



Scientist and stakeholder perspectives of transdisciplinary research: Early attitudes, expectations, and tensions



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ABSTRACT

Transdisciplinary approaches are becoming increasingly adopted as a way to research complex socio-environmental problems. Conceptually, transdisciplinarity aims to foster meaningful knowledge co-production through integrative and participatory processes that bring together diverse actors, disciplines, and knowledge bases. In practice, transdisciplinarity is more ambiguous. While there is a growing body of literature on such approaches, there remains no widely-accepted definition, concrete framework, or empirical strategy for how to carry out a transdisciplinary project. We propose that this lack of explicit structure and entrenched meaning leaves space for transdisciplinary approaches to be shaped by the evolving network of participating scientists and stakeholders, according to their perspectives of the approach and what it embodies. Here, we examine the perspectives of a diverse group of actors ($n = 42$) embarking on a 10-year transdisciplinary research project focused on building resilience to natural hazards and disasters in New Zealand. We present the findings of qualitative surveys and group interviews that investigate stakeholders' and scientists' early perspectives of transdisciplinary, or co-created, research. The study represents the first stage of longitudinal research that will continue over the course of the project. Results show that early actors in the project share an overall consistent understanding of co-created research. Participants described a process that integrated diverse people and knowledge; created benefits on both a social and personal level; fostered clear, two-way dialogue; and overcame pragmatic and intrinsic challenges. Collectively, participants agreed with adopting transdisciplinary approaches to natural hazard, risk, and resilience research, with stakeholders showing a stronger degree of agreement than scientists. While attitudes towards transdisciplinarity were overall positive, a number of underlying conflicts emerged in regards to carrying out new modes of knowledge production within traditional social and institutional structures. These conflicts result in a tension that is felt by actors involved in transdisciplinary projects early on, and in some cases, influences perception of their ability to fully participate in such an approach. Evaluating actor perspectives and expectations early in the transdisciplinary process can give insight into how attitudes, expectations, and conflicts might shape transdisciplinary efforts, and can provide relevant parameters for assessing change over time.

1. Introduction

The emergence of complex socio-environmental challenges such as climate change adaptation, sustainable development, and disaster risk reduction has coincided with calls for more integrative and participatory approaches to scientific research. Shaped by post-positivist concepts such as “post-normal science” (Funtowicz and Ravetz, 1993), “mode-2 knowledge production” (Gibbons et al., 1994), and “socially robust” knowledge (Nowotny et al., 2001), these integrative approaches argue that a more democratic approach to scientific research is needed

in order to solve intractable ‘wicked’ problems that have a high number of stakeholders, impacts, interdependencies, and uncertainties (Rittel and Webber, 1973; Hirsch Hadorn et al., 2008; Weichselgartner and Truffer, 2015). “Transdisciplinarity” represents one of the highest degrees of integration on the continuum of these research approaches. Moving beyond cooperation of disciplines (*multidisciplinarity*) and integration of disciplines (*interdisciplinarity*), transdisciplinarity represents knowledge co-production which transcends disciplinary, academic, and epistemic boundaries. Broadly, transdisciplinarity is considered a reflexive and inclusive approach to research that aims to solve

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societal problems together with scientific problems through high degrees of cross-fertilization, integration, and collaboration among academic and non-academic actors and diverse bodies of knowledge (Cash et al., 2003; Tress et al., 2004; Pohl and Hirsch Hadron, 2007; Jahn et al., 2012; Lang et al., 2012).

While there is growing consensus in regards to the ontological and conceptual framing of transdisciplinarity in the literature (Hirsch Hadorn et al., 2008; Jahn et al., 2012; Lang et al., 2012), there is not yet a shared understanding of how transdisciplinarity is carried out in practice (Zierhofer and Burger, 2007; Popa et al., 2015; Felt et al., 2016). Felt et al. (2016) observe that, “although there seems to be agreement that these approaches might nurture innovations of a new kind, we know little regarding the research practices” (p. 732). Although transdisciplinary concepts emerged as early as the 1960s and ‘70s, few projects have managed to demonstrate enduring, institutionalized transdisciplinarity (Mittelstrass, 2011; Lang et al., 2012; Brandt et al., 2013; Weichselgartner and Truffer, 2015). In part, this is because transdisciplinary approaches aim to frame and investigate problems in a fundamentally different way to the traditional positivist academic and institutional research approaches that have dominated in the past. Where traditional research approaches tend to conceptualize scientific knowledge as an independent and value-neutral objective truth, transdisciplinary contexts embrace a constructivist view of scientific knowledge, in which its value is tied to its societal relevance (Kuhn, 1962; Functowicz and Ravetz, 1993; Nowotny et al., 2001; Maasen and Lieven, 2006). Accordingly, entrenched funding structures and competitive academic programs that value high-impact disciplinary scholarship, empirical discoveries, and internal validity over external relevancy to practice, present a number of barriers to academic researchers who wish to lead or engage in transdisciplinary research (Payton and Zoback, 2007; Green et al., 2009; Clark et al., 2011; Jahn et al., 2012; Felt et al., 2016). Similarly, institutional constraints, policy settings, and resource limitations introduce a number of similar barriers to stakeholders (Weichselgartner and Kasperson, 2010; Tseng and Penning-Rowsell, 2012; Thaler and Levin-Keitel, 2015). Once underway, projects need to manage an ongoing “balancing act” (Boon et al., 2014, p. 58) between diversifying knowledge types while also aligning knowledge production towards a coherent shared goal (Boon et al., 2014; Klenk and Meehan, 2015). Consequently, transdisciplinary projects require great time, effort, and commitment on behalf of researchers, stakeholders, and funding bodies, yet there is limited guidance on how this hard work can be carried out in a way that guarantees outcomes.

