Chapter 8
Integrating Research and Practice in Emerging Climate Services—Lessons from Other Transdisciplinary Dialogues

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Abstract Because of their social and ecological impacts, complex issues of climate and broader environmental change have taken centre stage in public discourses and public policy. These issues typically transcend disciplinary problem-solving and call for cross-disciplinary as well as transdisciplinary research approaches, i.e. approaches that include practice partners and aim for solving real-world problems. A case in point are climate services, a newly emerging field that aims at delivering customised climate information, products and other services in relation to climate. This chapter proceeds on the assumption that climate services can benefit from experiences of integrating research and practice to solve real-world problems in other fields such as public health and social inequality. Based on this assumption, the aim of this chapter is twofold: we firstly describe selected results of a literature study that systematically reviewed and compared the use of transdisciplinary approaches across fields. We secondly derive a list of quality criteria for transdisciplinary dialogues from the literature and from the outcome of a workshop with practitioners that we organised in November 2014. Both may inform good transdisciplinary practice for climate services.

Keywords Transdisciplinary research · Practice partner participation
Climate change · Climate services · Literature review · Quality criteria

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8.1 Climate Services as a Transdisciplinary Approach—an Introduction

Because of their social and ecological impacts, complex issues of climate and broader environmental change have taken centre stage in public discourses and public policy. These issues, often labelled 'ill-defined', 'wicked' or 'messy' problems (Pohl and Hirsch 2006; Scholz 2011; Cuppen 2012; Jaeger 2008), typically transcend disciplinary problem-solving and call for cross-disciplinary[1] as well as transdisciplinary approaches, i.e. approaches that include a range of practice partners.[2] In the German-speaking world and originating from Jantsch (1972), transdisciplinarity has emerged as a concept which has as at its core the idea of 'different academic disciplines working jointly with practitioners to solve a real-world problem' (Häberli et al. 2001, 4). The inclusion of partners from practice, a problem-oriented approach and cross-disciplinary research in science are the defining and common features of transdisciplinary approaches (Brinkmann et al. 2015, 6ff; cf. Bergmann et al. 2012).[3]

Over the last couple of years, the new field of climate services has emerged, which is tightly connected to climate research. This field can be described as:

> the transformation of climate-related data – together with other relevant information – into customised products such as projection, forecasts, information, trends, economic analysis, assessments (including technology assessments), counselling on best practices, development and evaluation of solutions and any other service in relation to climate that may be of use for the society at large. (European Commission 2015, Box 1)

Climate services programmatically rely on the participation of practice partners to produce climate-related information and to assess possible impacts and adaptation options as well as scenarios and strategies:

> The development of climate services (…) requires a trans-disciplinary approach of co-design, co-development and co-evaluation. (European Commission 2015, 22)

Successful climate services, one can assume, benefit from the diverse expertise that the parties involved bring in, as well as from the need to take into account

[1]We use the terms cross-disciplinary and interdisciplinary interchangeably to refer to research collaboration across disciplinary boundaries but among scientists only.

[2]These practitioners are often labelled 'stakeholders' in the literature. The term originates from the management literature where it denotes 'any group or individual who can affect or is affected by the achievement of a corporation's purpose' (Freeman 2010 [1984], vi). In transdisciplinary contexts, however, the term stakeholder is problematic in our view because it obscures the fact that scientists are as much stakeholders in this context as is everyone else. We therefore propose and use the term 'practice partner/practitioner' to denote non-scientific actors.

[3]A leading institutional player is the 'Institute for Social-Ecological Research' (ISOE) in Frankfurt/Main, Germany.

everyone's interests and value preferences. However, there is not yet enough evidence on how best to set up, organise and govern the integration of research and practice for climate services. We therefore propose that climate services can benefit from experiences in fields with considerable longer experience of working with practice partners such as public health and the social sciences concerned with social inequalities, minority empowerment and broader environmental issues (Brinkmann et al. 2015, 14ff).

