element is that transdisciplinary research aims to solve concrete, real-world problems, rather than grapple with "academic" questions and hypotheses (Jahn *et al* 2012).[2] Pohl and Hirsh Hadorn (2007: 20) expand this element by stipulating that the research needs to contribute to the common good. Adding the two elements together, in concrete project situations we see researchers from different academic disciplines collaborating closely with stakeholders (or "practitioners") in striving to contribute to solution of pressing problems.[3] The need to

[2] Note that Basarab Nicolescu, who has been influential in shaping the discourse on transdisciplinarity, argues that joint problem solving is one of the aims of transdisciplinarity, but not exclusively so. He advocates for a broader "theoretical transdisciplinarity" (Nicolescu 2008: 12).

[3] The term transdisciplinarity is sometimes used as referring to the integrated collaboration of different scientific disciplines, which is more commonly labeled as "interdisciplinary." Conversely, in some cases, "interdisciplinarity" is used in the sense in which "transdisciplinarity" is used here: "research that involves experts from multiple disciplines and stakeholders investigating a common problem" (Bammer

actively engage practitioners has tended to limit the scope of transdisciplinary research to local or regional scales (Brandt *et al* 2013). A recent conceptual overview of transdisciplinary research elaborated the following comprehensive definition:

"Transdisciplinarity is a critical and self-reflexive research approach that relates societal with scientific problems; it produces new knowledge by integrating different scientific and extra-scientific insights; its aim is to contribute to both societal and scientific progress; integration is the cognitive operation of establishing a novel, hitherto non-existent connection between the distinct epistemic, social–organizational, and communicative entities that make up the given problem context." (Jahn *et al* 2012)

Why Transdisciplinarity?

The literature contains a number of arguments for why transdisciplinary approaches are needed. One strand of the "Mode-2 science" literature shows that the growth in demand for science has led to the development of more open systems of knowledge production in which science and society are pervasively intertwined ("transgressive", Nowotny *et al* 2001: 48). Another, not entirely separate, body of scholarship emphasizes the role of transdisciplinarity in the democratization of knowledge production (Funtowicz and Ravetz 2008, Cornell *et al* 2013). Komiyama and Takeuchi (2006) argue that sustainability science involves the application of the precautionary principle and that social acceptance of this principle requires transdisciplinarity. More broadly, calls for collaboration with society also need to be placed in a global research funding context where practical and direct usefulness of research is increasingly emphasized.

However, by far the most prevalent argument is that the nature of the problems facing the world today, "where facts are uncertain, values in dispute, stakes high and decisions urgent" (Funtowicz & Ravetz 1993) requires transdisciplinary approaches. Much of this thinking emerged in the 1980-90s, in efforts to address environmental degradation, new health threats, risks of technology and "risk society," but the basic building blocks of uncertainty, disputed values, and high decision stakes have changed remarkably little since then and are found in most writings about transdisciplinarity.

2013: 7).

For example, in *Principles for Designing Transdisciplinary Research,* Pohl and Hirsch Hadorn (2007: 20) argue that "There is a need for TR [transdisciplinary research] when knowledge about a societally relevant problem field is uncertain, when the concrete nature of problems is disputed, and when there is a great deal at stake for those concerned by problems and involved in dealing with them." Similarly, Brandt *et al* (2013) state that "Steering socio-ecological systems towards a more sustainable path is an inherently transdisciplinary problem, requiring cooperation between different scientific domains and society at large [.]"[4]

Wicked Problems and Complex Systems

One strand of the literature has developed the notion of "wicked problems" and linked this to complex systems science. A problem is "wicked" "in that it is difficult to define, multi-causal, has unforeseeable consequences, and is socially complex, without clear pathways to solutions, straddling a complex range and scale of governance structures" (Russel 2012, also see Text Box 1). Often, wicked problems arise from the solutions to earlier problems as unintended consequences of problem solving give rise to new problematic configurations (van der Leeuw 2012).

Text Box 1: Wicked Problems…

- Evade clear definition. They have multiple interpretations from multiple interests, with no one version verifiable as right or wrong.
- Are multi-causal with many interdependencies, thereby involving trade-offs between conflicting goals.
- Often lead to unforeseen consequences elsewhere when attempts are made to solve them, creating a continuing spiral of change.
- Are often not stable. Problem-solvers are forced to focus on a moving target.
- Can have no single solution. Since there is no definitive stable problem, there can be no definitive resolution.
- Are socially complex. Their social complexity baffles many management approaches.

[4] For similar arguments see, among others, Jäger 2008, Jäger *et al* 2013, Lang *et al* 2012, Miller *et al* 2014.

- Rarely sit conveniently within any one person, discipline or organization, making it difficult to position responsibility.
- Are uniquely grounded in place and time.

Resolution of wicked problems necessarily involves changes in personal and social behavior, changes that many be strongly resisted or encouraged, according to circumstances.