We propose that the ambiguity associated with transdisciplinary practice leaves space for the approach to be adapted and shaped by participating actors’ perspectives of what the approach embodies. While a project may conceptually adopt a “transdisciplinary” approach by facilitating shared governance, integrative structures, and collaborative processes, inevitably, the act of *co-creating* research will be done by the individual actors within the project – the “architects of participation” (Felt et al., 2012, p. 7). The scale and scope of transdisciplinary projects means that there are often many actors involved, who are likely to come from a broad range of backgrounds with varying worldviews and perspectives of integrative approaches. For example, actors from different institutions may have participated in inherently different styles of interdisciplinary collaboration in the past, under different organizational and epistemic contexts (Lengwiler, 2006). Actors may also have different individual views on the value, importance, and meaning of integrative research concepts. While there may be an imperative to “engage” in a transdisciplinary project, individual actors may have different perspectives about the importance, type, and timing of engagement that needs to take place (Allen et al., 2013; Bieluch et al., 2016). The concept of participatory research itself may be associated with a “plethora of meanings” (Felt et al., 2012, p. 26). Additionally, although a large body of scholars, practitioners, and funding agencies embrace and advocate integrative transdisciplinary

approaches, there remains ardent criticism of the approach as a means of “politicizing” science (Weingart, 1982; Maasen and Weingart, 2005). The individual attitudes of actors drawn into a large societal-scale project are likely to lie across a spectrum of such stances.

Collectively, these individual and social perspectives may have an impact on the decisions, engagement pathways, and outcomes of large transdisciplinary projects (Pohl et al., 2010; Rosendahl et al., 2015). Reflecting on a decade of transdisciplinary initiatives in Austria, Felt et al. (2016) observed that researchers translated transdisciplinary concepts into practice in different ways, adopting individual strategies that reflected their perceptions of how engagement and integration of actors should occur. Similarly, Swan et al. (2010) observe that the translation of integrative research concepts into practice often relies on the way that individual actors mobilize and adapt approaches as they confront challenges. Here, we examine actors’ perspectives at the beginning of a transdisciplinary project in order to explore the way that actors initially view and understand the approach, and to establish a reference point for observing changes in perspective over time. The study is framed around the interpretivist assumption that each participating actor will hold an individual perspective of the transdisciplinary research process, which is reflected in their attitude, perceived values, and expectations for the approach, and that this will evolve over the course of their experience in the project. We explore these perspectives through qualitative surveys and group interviews with stakeholders and scientists involved in the onset phase of a 10-year disaster resilience research project in New Zealand, the Resilience Challenge.

The purpose of carrying out this study at the onset of the Resilience Challenge project is to understand early actors’ perspectives of transdisciplinary, or co-created, research. This purpose serves two aims: (1) to understand the expectations and attitudes of a group of actors initiating a long-term transdisciplinary research project, and (2) to establish a relevant set of parameters upon which to monitor changes in the project’s actors’ perspectives over time. This study does not evaluate the effectiveness of the project or its approach. Rather, it examines how actors view and understand the transdisciplinary process. Understanding collective expectations and attitudes towards transdisciplinary research early-on, and revisiting these longitudinally, may contribute insight into ways that transdisciplinarity evolves reflexively over time (Swan et al., 2010; Cradock-Henry et al., 2017). A number of authors have proposed lists of the key conceptual elements, phases, or attributes of transdisciplinary science (e.g., Lang et al., 2012; Klenk and Meehan, 2015; Polk, 2015). These provide a valuable framework for understanding transdisciplinary projects. However, having an actor-based, context-specific set of goals and expectations may foster more sensitive observations of a particular project’s transdisciplinary practice. In addition to establishing a meaningful common ground for observing longitudinal change, we aim to bring project-specific context and definition to a loosely-defined approach. While a number of studies have reflected on project experience retrospectively (e.g., Felt et al., 2012, 2016; Boon et al., 2014), there is less work investigating actor perspectives of transdisciplinarity before the project commences. Understanding initial attitudes and expectations for the process may be useful for identifying any potential issues early on. Exploring actor understandings of the transdisciplinary process also allows for comparison of how the perspectives of a diverse group of individual actors align with conceptualizations of transdisciplinarity in the literature.

2. Resilience to Nature's Challenges

Natural disasters are caused by the cascading impacts of natural hazards on society. Events such as cyclones, earthquakes, landslides, tsunamis, and volcanic eruptions are natural processes in Earth’s dynamic landscape. However, these processes can become sources of extreme risk when they impact communities, infrastructure, and valuable societal resources such as crop land, lifeline utilities, and fresh water. Disasters result when a society’s ability to cope with these

systemic impacts is overwhelmed or compromised (UNISDR, 2009). Past work in natural disaster-related fields has traditionally been divided, with quantitative investigations of physical hazard and risk being carried out in parallel to qualitative investigations of social vulnerability and capacity. However, it is becoming increasingly apparent that disasters need to be addressed as coupled human and natural systems, with research encompassing a broad range of topics such as earth sciences, statistics, sociology, economics, politics, health, the built environment, and the cultural and social fabric of at-risk communities (Cutter et al., 2008; Gaillard and Mercer, 2012; Davies et al., 2015). Engaging with the stakeholders who live and work in disaster risk areas is also increasingly recognized as way to empower at-risk communities, develop appropriate disaster risk reduction solutions, and better manage ongoing crises (Beaven et al., 2016). The recently adopted United Nations' Sendai Framework for Disaster Risk Reduction 2015–2030 (UNISDR, 2015) echoes this shifting cross-disciplinary stance, with greater calls for the integration of hazard and risk science into policy than any previous global disaster risk reduction frameworks (Aitsi-Selmi et al., 2016).

Resilience to Nature's Challenges – *Kia manawaroa - Ngā Ākina o Te Ao Tūroa* (Resilience Challenge) is a government-funded 10-year transdisciplinary research project with a mission to enhance New Zealand's resilience to natural disasters. The Resilience Challenge seeks to move away from traditional practices where natural science and social science aspects of resilience are investigated separately, and move towards an inclusive, transdisciplinary, “co-created” approach to resilience research (RNC, 2014). It embraces the resilience paradigm of “transformative change” outlined by Handmer and Dovers (2009), where resilience is conceptualized as a long-term ongoing process that occurs at multiple societal levels. The Resilience Challenge aims to achieve transformative resilience through a participatory approach which thrives on crossover at the science-policy interface. It aims to foster knowledge co-production among actors from different backgrounds and disciplines, through a process which supports the joint identification of important issues and shared goals, to develop enduring solutions to real problems facing New Zealand cities and communities (RNC, 2014). The project is one of eleven 10-year National Science Challenges funded by the New Zealand Ministry of Business, Innovation and Employment (MBIE). Each “challenge” project aims to tackle a large-scale intractable problem area of national significance (e.g., resilience, childhood health and wellbeing, nutrition, and biodiversity) (MBIE, 2016). All of the projects are built around integrative research approaches that seek to deliver impact on ‘real’ societal problems, suggesting a national-level commitment to transdisciplinary research styles.

