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Transfer as a reciprocal process: How to foster receptivity to results of transdisciplinary research

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A B S T R A C T

Transdisciplinary research (TDR) seeks to address real-world problems and aims to be socially transformative. This normative objective extends beyond particular TDR projects, as real-world problems are embedded in concrete contexts but, at the same time, are also related to wider societal challenges that are not restricted to one context. Therefore, TDR generally entails transfer of knowledge and results to other contexts. However, the TDR discourse has mainly treated transfer efforts from the perspective of scientific generalization, translation and packaging of knowledge. Within this understanding of transfer, little attention has been paid to interplay between contexts and the role of new contexts themselves.

This article is based on qualitative explorative research on four TDR projects. Its results were iteratively derived through project analysis, reflection on insights from the literature and discussions with TDR experts. We propose that transfer is a complex reciprocal process in which different types of knowledge are provided and transferred to other contexts, where knowledge is adapted, enriched and modified. In addition to project researchers, actors in other (pick-up) contexts also play an important role for successful transfer and appropriation of TDR results. Generating transfer potential within the duration of a project depends on being aware of potential pick-up contexts. To address the interdependent aspects of transfer (results, mediation, and appropriation in other contexts), we present a comprehensive model outlining TDR transfer processes. To support projects seeking to raise their transfer potential in a more conscious manner, we also formulate three overarching recommendations: 1) process results for transfer adequately, 2) identify and support intermediaries and, 3) increase awareness of and address other contexts. Considering these recommendations while also being aware of their interdependence may increase potential for transfer of knowledge and results to other contexts. Our conceptual understanding acknowledges the complexity and non-linearity of endeavors to take advantage of case-specifically gained knowledge and results in other contexts or at other scales.

1. Introduction

During the last two decades, a notable body of literature has emerged regarding the essential characteristics, capacities and challenges of conducting transdisciplinary research (TDR). In general, there is a shared understanding that the aim of TDR is to produce knowledge to cope with real-world problems (Pohl and Hirsch-Hadorn, 2007; Walter et al., 2007; Carew and Wickson, 2010, 2014; Roux et al., 2010; Bergmann et al., 2012; Jahn et al., 2012; Lang et al., 2012; Belcher et al., 2016; Newig et al., 2019). Against this background, TDR is seen as appropriate for contributing towards solutions to societal problems

in the contexts where they occur. Further, it is presumed to promote scientific innovation and progress. Pursuing both the societal and scientific objectives at the same time is, however, considered a challenge.

This growing discourse also envisions TDR substantially contributing towards the sustainable transformation of society. Such a normative objective indicates a further challenge that goes beyond the contexts of specific research projects, as real-world problems are usually tied to societal and sustainability challenges on a larger scale, whose occurrence is not restricted to one particular context. Consequently, transdisciplinary projects are situated in a field of tension between two requirements: First, they are supposed to provide

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solutions that have a close fit to specific context conditions while, second, they are also usually expected to provide knowledge for other cases in other contexts (Krohn, 2008).

Although the first challenge – generating actionable knowledge and scientific evidence at the same time – has already received great attention in TDR literature, the second – creating context-specific solutions that can (at least partly) be transferred to other contexts – has thus far not been addressed to the same extent. In various publications, transfer of knowledge and results to other contexts has mainly been treated in terms of scientific generalization (see for example Jahn et al., 2012; Lang et al., 2012; Scholz and Steiner, 2015).

The research presented here seeks to address this gap and contributes towards ongoing discussions concerning transfer of TDR results to other contexts (hereafter usually abbreviated as 'transfer'). We have put emphasis on considering the implications of TDR praxis, asking what kinds of conditions can enable transfer, as part of ongoing joint research between scientists and practitioners. Therefore, we have not focused on transfer to practice or scientific fields in the immediate environment of TDR projects but, rather, on transfer that transcends spatial, temporal and thematic contexts of the original transdisciplinary project. Thus, the research presented here spotlights second- and third-order societal effects of TDR, which – in contrast to first-order effects – occur outside immediate project contexts (Lux et al., 2019).

The research highlights such approaches that seek to go beyond the unidirectional linear understanding of transfer. Emphasis has also been put on discovering what kinds of capabilities participants from the analyzed projects perceived as suitable for further development of concepts and practices that can facilitate transfer of results and knowledge to other contexts.

The paper is organized as follows: First, we introduce relevant aspects of the current research regarding transfer in general and from within the TDR discourse in particular (Section 2). Then we provide a brief overview of our empirical data and methods (Section 3). The subsequent section summarizes the results and presents our insights and conceptual considerations as well as recommendations for TDR praxis (Section 4). In the discussion (Section 5), we reflect upon our results and point out the necessity for further research due to the limits of our study. The article ends with our conclusions (Section 6).