When we analysed appropriate literature, we found that the communities and discourses in the different thematic fields are not yet interconnected. To our knowledge, neither theoretical insights nor empirical case studies on the transdisciplinary mode of collaboration have so far been systematically reviewed and compared across fields. While solution for real-world problems through including practice partners is at the heart of all approaches, the terminology varies widely and the approaches do not necessarily refer to themselves as transdisciplinary.

Indeed, in the English-speaking world, the term 'transdisciplinarity' is not distinct in meaning and 'a universally accepted definition for transdisciplinarity is still not available' (Jahn et al. 2012). Concepts such as 'integrative applied research', 'multidisciplinarity' or 'team science' (USA) are used to describe interdisciplinary research that is carried out in collaboration with practice partners. Welp et al. (2006) speak of 'science-based stakeholder dialogues', whereas in Australia Bammer (2013) criticises the 'scattered landscape of definitions' and advocates the term 'Integration and Implementation Sciences (I2S)' to overcome the fragmentation (cf. I2S). In the field of Earth system science and sustainability science, the science and technology studies' terms 'co-design' and 'co-production of knowledge' are becoming more commonplace (Mauser et al. 2013).

So, despite an increasing popularity of transdisciplinary modes of knowledge production, there is no consensus in the literature on terminology. Approaches in the environmental, social and public health fields apparently pursue rather similar goals but without referring to one another. The aim of our literature search therefore was to give a comprehensive review of existing approaches across fields, to derive a first set of quality criteria and to inform good transdisciplinary practice for climate services and the respective dialogues.

In the following, we present selected results of the literature review with a focus on the six distinct types of approaches that we identified in more than 400 publications across fields (Sect. 8.2). Based on this cross-field comparison, we will then list quality criteria for good transdisciplinary practice (Sect. 8.3) and present some conclusions and an outlook from this initial review (Sect. 8.4).

8.2 Selected Results of a Literature Review on Transdisciplinary Approaches in Different Fields

8.2.1 Intensity of Participation

A major issue in integrating research and practice is the form and intensity of practice partner participation. Stauffacher and colleagues (2008) have identified five different intensities of public participation in a classification that can be fruitfully applied to the involvement of practice partners in climate services (a similar participation spectrum has been developed in 2014 by the International Association of Public Participation, see IAP2 (2014)).

Figure 8.1 shows different degrees of participation intensity, ranging from mere information by way of unidirectional communication from researchers to practice partners over increasingly inclusive and balanced formats (consultation, cooperation and collaboration) to the highly inclusive empowerment of practitioners. In the first two formats, information and consultation, respectively, practice partners or scientists may or may not acknowledge the other parties' concerns and expertise. Stauffacher and colleagues (2008) furthermore differentiate cooperation (where the authority over the transdisciplinary dialogue is with the science side) from collaboration which they define as partnership on an equal footing and which they see as a prerequisite for 'true participation'. In the most inclusive format—empowerment—authority shifts from balance to the practice side and final decision-making within projects is left to the practice partners.

What can we learn from Stauffacher and colleagues? Even though there is a clear normative ideal behind the intensity scale, it suggests that there is no 'one-size-fits-all' approach to participation. Different intensities of involvement can be mixed and combined within one project and always depend on the specific research question and goal of the project.

8.2.2 Characteristics of Different Transdisciplinary Approaches

The major result of our literature review (Brinkmann et al. 2015) was a classification of six distinct types of approaches to the integration of research and practice:

- Participatory Action Research (PAR)
- Community-based Participatory Research (CBPR)
- Participatory Policymaking
- Transdisciplinary Case-Study Approach of ETH Zurich
- Transition Management
- Model developed by ISOE (Institute for Social-Ecological Research)