The Resilience Challenge structure aims to remove the silos that traditionally characterize hazard, risk, and resilience research (e.g., scientific evaluation of a physical hazard vs. the planning process for dwellings in a community), in order to create innovative and lasting solutions to resilience problems in typical New Zealand settings. The concept for the Resilience Challenge project was developed through a series of nationwide participatory workshops in New Zealand, which resulted in an overall structure that comprises two components, “laboratories” and “toolboxes”. Laboratories are thematic spaces, i.e., rural, urban, coastal, and indigenous settings, in which co-created research processes are carried out. The co-creation laboratories are supported by a matrix of toolboxes from which underpinning skill sets can be drawn upon, depending on relevant needs (e.g., economics, governance, hazard assessment, engineering, cultural studies, and resilience benchmarking techniques). Surrounding the Resilience Challenge are a range of other major research programs that focus on natural hazard risk in New Zealand, and partner with the project on shared aims. Actors from more than 30 different institutions, communities, and organizations across the country make up these laboratories and toolboxes.

The diversity of the Resilience Challenge team is reflective of the

diversity and breadth of the goals the project aims to achieve. However, it also foreshadows potential challenges in bringing together diverse research priorities and practices. While actors are brought together under the shared objectives of the Resilience Challenge, individuals will be making contributions from within their existing institutional and community roles across the country, which may operate with different priorities, practices, and worldviews. The project does not lay down a concrete strategy for developing solutions, as it encourages each laboratory space to co-define problems, co-develop solutions, and co-create the research process collaboratively. Accordingly, we argue that it is important to understand actor perspectives of co-created research in order to grasp the situational context that may shape the way process begins and evolves.

3. Methods

A mixed-methods approach was adopted for this study, in which one online survey and two small semi-structured group interviews were used to gather information from early-stage actors in the Resilience Challenge. The survey was used to collect anonymous data about individual scientist and stakeholder perspectives, while the group interviews were used to gain deeper collective insight from groups of stakeholders with existing relationships. It is important to note that in this study, we generalize actors into the categories of “scientist” and “stakeholder”. While this generalization has limitations, in that it dichotomizes actors and does not account sufficiently for actors who work in boundary roles, this distinction is adopted because the Resilience Challenge is focused on addressing problems at the science-policy interface. At this early phase of the project, it allows for exploring potential differences between these groups which traditionally operate in different scientific and institutional settings. Participants self-categorized themselves into a “science” group (primarily actors in universities and research institutes). “Stakeholders” were considered those who identified in other groups such as government, transportation, and business. For the purposes of this study, “co-created” research was used as a synonym for “transdisciplinary” research, in order to capture the essence of the deeply collaborative conceptual approach, but prevent potential confusion associated with the terms “transdisciplinary”, “interdisciplinary”, “multidisciplinary”, or “participatory”, and to use the terminology adopted by the project. The authors who carried out primary data collection, analysis, and interpretation were not embedded within the laboratories or the toolboxes of the Resilience Challenge.

3.1. Online survey

The online survey consisted of 10 questions. Five of the questions were open-ended, and encouraged participants to think critically about what they think a “co-created” approach to natural hazard and risk research should look like in New Zealand. Participants were encouraged to think broadly about what co-created research is (Q1), what defining features make it different from traditional approaches (Q2), what would motivate them to participate in such an approach (Q3), what challenges might arise (Q4), and about the language or terminology used in such an approach (Q5). The remaining five questions centered on demographic information, a space to provide additional thoughts, and a multiple choice question asking participants to rank on a 10-point Likert scale how much they agreed or disagreed with adopting a co-created approach to natural hazard and risk research.

Snowball sampling methodology was used to recruit participants. E-mail invitations with a link to the survey were distributed to all of the designated project leaders within the Resilience Challenge, who distributed the invitation amongst their research team and collaborating stakeholders. Invitations were also sent to existing groups affiliated with natural hazard and risk research and disaster management throughout the country (e.g., lifelines groups, research groups and

institutes, environmental groups, and university departments), as well as to stakeholders who participated in the workshops in the development stage of the Resilience Challenge. The invitation encouraged people to share it with any other potentially interested parties. Participation was anonymous in order to encourage open and honest disclosure of opinions and views.

NVivo was used to carry out inductive thematic analysis (Braun and Clarke, 2006) of text responses in order to identify key themes that emerged from participant responses. Thematic analysis is a qualitative method that involves critically reading large bodies of text and coding, or classifying, certain passages, which are associated with a particular theme. In the inductive approach used here, themes were identified by recognizing emergent trends in the data at both the semantic and latent level (Braun and Clarke, 2006).

3.2. Semi-structured group interviews

Two semi-structured group interviews were carried out in parallel to the online survey to gain contextual insight on stakeholder perspectives towards participating in the research. A snowball sampling methodology was used to recruit participants for the group interviews, using the same social network as the online survey. Two focus groups were hosted, one in the South Island, and one in the North Island of New Zealand. The same facilitator was present at both groups, and went through a semi-structured set of questions, which were designed to create a two-way dialogue about views, goals, and expectations for stakeholder engagement and involvement in the Resilience Challenge research. The group interviews were also analyzed using a thematic analysis approach (Braun and Clarke, 2006).

4. Results

4.1. Online survey

The online survey was open for approximately one month, during which 42 people participated (Fig. 1). Approximately 45% of the participants identified themselves as “scientists” and 55% in other stakeholder categories (e.g., government, business, transportation). Just over half of the participants were female (51%), 42% identified as male, and 7% preferred not to say. Participants spent an average of 22 min completing the survey, and their collective responses generated over 15,000 words of text for thematic analysis. The majority of participants agreed with the notion of working towards a co-created approach to hazard, risk, and resilience research (Fig. 2A), with stakeholders expressing a higher degree of agreement ($x = 9.1$) than scientists ($x = 7.8$), $p < .05$ (Fig. 2B).