2. Theoretical background

In this section, we review three approaches that have helped to develop our own understanding of the transfer of knowledge and results to other contexts. First, we consider conceptions of how to bridge the gap between knowledge production (generally associated with science) and applications beyond scientific realms. Second, we reflect on how TDR strives to bring collaboratively produced knowledge into action. Third, we show how TDR has attempted to cope with the challenge of transferring knowledge and results to other spatial or thematic contexts.

2.1. Overcoming linear conceptions of transfer

In the traditional understanding of transfer, a gap between knowledge production and application needs to be bridged. Terms such as transfer, knowledge transfer and dissemination often refer to the transport of scientifically generated results to a target community, whereby a one-sided knowledge deficit within the target group is assumed. For this unilateral model, best known from technology-transfer approaches, "scientists set the research agenda, do the research, and then transfer the results to the users" (van Kerkhoff and Lebel, 2006:450).

From the perspective of this model, transfer means that science produces objective facts that "need to be 'translated' (summarized, packaged, prioritized, and presented in a form understandable and useable by practitioners)" (Greenhalgh and Wieringa, 2011:503). Yet, this linear understanding of transfer, with its narrow focus on the

knowledge–action gap is now being contested. In their critical review article, Greenhalgh and Wieringa (2011) stress the importance of recognizing the "fundamentally social ways in which knowledge emerges, circulates and gets applied in practice" (Greenhalgh and Wieringa, 2011: 502). Although their conclusion originates in the context of medicine and health care, it is also applicable in various fields where case-specific knowledge is generated and supposed to be taken up by actors in other contexts and on different scales. Heinsch et al. (2016) strengthen this argument within the context of social work by referring to other already existing models (e.g. the socio-organizational model or the interaction model) that can enable the establishment of new linkages between scientific research and society.

Other efforts originating in fields more related to sustainability issues describe research–practice interactions based on the concepts of co-production of knowledge and social learning as well as the role of knowledge brokers (van Kerkhoff and Lebel, 2006; Crona and Parker, 2012; Chapman et al., 2017; Roux et al., 2017). Studies of knowledge utilization, for example, have provided insights into how knowledge is influenced by social interaction as well as by organizational factors (Landry, 2003; Reed et al., 2010). Moreover, a well-established scale exists for measuring knowledge utilization that maps the consecutive steps knowledge goes through in new environments: from reception via cognition, discussion, reference, and effort to influences on decision-making (Crona and Parker, 2012).

Overcoming the linear thinking of the traditional transfer models has also gained relevance in the field of communication. For decades, the one-way Shannon-Weaver communication model has been contested regarding the social processes it fails to consider (Reardon and Rogers, 1988). Of particular interest to our research are insights related to the umbrella term knowledge exchange. This concept has been developed in a wide range of fields and disciplines, mainly for the purpose of linking together research, policy, and practice. In an extensive review, Fazey et al. (2013) describe knowledge exchange as a "process of generating, sharing, and/or using knowledge through various methods appropriate to the context, purpose, and participants involved" (Fazey et al., 2013: 20), within which they also include related concepts such as sharing, knowledge generation, co-production, knowledge transfer and brokerage of knowledge. They conclude by formulating a research agenda geared towards gaining a better understanding of and improving knowledge exchange within the field of environmental management.

The critique concerning one-way, unilateral models and approaches discussed above leads us to the question of finding appropriate terms for our analysis. We are aware of the shortcomings and inadequacies of the term transfer, as described in detail by Davies et al. (2008), and agree with these authors that, although the term knowledge transfer "has become established as shorthand for a wide variety of activities" (Davies et al., 2008, 188), it still misrepresents the "messy engagement of multiple players with diverse sources of knowledge" (Davies et al., 2008). Despite all the evidence that linear approaches to transfer fail to bring knowledge effectively into practice, the concept seems to be deeply rooted in the notions of both science and policy making (van Kerkhoff and Lebel, 2006).

In our understanding of transfer as a concept, we acknowledge its complexity and non-linearity. Nonetheless, by sticking to the conventionally used term transfer, we assume that we will be able to reach a wider audience and, thus, contribute towards overcoming the shortcomings and ineffectiveness of previous linear perspectives. Furthermore, we feel that our usage is in line with the terminology used for communication with participants during the research process (transfer and transferability, Lux et al., 2019).