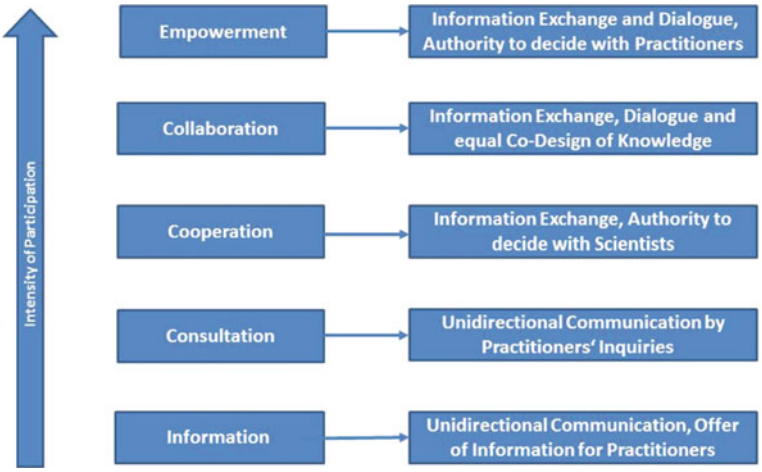

Fig. 8.1 Degree of public involvement in transdisciplinary approaches (Brinkmann et al. 2015, following Stauffacher et al. 2008, own translation)

The approaches have been developed since the late 1960s in different fields and each approach belongs to a specific community of scientists and practitioners. Only the latter three approaches refer to themselves as 'transdisciplinary approaches'. In the following, the approaches are presented in the order of their historical emergence.

In Participatory Action Research (PAR), practice partners are involved as 'co-researchers' with equal rights to find practical solutions for problematic conditions in their respective institutional or social environments and everyday life (Swantz 2008). Methodologically, this is sought by a cycle of intervening Action Experiments, and the consequences are reviewed in a dialogue between all parties involved. The overall aim is to facilitate mutual learning and to create a self-reliant lifestyle for the practice partners (Argyris and Schön 1989). Terminologically, PAR employs the term participation rather than transdisciplinarity.

Community-Based Participatory Research (CBPR) also strives for practically useful insights, which may lead to a sustainable improvement of life conditions and to an empowerment of the researched community. CBPR uses a broad range of research methods and explicitly expands the circle of involved people from scientists and community members to organisational or political representatives to inform and instruct on this institutional level (Israel et al. 2005). CBPR puts the conceptual focus on multi-perspectives and the equal value of lay and expert ways of knowing.

Participatory Policymaking involves practice partners in structuring evidence-based policy processes. In these processes, actors negotiate multiple interests, conflicting targets and often make decisions under uncertainty (Mayer et al. 2013; Thissen and Twaalfhoven 2001). The approach aims at producing reliable results grounded in communicative exchange and joint learning, despite different

value perceptions and perspectives (Edelenbos 1999). Unlike in CBPR and PAR, the permanent involvement of practice partners is not mandatory in all project phases.
The Transdisciplinary Case-Study Approach of ETH Zurich (TdCS) deals with complex real-world problems from the field of sustainability. It focusses on mutual learning between all participants and attempts to integrate local, scientific and organisational knowledge to find so-called socially robust problem solutions (Scholz et al. 2000; Scholz 2011). The degree of practice partner involvement in the different project phases varies. In general, all parties involved are regarded as authoritative in their ways of knowing, and a knowledge synthesis is sought in a joint and discursive way (Scholz and Tietje 2002).
Transition Management sees itself as a governance tool for large-scale and long-term structural transitions of society towards a desirable state such as sustainability (Rotmans et al. 2001). By connecting diverse and innovative practice partners, interdisciplinary research teams stimulate their inventiveness and the rise of new networks. Mutual learning and dialogue are expected to free capacities that were hitherto undetected as well as action and solution potentials (Nevens et al. 2013).
The Model developed by ISOE (Institute for Social-Ecological Research) strives for combining the solution of real-world problems with the development of scientific knowledge and methods (Jahn 2005). The production of knowledge is mostly science-driven and takes place within disciplinary boundaries. However, an integrative concept is agreed upon from the start of every project and structures the entire approach, thus facilitating the subsequent integration of different kinds of knowledge in a joint effort with relevant practice partners (Bergmann et al. 2012). As in the TdCS approach, transdisciplinarity is seen as an integral part of the approach and sustainability serves as a leitmotif.