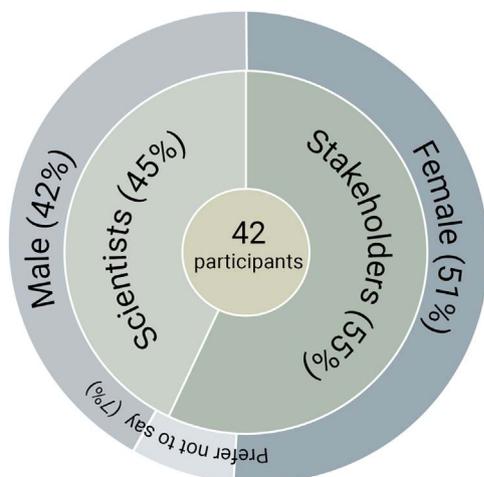
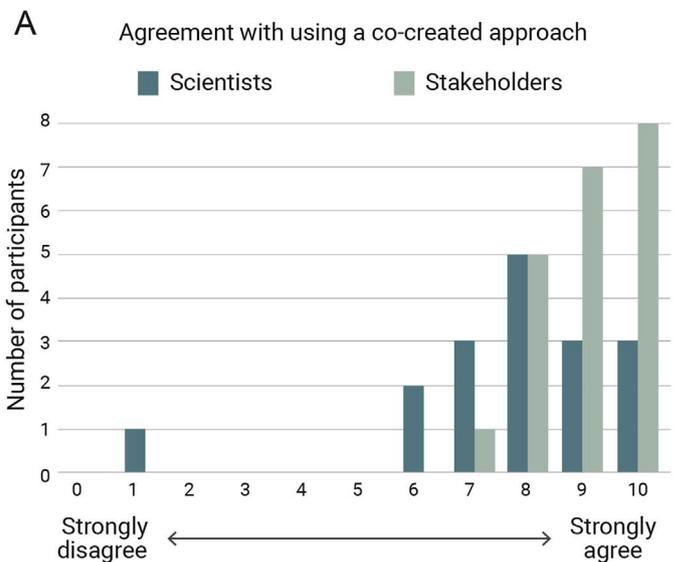


Fig. 1. Chart showing gender and role of survey participants.



B Degree of agreement: Scientists and stakeholders

Value*	Scientists	Stakeholders
Mean	7.8	9.1
Median	8	9
Mode	8	10

* On a scale from 0 - 10, where 0 = strongly disagree and 10 = strongly agree that a co-created approach to resilience research should be used

Fig. 2. (A) Bar graph illustrating the degree to which scientist and stakeholder participants agree with the idea of using a “co-created” approach to hazard, risk, and resilience research, and (B) and table showing the mean, median, and mode values for each group.

4.1.1. Thematic analysis

Four broad themes arose from participants’ discussion of what characterizes and defines co-created research. Participants described a process characterized by: (1) benefits, (2) challenges, (3) integration, and (4) dialogue (Fig. 3). These are explored in more detail below:

Benefits of a transdisciplinary approach

Overall, participants described transdisciplinarity as a process with benefits on both a social and individual scale. On a broad, social scale, the approach was regarded as “egalitarian”, “democratic”, and as a way to share “ownership” of problems and solutions that have “real meaning to people”. That is, by including, respecting, and valuing stakeholder and researcher perspectives on an equal level, co-created research could “empower people” to be interested, invested, and proactively involved in resilience research and the problems it seeks to address. Participants envisioned co-created research as a pathway to bring “tangible” outcomes to “real” issues by “working together” with communities. Participants also described potential benefits on an individual level. Scientists expressed that a co-created approach could be “rewarding”, “fulfilling”, and “exciting” by increasing the potential for their research to “address a real problem” and to develop findings that “will actually be useful”. Stakeholders, in particular, connected notions of self-efficacy with the approach, describing that a co-created process would enable them to “play a role” in finding solutions where traditional top-down research approaches did not:

Qn. 1

...being able to make a difference [and] feeling empowered to be part of

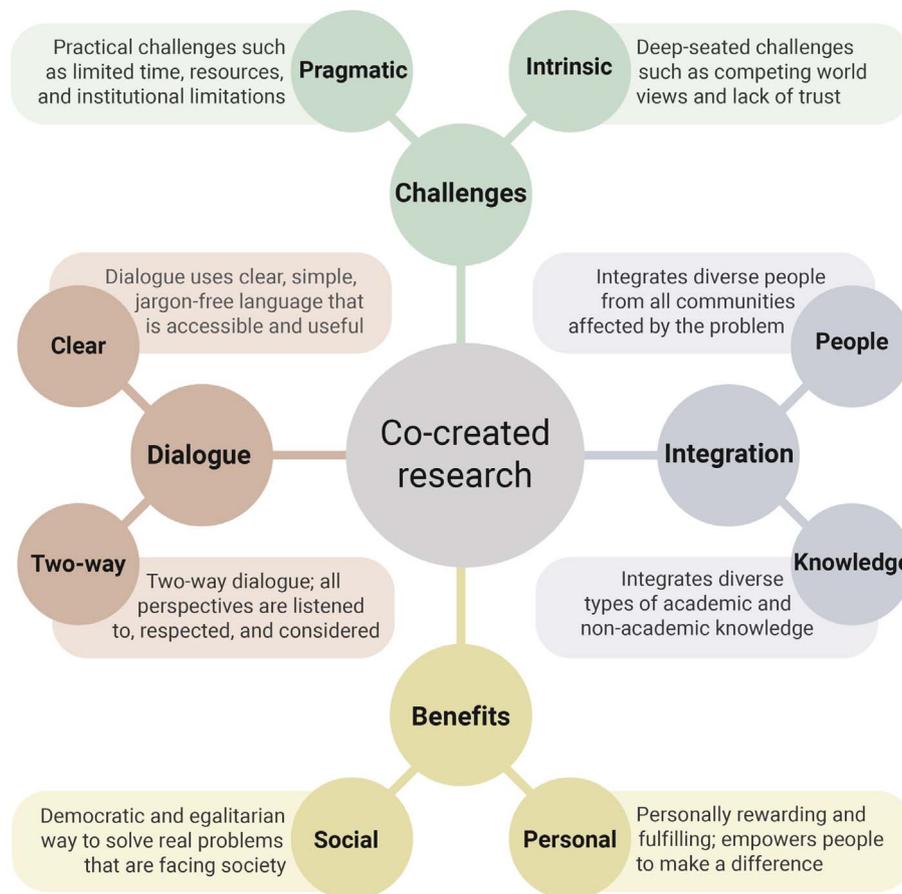


Fig. 3. Synthesis of key themes that emerged from the thematic analysis of survey responses describing participant perspectives of “co-created” research.

making things happen, rather than having options presented to me fait accompli. – Stakeholder 21

Qn.2

...by having ‘skin in the game’ [I would] become more invested the process and success of the project. – Stakeholder 14

Qn.3

I would be motivated...if I could see how my input influenced the project, if I could see that my involvement was valued by the researchers, and if I felt a sense of ownership over the project. – Stakeholder 6

Meaningfully integrating stakeholders into the research process brings with it new understandings and tacit knowledge of the problem, but may additionally bring institutional investment and personal commitment. These responses suggest that having a voice in societal problem-solving brings with it a sense of personal responsibility and ownership for the outcomes of the process. However, the project must value actor contributions and recognize their impact in order to foster and maintain this level of commitment.