Source: Brown 2012, 62-3.

The wicked, messy nature of the problems has led many authors develop linkages to complexity theory and systems thinking. Systems science has shown that complex systems cannot be explained in terms of the workings of the component parts alone (Mitchell 2009). "Emergent" phenomena arise from the *interactions* of the parts of the system, so that the whole is more than the sum of the parts. Therefore, a holistic, rather than reductionist, approach to knowledge construction is needed. Furthermore, an important aspect of complex problems is that they can be viewed from a range of points of view. These multiple perspectives can be mutually contradictory but still be valid at the same time (Funtowicz & Ravetz 2008). There is no single "correct" or privileged point of view. In addressing real world, complex problems, when reductionist approaches do not work and multiple perspectives need to be addressed, a process is needed that encompasses a wider range of actors and ways of knowing. This needs to be done systematically and in a rigorous way to ensure "quality control," and form an "extended peer community" beyond scientific circles to include participants whose legitimacy and competence are established based on broader societal and cultural considerations (Funtowicz and Ravetz 1993: 752, also Table 1 below).

Towards Assessing the Need for Transdisciplinarity

The preceding discussion has shown that a broad consensus consists in the literature that it is the particularly complex nature of GEC and other problems facing humanity that calls for transdisciplinary research. How, then, can the insights from the literature be used to assess in what cases a transdisciplinary approach needs to be adopted and when not? Here, two possible elements of such an assessment are suggested.

First, it has been shown that the work on “post-normal science” by Funtowicz and Ravetz was important in shaping the discourse on transdisciplinary research. Key elements that distinguish post-normal science from core (disciplinary) science, as well as from applied science and professional consultancy (e.g. medical practice and certain types of engineering where professional judgment is more important than standard techniques to manage quality) are summarized in Table 1. Funtowicz and Ravetz were early to point to the importance of uncertainty and decision stakes as defining characteristics of post-normal science (rows 2 and 3 in Table 1). Progressing from core science to post-normal science (reading from left to right) the decision-making stakes change from low to high and conflicting. Systems uncertainties refer to the degree to which the issues can be captured in knowledge: such uncertainties are externalized in core science, managed at technical and methodological levels in applied science and professional consultancy, but involve epistemological and ethical issues in post-normal science. These two elements can be combined in a two-way matrix to assess the need for transdisciplinarity.

Table 1: Main Characteristics of Four Types of Science

	Core Science	**Applied science**	**Professional consultancy**	**Post-normal science**
Goal	Curiosity-motivated	Mission-oriented	Client-serving	Issue-driven
Decision stakes	Low: by definition no external interests	Simple & small: straightforward external use of results	In conflict: involving human stakeholders & natural systems	Conflicting (high) stakes
System uncertainties	Low, “puzzle-solving”	At technical level, managed by standard routines & procedures	At methodological level: needs personal judgment based on higher skills	At epistemological/ ethical level (high)
Quality evaluation focus (‘p-fourth’)	Process	Products	‘Person’: competence of consultant	Purpose

Peer community	Subject-specialism peers	Direct producers, sponsors & users of research	Includes clients (but they lack expertise)	Broader communities
Source: Compiled from Funtowicz and Ravetz 1993.				

A similar matrix is proposed by Jahn *et al* (2013, see Table 2). They employ the common categorization of knowledge involved in transdisciplinary research: system knowledge (of the current state of the system/issues), orientation (or target) knowledge (of the desired state of the system, "solution"), and transformation knowledge (on how to get to the desired state). When agreement on both values and on knowledge is low, we are dealing with wicked problems and stakeholder participation is particularly required. Jahn *et at* further recognize three levels at which knowledge can be integrated (or not): the epistemic, the social-organizational, and the communicative levels.

Table 2:

Types of Knowledge and Stakeholder Participation in Different Knowledge/Value Configurations

		Agreement on Values	
		High	Low
Agreement on Knowledge	High	Transformation knowledge lacking: SH participation recommended, but not mandatory	Orientation & transformation knowledge lacking: SH participation mandatory in Phases 1 & 3
	Low	System & transformation knowledge lacking: SH participation recommended, but not mandatory	System, orientation & transformation knowledge lacking→ wicked problems: SH participation mandatory throughout
Source: Compiled from Jahn *et al* 2012			

The post-normal science scheme and the Jahn *et al* scheme can be combined or used separately as the basis for a set of criteria for assessing the need for transdisciplinarity.

Next Steps

The above analysis is limited to a sample of conceptual contributions to the transdisciplinarity literature. The RIHN-RISTEX research project next needs to take this analysis further by examining how these conceptual reasons for adopting transdisciplinarity are incorporated in actual real-world research projects and literature. We propose to undertake a further literature review of studies that have applied transdisciplinary approaches and examine what arguments are used for their adoption and if the results from the study justify their adoption.

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