To systematically compare these approaches, they were analysed within several categories. The categories were compiled to reveal differences and similarities as well as typical patterns in application fields, participants, process design, scientific connectivity (i.e. proximity to academic discourses), methodology, normative principles and objectives. These characteristics form a specific pattern for every approach (Fig. 8.2). It is important to note that the six ideal types include greatly diverse individual case studies, in line with the overarching conceptual and methodological principle of context sensitivity.

8.2.3 Comparison of the Approaches in the Fields of Environment and Sustainability

What can we learn from our typology of approaches for the newly emerging field of climate services? As climate services are an applied field within the broad field of Earth system sciences, it can be assumed that the approaches that focus on

	Fields of Application		Practitioners involved					Process Design	Scientific Connectivity	
	Environment and Sustainability	Welfare, Health, Development	General Public	Locally Affected	Association Representatives	Policy Makers / Administrators	Other Experts	Phases of different Practitioners' Involvement	Systems Knowledge	Transformation Knowledge
Participatory Action Research		•		•						•
Community-based Participatory Research		•		•	•					•
Participatory Policymaking	•	•	•	•	•	•	•	•		•
Approach of ETH Zurich	•		•	•	•	•	•	•	•	•
Transition Management	•				•	•	•	•		•
ISOE-Model	•	•	•	•	•	•	•	•	•	•

	Methods			Normative guiding Principles			Objectives			
	System Analysis/ Modeling/ Scenario Analysis	Workshops/ Dialogues	Action Experiments	Sustainability	Strengthening Democracy	Integration of Underprivileged	Mutual Learning and Exchange of Views	Policy Design	Capacity Building (Empowerement)	Capacity Building (Awareness Rising)
Participatory Action Research		•	•			•	•		•	
Community-based Participatory Research		•	•			•	•		•	
Participatory Policymaking	•	•			•		•	•		
Approach of ETH Zurich	•	•		•			•	•	•	•
Transition Management	•	•	•	•			•	•	•	•
ISOE-Model	•	•		•			•	•	•	•

Fig. 8.2 Key characteristics of types of transdisciplinary approaches (after Brinkmann et al. 2015, 60)

'Environment and Sustainability' as their key fields of application are apt for climate services as well (cf. Fig. 8.2, column 1): Participatory Policymaking, Approach of ETH Zurich, Transition Management and the ISOE-Model. Indeed, these approaches show similarities in many categories:

- All try to involve a great variety and range of social groups (cf. column practitioners involved).
- All alternate phases of varying involvement intensity in the project (cf. process design).
- The approaches of the ETH Zurich and the ISOE-Model aim at creating what they call practical 'transformation knowledge' but they also aim at generalising the case's findings in order to integrate 'system knowledge' into academic discourses and thus to stimulate further research. Both approaches regard the connectivity to academic discourses as equally important as the solution of the real-world problem (cf. scientific connectivity).
- Methodologically, all four approaches use workshops with manifold 'tools for facilitating communication (communication tools) and tools for formalising actors' mental models and assessments (analytical tools)' (Welp et al. 2006). Among the latter are system analyses, modelling of specific system situations and scenario analyses. A discussion and evaluation of these models and scenarios by practice partners scrutinises the usefulness of the different steps in problem-solving within the project (cf. methods).
- In terms of objectives, the four approaches all intend to enhance mutual learning and aim for 'policy design' by way of information, counselling and supporting real-world decision-making (cf. objectives).

There is a broad range of approaches available to design a transdisciplinary process, but the above-detailed range emerges across the different research fields. Thus, despite the very different questions to be solved, the motivating idea, the process design, the objectives as well as the methods do not differ much. Also, scholars representing the models of ETH Zurich and ISOE, respectively, recently started to collaborate (for a fruitful attempt to compile their principles of transdisciplinarity see Lang et al. 2012).