Pragmatic and intrinsic challenges

While stakeholders and scientists both saw benefits in adopting a co-created approach to research, they also outlined pragmatic and deeper intrinsic challenges associated with the process. Participants acknowledged that the process of co-creation was going to be “complicated,” “difficult”, and “take a bit of time to get right”. The most widely identified pragmatic concern was a perception of the process being highly time-consuming and resource-intensive. This gives rise to a problematic situation, in that the approach demands time, people, and resources to be carried out appropriately, yet actors may feel over-

burdened, and have limited capacity to accommodate these pressures in their respective roles and institutions:

Qn.4

...Collaboration takes time...rush it and miss important details... [but] we’re all so busy and we need the importance of our time to be recognized and respected... So give it time, but be efficient and effective. – Stakeholder 19

Qn.5

... it would be difficult to incorporate within conventional project frame works. – Stakeholder 2

Transdisciplinarity thrives on collaboration across disciplines and organizations. Transdisciplinary actors will therefore necessarily be embedded in different situational contexts, each with its own responsibilities and duties outside of the project itself. Traditional structures that actors work within may not be flexible to increased demands on time and resources that transdisciplinary projects may require. Institutional support for co-created work was a particular concern among scientists, who expressed that in addition to the high transaction costs, transdisciplinary research deviated from traditional academic agendas, funding structures, and expectations:

Qn.6

[There is a need for] support for this type of research in terms of funding and training, and recognition that this approach may not result in any new knowledge. In effect, it seems to be more suited for prompting societal change and education than scientific endeavor. – Scientist 16

This comment also highlights the positivist epistemologies that dominate in scientific environments. Scientific endeavor and societal

change may be viewed as distinctly separate concepts that are developed through distinctly different processes. Conceptually, transdisciplinarity aims to innovate ways to address scientific problems together with societal problems. However, this introduces difficulties in practice, as the open, collaborative, inclusive nature of the approach may not align with the imperative for competitive, cutting-edge discoveries in scientific settings. Both scientists and stakeholders also described intrinsic, deeper-seated challenges that would need to be faced, such as building new and “long-lasting” relationships and “developing mutual trust among all involved”. To do this, the transdisciplinary approaches were seen as needing to break down existing power relations and traditional hierarchical structures. In addition, the process would need to cope with reconciling and assimilating competing world views.

Qn.7

Most experts have studied their subject area for years, and consider their world view as correct, making it somewhat fixed. – Stakeholder 22

Qn.8

Reconciling diverse interests, opinions and values is incredibly difficult. – Stakeholder 5

These comments highlight that actors have an understanding that different worldviews and perspectives will be embraced in the process, and that this may cause issues that could be difficult to resolve. Perspectives of “expert” worldviews as unyielding may be reflective of past practices, in which scientific expertise was drawn upon in policy as the value-neutral objective truth. Co-production approaches accept multiple worldviews as equally true, which introduces both advantages and challenges in these contexts.

Integration of diverse people and knowledge

The majority of participants described co-created research as an integrative and structured process, which should aim to be “inclusive” of “all those affected” by the problem being investigated, from interdisciplinary academics to stakeholders from many sectors, and members of the community:

Qn.9

To me, co-created means that all parties are involved at all levels. – Scientist 9

In addition to integrating diverse people, participants voiced that the process should integrate diverse types of knowledge. While traditional academic sources of “pure” disciplinary scientific knowledge were still seen as integral to co-created research, participants also outlined the importance of community-based knowledge. “Listening” and “respecting” knowledge from communities who have experienced disasters or hazardous events in the past was a particularly strong theme with many respondents. These stories of experience were seen as an “opportunity for hands-on learning” for researchers, but also as a way to make the affected communities feel valued, listened to, and motivated to participate in resilience-building initiatives. Integration of indigenous knowledge and cultural world-views were also considered essential parts of a co-created research process:

Qn.10

It would be a shared knowledge process which would value local and indigenous knowledge. – Scientist 19

Many participants mentioned the importance of having a highly-skilled facilitator role for organizing and leading this integration and driving engagement efforts. Quality facilitation was seen as an essential component of the project structure, and key for integration of groups who have “traditionally been overlooked” and for providing a “safe

space” for sharing ideas. Facilitation and engagement that was inclusive and constructive was seen as needing to occur iteratively over the course of the project, from identifying the problem, through researching solutions, to applying findings. Facilitators were viewed as necessary agents for bridging barriers between disciplines and organizations and for bringing different perspectives together to co-create research. Overall, the project structure was described as being both organic and organized:

Qn.11

It is a little anarchic (but not without a structure to it). – Stakeholder 21

This comment highlights the difficulties associated with developing a consistent strategy or methodological framework for carrying out transdisciplinary approaches. Transdisciplinary projects require space for reflexivity, but this space introduces risk in terms of losing focus towards a shared goal.

Accessible and multidirectional dialogue

Dialogue and communication was also a strong theme arising from discussions. Participants remarked on the importance of transparent, accessible (jargon-free and simple) dialogue, but also the importance of continual two-way feedback:

Qn.12

Dialogue would be in language and at a level to encourage/welcome participation. – Scientist 19

Generally, participants expressed that it was important to be cognizant and careful of the language and labels used to define different actors, but that it should not be “dwelled upon”. Many participants recognized the restrictions and limitations which can be incidentally imposed by labels, but also acknowledged the need for labels in order for a structure to take form and facilitate the flow of knowledge between groups:

Qn.13

If a title empowers someone to feel like their view is important and worth listening to, it is useful. If it pigeonholes them into feeling like they are not wanted in some parts of the process, then it isn't. – Scientist 3

However, many participants did express that labels such as “end-user” could be limiting, and that broad labels such as “partner” and “collaborator” could be more encouraging:

Qn.14

Do not think of [us] as a group on which research is imparted. There's a lot of knowledge here to start with. Nor are we end users... collaborators is a good term for this type of relationship, I think. If we are truly co-creating then what we have to say is as important as [what] the researchers have to say. – Stakeholder 19

Regular feedback was seen as a way to keep the large and diverse group committed to the shared long-term goals of co-created research. Many added that feedback about project successes and how their teams' input was making an influence would personally motivate them to sustain participation:

Qn.15

I would stay interested if my participation was more than just token, and I could see real benefit for a community and my own professional development. – Scientist 13

4.2. Semi-structured group interviews

Seven stakeholders participated in the two group interviews. One

two-hour group interview session was hosted with five stakeholders from different stakeholder organizations in the South Island, including local government, environmental agencies, emergency management groups, and health boards. A second two-hour group interview was held with two organizational stakeholders in the North Island, representing local emergency management groups and city council. The small groups allowed for in-depth, social discussion in a safe environment. A few additional points emerged from the interviews regarding the goals and expectations for “co-created” research, including: the importance of utilizing existing stakeholder networks in creative ways, and maintaining a multi-layered “big picture” of the problem being investigated.

Stakeholders felt strongly that in order to efficiently engage and prevent stakeholder fatigue, new transdisciplinary projects needed to engage with existing networks. They noted that many organizations already have ongoing initiatives for managing large scale environmental problems. Participants felt that new research initiatives should align with these, and coordinate their objectives. This view was particularly strong among South Island stakeholder participants, who have experience related to Christchurch's recovery from the 2010–2011 Canterbury Earthquake Sequence (see [Bannister and Gledhill, 2012](#)). Participants explained that consideration of existing efforts and networks was important for building trust and collaboration. They explained that new projects would best achieve integrative knowledge co-production if they “teamed-up” with ongoing activity.

Similarly, participants stressed that stakeholder institutions have strong existing networks and relationships that should be built upon. For example, several government agencies have long-established engagement networks, including committees and panels for interacting with local communities of practice. Participants expressed that new research projects may be able to gain momentum by joining forces with local stakeholder organizations who have an active, invested, and interested group of public already organised. They saw this as a way to maximize the use of resources and maintain consistent messaging. Participants also noted that each city or town is uniquely complex, with different social structures and different environmental problems. Local stakeholders have intimate knowledge of the historical impacts and local capacities of an area, which should be integrated and embraced in research approaches which aim to address large-scale problems.

Stakeholder participants also emphasized the need to take a “whole-systems” approach that considers the many different levels and dimensions of environmental problems, from scientific research, to public awareness, social behavior, economic stability, and government policy. At a government organization level, participants noted that “two-way” dialogue is important. For example, emergency management teams can use resilience research to inform policy, while research teams can optimize relevancy of resilience research by understanding emergency management operations. As in the survey, focus group participants also emphasized the importance of high-quality facilitation of engagement to maintain a clear and inclusive dialogue across boundaries. Regular evaluation of engagement efforts was regarded as “absolutely” essential during the project. Participants described the value in having a reflexive project structure that adapts and responds to changes in the nature and scope of the problem over time.

5. Discussion

5.1. Conceptual agreement, uncertainty in practice

As a research approach, transdisciplinarity is still considered emergent, loosely defined, and lacking traction in practice ([Pohl, 2011](#); [Lang et al., 2012](#); [Brandt et al., 2013](#); [Kirchhoff et al., 2013](#)). However, our results suggest that despite this fragmented presence, there is generally a consistent understanding and awareness of transdisciplinarity and its objectives among the diverse group of transdisciplinary actors in the Resilience Challenge in New Zealand. While the Resilience Challenge research strategy clearly outlines the integrative

and cross-disciplinary nature of the research, it does not explicitly define detailed typologies, epistemologies, and methodologies of transdisciplinarity. In this sense, participants' responses largely represented their individually constructed perspectives of the approach. While the discourse on transdisciplinarity over the past 40 years is considered laden with heterogenous rhetoric and terminology ([Jahn et al., 2012](#)), this group of actors shares a common conceptual understanding of the approach that is relatively consistent with scholarly consensus in the literature. This may be reflective of the evolving scientific funding climate in New Zealand, which encourages integrative approaches, but also may suggest a wider permeation of co-production concepts among science and policy realms over the past decades.

While participants' responses reflected conceptual agreement, there remains uncertainty about methodological practice of the approach. Participants described tools and strategies to facilitate co-created research in practice (e.g., expert facilitation and community storytelling), but also identified issues problematic to practice. For example, there remains uncertainty in regards to how the approach will foster scientific advancement for some. Dominant epistemological perspectives in the natural sciences do not necessarily assess value together with societal impact, and this is reflected in some scientists' perspectives of the challenges associated with the approach (e.g., [Qn.6](#)). Additionally, although the vast majority of participants agreed with adopting a co-created approach to hazard, risk, and resilience research, stakeholders showed a stronger level of agreement than scientist participants ([Fig. 2](#)). This suggests that stakeholders may see transdisciplinarity as way to meet their practice-based needs differently than traditional disciplinary research approaches used in the past, and this is supported by the responses of stakeholders in the group interviews. For stakeholders, the “real-world” problem solving-nature of transdisciplinary approaches may be perceived as an instrumental way to close the “usability gap” between science and policy ([Kates et al., 2001](#); [Reed, 2008](#); [Lemos et al., 2012](#); [Kirchhoff et al., 2013](#); [Reed, 2008](#); [Lemos et al., 2012](#); [Kirchhoff et al., 2013](#)). In scientific settings, the instrumental benefits may be less apparent.

5.2. Tailoring transdisciplinary approaches

A number of scholars have proposed instrumental research frameworks for working towards problem-focused goals and outcome-driven solutions. Typically, these consist of 4–6 broad stages, which move from problem definition, to conducting collaborative research, to applying results (e.g., [Pohl and Hirsch Hadron, 2007](#); [Jahn et al., 2012](#); [Lang et al., 2012](#); [Mauser et al., 2013](#); [Polk, 2015](#)). Yet these stages sit at an abstract level in regards to actual implementation within a project. Each problem is highly contextual based on the problem setting and actors affected. In this sense, the framework will be highly shaped and refined based on the way actors interpret and understand the collective components of transdisciplinary concepts and stages. Understanding how participants view these aspects can give insight into how these broad frameworks can be calibrated and optimized for a particular project and group of actors.

For example, the analysis presented here suggests that actors in the Resilience Challenge are motivated by self-efficacy, i.e., the notion that they are individually able to take action that makes a difference in the outcome of the project (e.g., [Qn. 1, 2, 3](#)). Accordingly, providing regular, constructive feedback with evidence of the impact of an actor's input and influence is likely to help sustain and encourage continuous participation. Prioritizing this action could have a positive impact on involvement for this particular project and group of actors. Other notable priorities for the Resilience Challenge would be integration of indigenous knowledge and actors. New Zealand's indigenous Māori community have a complex kinship-like relationship with the natural environment, and they are legally regarded as key partners in all environmental projects in New Zealand ([RMA, 1991](#)). Māori acknowledge that the environment holds important physical, spiritual, and

metaphysical values, and they trace their genealogical connection back to the land, forests, seas, and waterways. Further, Māori have rich intergenerational knowledge about New Zealand's ecosystems and environments, and can therefore offer valuable insight into modern environment challenges, and in many ways, can help foster a broader understanding of hazard and resilience issues (King et al., 2007; Harmsworth, 2005; Kenney and Phibbs, 2015). Indigenous knowledge, while implicitly included in broader frameworks, is explicitly prioritized within the Resilience Challenge project context. The project's dedicated indigenous laboratory aims to foster the integration and inclusion of Māori ways of knowing throughout the research process. Participants of this study also outlined the importance of aligning with ongoing resilience initiatives within New Zealand. Transdisciplinary research strives to be inclusive, and it is essential that new transdisciplinary projects aim to identify and collaborate with existing efforts.

Overall, the stakeholder and researcher feedback presented here allows for the broad stages of existing transdisciplinary frameworks to be refined based on the perspectives, tacit knowledge, and experience of the project actors. In a systematic review of 236 academic papers on transdisciplinary research projects, Brandt et al. (2013) found that very few projects realized a fully empowering co-created process. They suggest that this is in part due to a lack of clearly framing the transdisciplinary concept. While a general shared framework is still needed in the transdisciplinary community, the results presented here suggest that framing the concept together with project partners can help refine the broad concept of “co-creating” research in a way that is meaningful and relevant on a project-specific basis. Collective efforts to collaboratively define and refine transdisciplinary frameworks can help transdisciplinary projects achieve a more targeted approach that addresses shared needs, and uses the most relevant pathways. However, it must be emphasized that transdisciplinarity is still in its infancy, and even with a shared understanding and common ground for the approach, there will undoubtedly be a number of transitional challenges to be overcome.

5.3. Underlying tensions

An underlying tension emerged from participants' broad and sometimes conflicting perspectives of transdisciplinarity (Fig. 4). For exam-

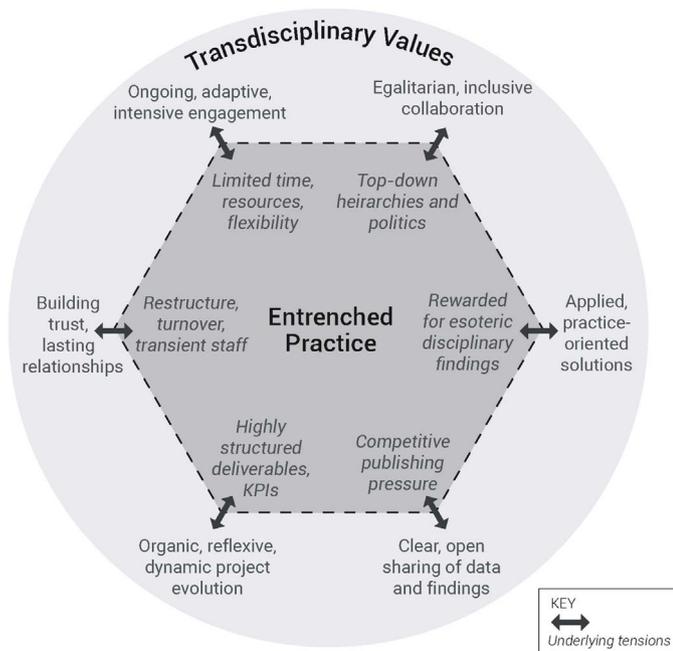


Fig. 4. Schematic illustrating the tension created by carrying out transdisciplinary research approaches within entrenched structures.

ple, some participants noted that it takes a lot of time and commitment to meaningfully engage and co-create knowledge, but then also remarked that stakeholders and researchers are already overburdened and have little time and resources to commit to such efforts (e.g., Qn.4). Other participants noted that the processes needed to evolve organically and reflexively, but then also remarked that it is essential to have a clear and defined structure to the approach so that it stays on course (e.g., Qn.11). These, and other conflicting perspectives, echo the uncertainty and fragmentation associated with transdisciplinarity in the literature. For example, Russel et al. (2008) argue that a number of “contradictions” (p. 465) are present in transdisciplinarity due to social, political, and financial drivers behind the approach, which have pushed the concept in different directions simultaneously. Similar contradictions arise from transdisciplinarity's lack of a coherent praxis or methodology (Swan et al., 2010; Felt et al., 2016). Polk (2015) observes that transdisciplinarity is in a “paradoxical situation” (p. 121) in that it is both part of, and separate from, traditional research contexts, which presents complications to its applications and legitimacy in practice.

Many of the conflicts raised by participants can be attributed to the process of carrying out a new research approach within entrenched traditional research structures. Support for and agreement with the idea of transdisciplinarity is strong (e.g., Fig. 2A), yet actors who desire to participate feel hindered by the existing institutional structures they work within, which were built to support and reinforce traditional knowledge production modes (e.g., Qn.5, Qn.6). This incompatibility has resulted in a tension between transdisciplinary values and the constraints imposed by entrenched practice. While a number of scholars have pointed out that existing institutions and funding structures have not yet adapted to transdisciplinarity (e.g., Pohl and Hirsch Hadron, 2007; Jahn et al., 2012; Swan et al., 2010; Weichselgartner and Truffer, 2015), our analysis suggests that this lack of organizational adaptation is more than an overarching conceptual issue. It also affects actors' perspective of the process, and their perceived capacity to take part in such an approach early on in the project. The participants of this study openly grappled with friction between a desire to participate in the approach, and feeling constrained in their ability to do so in the context of their respective day-to-day duties because of the high demand on time and resources (e.g., Qn.4, 5, 6, 11). Fig. 4 outlines coupled examples of some of the tensions noted in participant responses, and illustrates the conflict between entrenched practice and transdisciplinary values.