8.3 Towards Quality Criteria for Transdisciplinary Dialogues

8.3.1 Integration of Experiences and Literature Studies

Successful mutual learning in transdisciplinary contexts is a challenge that needs to be tackled on a case-by-case basis. We were nonetheless interested in deriving criteria for how to best set up, organise and govern the integration of research and practice for climate services. Motivated by similarities in objectives and

methodology as shown in Fig. 8.2, we organised a workshop including participants from research and practice across all fields and sectors. In mixed groups, they collected their experiences and reflected on the aspect of practice partner integration (Schuck-Zöller 2015). In this way, a set of criteria and success factors emerged. In a second step, this empirically derived set of criteria was compared to and integrated with discussions in the literature. In doing so, we found that many criteria were mentioned both by the workshop participants and in the literature. Thus, we could identify a combined set of quality criteria. In the following, we present a list of ten criteria. All seem of importance for the success of transdisciplinary processes, but they might carry different weight depending on the degree of involvement of participants (Fig. 8.1), the aim of the research project, and the transdisciplinary approach chosen (cf. Sect. 8.2.2, also Klein 2008). The presentation follows, as far as possible, the order of a transdisciplinary process.

8.3.2 Ten Quality Criteria for Transdisciplinary Dialogues

1. Constructive selection and involvement of participants—Are the groups and types of practice partners who are to be invited selected by a systematic analysis (often called 'stakeholder analysis' cf. e.g. Reed et al. 2009)? Is the range of different views from research and practice broad enough to tackle the real-world problem under study (Cuppen 2012)? Is the criterion for invitation made transparent to all parties (Scherhaufer and Grüneis 2014; Heimerl 2012; Froggatt 2013)?
2. Setting the scene for co-design and co-production—From the beginning, all participants must get time and space to articulate their needs, views and value preferences with regard to the issue under study (Scherhaufer and Grüneis 2014). This is a question of a good communication set-up and facilitation, and enough time must be factored in for initial negotiations of the project's aims, means and processes. It is crucial to find common ground in a shared conceptual repertoire: The terms that are used should be sufficiently popular and a shared understanding of key concepts is indispensable. Throughout the process, all parties should promote partnership on equal footing. Interactive authority which operates to marginalise participants should be counteracted, e.g. by the facilitation of dialogues by an experienced moderator (McDonald et al. 2009).
3. Problem definition and focus: clarification of mutual expectations—Against the backdrop of diverse interests, relevances, ways of knowing and value preferences among participants, the research object as well as the goals of the project should be clarified at the beginning of the project to prevent subsequent misunderstandings and disappointments (Scherhaufer and Grüneis 2014). Ideally, the research question is relevant for practice and science (Steinke 2000). This challenge takes time and needs ample discussion between all participants, but a joint formulation of the research question is a prerequisite for joint problem ownership.

4. Joint problem ownership—The motivation and commitment of the parties involved can only partly be influenced by the project management. If practice partners participate actively and responsibly in the project design, they will more easily be able to see their involvement as making a difference (Scherhaufer and Grüneis 2014). To achieve joint problem, ownership is key for safeguarding continuous engagement. It also increases acceptance of the project's activities and outcomes.

5. Professional planning and management—Communication within the project has to be managed professionally. This includes the application of appropriate and constructive communication and analytical tools (cf. 2) throughout the project and tailored to its different phases (Scherhaufer and Grüneis 2014). To achieve partnership on equal footing, it can be helpful, e.g. to enrol a professional moderator from outside the project to facilitate dialogue. While there is still a perceived lack of expertise in transdisciplinary work and professional facilitation in research communities, some capacity building activities have been initiated in recent years (e.g. by td-net, Australian National University and Future Earth).

6. Space and time for reflection and iteration, project flexibility—Self-reflection in workshops and other meetings is necessary to keep articulating and exchanging different viewpoints, to re-think the methodology and to keep all parties engaged. In the methodology of transdisciplinary processes, the monitoring of common work processes takes centre stage (Bergmann et al. 2012). Every milestone in the project should be complemented by a reflection and monitoring phase which, if necessary, allows for adaptations in the project direction. Flexibility is needed in the conceptual and temporal framing of the project to accomodate this challenge (Reitinger and Ukowitz 2014). As it is very difficult to foresee the development in detail, the project framing and structuring should allow for flexibility in terms of redesigning single parts and milestones by common agreement throughout the project.