The conflicts anticipated by early actors in this study align with findings from recent work reflecting on experiences of transdisciplinary projects. Dialectical tensions between new modes of knowledge production and traditional institutional structures can play out in complex ways in practice, often resulting in traditional and transdisciplinary approaches contradictorily operating in parallel (Swan et al., 2010; Felt et al., 2016). Felt et al. (2016) observe that this coexistence can result in different actors working within different epistemic contexts within the same transdisciplinary project. Swan et al. (2010) conclude that collision of these coinciding values can, in some cases, result in reinforcing traditional more ‘efficient’ modes of knowledge production. These types of emerging issues lie implicit and unaddressed in most project structures, but can have an effect on the way that actors engage and commit to transdisciplinary values (Felt et al., 2016). Our findings suggest that the effect of these tensions may be in place from a very early stage. Acknowledging that this tension exists, and that it is a byproduct of transitional research culture rather than a shortcoming of individual actors, provides an objective lens for assessing such tensions and addressing potential conflicts. Encouraging constructive discussion around anticipating and addressing these systemic challenges may help create a space for mitigating the “collisions” (Swan et al., 2010) and “uneasy relationships” (Felt et al., 2016) that can develop if left unaddressed.

5.4. Limitations and future work

In theory, all people at risk from natural hazards are considered stakeholders of disaster resilience research. We acknowledge that the focused and top-down snowball sampling methodology adopted here has limitations. In particular, the sample is biased by the network of relationships that exist, and that more well-connected populations are more likely to be included in the sample and peripheral or marginalized groups are likely to be under-represented. Further, this study is based on a confined group of New Zealand participants, and a wider scale study of how transdisciplinarity is viewed by a broad range of different researchers and stakeholders would be a valuable contribution to understanding the breadth of perspectives and challenges facing actors in transdisciplinary research. In addition, we acknowledge the limitation imposed by generalizing actors as scientists or stakeholders for the purpose of this study, as many actors may identify in both of these groups.

While this study contributes empirical insight into a topic which is largely conceptual in nature, we acknowledge that there are limitations to collecting empirical data from a transitory group of actors in a broad, reflexive, and inclusive approach. There is no “control group” for this type of analysis. In this study, the past participatory experience of each actor is unknown. Actors who are involved at early and formative stages of the project may be involved because they have a particular set of transdisciplinary skills or experiences. Future work would add value to such studies by addressing participant backgrounds in better detail. This study is also based on individual views before participation in a transdisciplinary project. Future work evaluating the perspectives of stakeholders and researchers over the course of a co-created research project will contribute valuable insight into how these perspectives and perceptions shape transdisciplinary approaches in practice. Lastly, participants of this study agreed with adopting a co-created approach to resilience research, but further work is needed to understand how perception of conflicts and tension affects actual researcher and stakeholder contribution, and how this friction can be mediated.

6. Conclusions

Although there is growing academic consensus regarding the conceptual framing of transdisciplinarity as a research approach, there is no widely-accepted definition, framework, or empirical strategy for how to carry out transdisciplinary research. In addition to this lack of coherent practice, the actors involved in transdisciplinary projects inevitably come from a wide range of backgrounds, each with their own set of values and worldviews. Bringing together diverse actors, embedded within different institutional settings and knowledge contexts, to carry out an ambiguously structured research approach carries with it many pragmatic and intrinsic challenges. The goal of this study was to better understand actor perspectives and expectations of the transdisciplinary research process early on, with aims of forming a basis for longitudinally investigating how actors experience this reflexive research process over time. We use a project aimed at enhancing disaster resilience in New Zealand as a case study to qualitatively analyze scientists’ and stakeholders’ early understandings and perspectives of the transdisciplinary research approach that they are about to embark on.

We find that early actors in the project have a consistent understanding of what transdisciplinary or “co-created” research embodies. Participants’ descriptions of the process and its defining characteristics aligned closely with the normative values outlined in the academic scholarship on transdisciplinarity. This suggests that despite the lack of traction and inconsistent typologies identified in the literature, transdisciplinary concepts may be becoming more familiar among scientists and stakeholders, particularly among those who work in settings where collaborative “mission-led” research has received government investment. Early actors in the project collectively agreed with adopting

transdisciplinary approaches to natural hazard, risk, and resilience research. Stakeholders, in particular, strongly agreed, and see transdisciplinary approaches as a way to create useful solutions to societal problems in practice.

While the literature recognizes many broad social-level normative benefits of the transdisciplinary process, participants highlighted that the process could also hold substantial personal rewards, by fostering feelings of inclusion, empowerment, and involvement in societal change. Our analysis shows how this type of tacit knowledge and insight can be used to inform and tailor the approach for specific projects in order to reflect shared goals and meaning. For example, this self-efficacy factor emerged as a strong motivation for participating in transdisciplinary research. Accordingly, explicitly recognizing the contributions of actors and how they are helping to achieve impact may help sustain and prolong meaningful participation. In addition, understanding the early context-specific perspectives of actors can help a project understand collective expectations for the project’s initial trajectory and provides a tangible set of goals and values to use as a basis for observing and understanding change (e.g., Fig. 3). It can also help identify potential inconsistencies or conflicts which may need addressing.

Participants’ descriptions of the challenges associated with transdisciplinarity revealed an underlying tension associated with carrying out new modes of knowledge production and research within entrenched institutional structures. While the friction between transdisciplinary values and traditional institutional structures has been recognized by others (e.g., Pohl, 2011; Swan et al., 2010; Weichselgartner and Truffer, 2015; Felt et al., 2016), our findings suggest that such tensions are more than an overarching conceptual issue, but are felt by actors early on in the project. In some cases, this causes actors to anticipate shortcomings in their ability to fully participate. This latent tension results from pragmatic issues, such as perceived stress on limited time and resources due to institutional commitments, but also on an epistemic level, in that the investment in societal knowledge co-production may not be as valued or captured in some organizational structures. It is thus important to identify and address these conflicts explicitly among the project team, and acknowledge this potential issue as an objective byproduct of a larger changing research culture, and not a shortcoming of individual actors or processes. Future research on ways to cope with and mitigate these tensions could help introduce ways for the transdisciplinary community to move forward past these barriers constructively.

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