7. Integration of different ways of knowing—This is a key success factor for transdisciplinary processes. As exemplified in the ISOE-Model, to negotiate an integration plan at the beginning and have it frame the entire project helps to ensure that the outcomes of different phases and methodologies can be interconnected and applied to the overarching research question (Bergmann et al. 2012).

8. Credibility, neutrality and trust—The managing institution has to act as neutral as possible to achieve credibility with all participants (Scherhaufer and Grüneis 2014; Schuck-Zöller et al. 2014). They must be able to trust that their involvement in the project, e.g. by way of providing knowledge and information, does not lead to personal or community disadvantages such as in relation to media communication or the provision of personal data. Trust is essential for transdisciplinary research, as it is for all spheres of communication (Swantz 2008).

9. Coherence and constructive handling of contradicting viewpoints—Contradictions in viewpoints, interests, value preferences or findings that might occur over the course of the project must be openly discussed and negotiated to create valid and useful findings and meet everybody's needs (Heimerl 2012;

Froggatt 2013). In transdisciplinary research, this is a greater challenge than in scientific research because of the broader spectrum of perspectives involved.

10. Transparency and overall project documentation—All steps in setting up and managing a transdisciplinary process should be open and transparent, both for all participants involved, and for subsequent evaluation (Reitinger and Ukowitz 2014). For this reason, every step should be communicated within the project and documented for future reference (Scherhaufer and Grüneis 2014). In transdisciplinary research, this includes documentation of initial negotiations, methodologies, processes and management activities.

8.4 Conclusions and Outlook

This chapter presents considerations on how to best set-up and govern the integration of research and practice based on a literature review and reflections of hands-on experiences in transdisciplinary contexts. We have categorised and presented six different types of transdisciplinary approaches, out of which four shows proximity and suitability for application in climate services.

In summary, the review and comparison of approaches from different fields and research areas confirm the following similarities between the approaches: the involvement of practice partners, a real-world problem-oriented design and interdisciplinary work in science. Approaches that alternate research phases without practice partners with phases of transdisciplinary collaboration appear more apt to feed findings back into academic discourses. This illustrates the great challenge of combining continuous practice participation with 'use-inspired basic research' (Clark 2007). Across all approaches, we can identify an ideal-typical frame for the design and process in both a social and a content-related dimension. Socially, the value of open and engaged mutual learning through knowledge exchange and changes in perspectives is promoted, which is perceived as expedient by all participants. With regard to contents, the knowledge that is produced by transdisciplinary collaboration should be both, practicably applicable in solving the original problem and of scientific value.

Having compiled a set of quality criteria of transdisciplinary research, it seems pertinent to go forth in the direction of evaluation and ask how the impact of transdisciplinary processes can be appropriately assessed. To move towards this direction, an evaluation framework for transdisciplinary processes must be developed. The ten quality criteria can provide a first scheme of what should be evaluated. To fuel this process, new indicators—both qualitative and quantitative ones—are needed to assess or measure the quality of processes, products (outputs) or outcomes, or impacts of transdisciplinary research (McNie 2013). A recent and promising initiative in this regard is the ISOE-led project TransImpact, funded by the German Ministry for Education and Research. An earlier discussion on this was triggered by the Annual Conference of the German Society for Human Ecology

(DGH) in 2005 (cf. Stoll-Kleemann and Pohl 2007). The discussion can further benefit from the systematic literature review presented in Wall et al. (2017) and recent work of Schuck-Zöller et al. (2017). What is still open to discussion is the field of how to assess societal impact of research and, above all, transdisciplinary processes. Here still some work has to be done.

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Carina Brinkmann holds a degree in sociology from the University of Bielefeld and has contributed to various research projects regarding the relationships between science, media and the public. Currently, Carina is working for the Federal Association of German free papers and is mainly concerned with sustainabilty issues and the optimizing of logistical processes.

Simone Rödder is an Assistant Professor of Sociology at the University of Hamburg. She heads the research group ‘Understanding Science in Interaction’ at the University’s Cluster of Excellence ‘Integrated Climate System Analysis and Prediction’ and teaches in the Cluster’s graduate school. Simone has an academic background in biology and sociology and is a trained journalist. Her main research interests are the sociology of science and science communication.