2.2. Knowledge transfer according to the TDR discourse

The idea of transdisciplinarity entails a fundamental criticism of the traditional disciplinary academic system (Klein, 2014). In TDR, actors

from inside and outside academia collaboratively address the increasing mismatch between complex real-world problems and existing forms of scientific knowledge production (Biggs et al., 2008; Hoffmann-Riem et al., 2008; Heinrichs and Gross, 2010). The common understanding underlying TDR is that there are uncertainties and knowledge gaps on both sides, which can only be dealt with through integrating different scientific and extra-scientific insights. Through integration, the problem context can ideally be established already in the project-constitution phase, when a given complex societal problem is jointly identified and transformed into a transdisciplinary research object with corresponding research questions and goals. Subsequently, this integrative mode of research should be maintained – with varying intensity – throughout the whole research process (Bergmann et al., 2012; Jahn et al., 2012; Lang et al., 2012).

Efforts to make use of the results of TDR in practice generally take place during the final project phase (e.g. Lang et al., 2012; Jahn et al., 2012), where researchers and practitioners evaluate whether outcomes have met their expectations and, especially for the latter, needs. Jahn et al. (2012: 7) explain that, in the last phase of ideal-typical TDR, a second-order – a transdisciplinary – integration takes place, in which mutual critique is carried out with participants from science and practice. This potentially makes the results better suited to the needs of both scientists and societal actors.

This phase has normally ended quite traditionally with a process of summarizing, translating, and packaging the resulting insights into products for specific target groups (Defila et al., 2006; Roux et al., 2006; Lang et al., 2012). After the last phase of knowledge packaging and immediate transfer, researchers usually leave further handling of the results in practice to participating key stakeholders. The notions of reflecting on "how these products will fit target group's current practices and agendas" (Pohl and Hirsch Hadorn, 2007: 27; cf. also Polk, 2014) or of taking up generated results into community problem-solving strategies (Mitrany and Stokols, 2005) go a step further.

How the transfer of TDR results into practice can be fostered after completion of a given project has recently been discussed from the perspective of their potential for (societal) effectiveness. Possible indicators for long-term effectiveness are, for example, productive interactions, which can include direct personal interactions, indirect interactions through texts and artefacts or through financial exchange (Spaapen and van Drooge, 2011; also e.g. Wolf et al., 2013; Krainer and Winiwarter, 2016; Rütten et al., 2016; Schneider and Buser, 2018). Other authors emphasize the use of intermediaries and networking (e.g. ESRC, 2009; Kaufmann-Hayoz et al., 2016). De Jong et al. (2011:66) highlight "the dissemination of research results by people", and Maag et al. (2018:1) refer to an "increasing number of knowledge brokers who work at the interface between research, policy and practice".

The TDR literature clearly shows that TDR projects are becoming increasingly engaged to generate potential for effective transfer of knowledge and results (i.e. ensuring transferability). Concepts for transfer beyond immediate contexts that TDR projects are embedded within could build upon these experiences.

2.3. Transferring knowledge to other contexts

Considering the high conceptual expectations for what TDR should ideally be able to achieve, as outlined in Section 2.2, the literature still contains relatively few methodological references when it comes to supporting transfer of knowledge and results from one context to another spatially or thematically distant area under different framework conditions. Adler et al. (2017:180) emphasize that "a profound understanding and management of the challenges related to knowledge transfer across cases are missing." Thus far, the methodological challenge of transferring knowledge between contexts has often been dealt with in terms of scientific generalization. Lang et al. (2012: 38), for example, recommend the integration of "the generated knowledge into the existing body of scientific knowledge" for transfer and scaling-up

efforts. Yet, the generalization of case study results is regarded as a major challenge for TDR, since real-world situations are unique and cannot be repeated the same way as lab experiments can (Lang et al., 2012; Wiek et al., 2012; Scholz and Steiner, 2015).

Krohn et al. (2017) point out that high expectations regarding isolation of a valid, decontextualized core of knowledge are hardly justified. From the broad perspective of social research, Davies et al. (2008: 189) also recognize "serious limits to the extent to which objective, stable and acontextual knowledge can be created". We agree with the presumption that generalization and decontextualization of knowledge alone are not enough to promote transfer and that transfer to other contexts is a methodological challenge for TDR (Adler et al., 2017; Krohn et al., 2017). As a potential means for addressing this problem, Krohn et al. (2017: 345, translation by authors) argue that, "not only repetition but also aspects such as modification and adaptation can" become essential elements of TDR. Meanwhile, Adler et al. (2017) propose an approach for conceptualization of transfer based on similarities and dissimilarities between existing cases. However, the question of how imitation, modification and adaptation can actually be enabled in TDR praxis has thus far received little attention in the literature.

In sum, it can be said that the TDR community does not yet have a common understanding of transfer of knowledge and results between contexts nor a methodological framework for effectively addressing the related challenges. Moreover, these issues seem to have been barely reflected upon in the literature, and it is unclear which new approaches that seek to go beyond the traditional linear understanding explained above have already been applied and assessed in TDR practice. This insight became the starting point for our own research.

3. Data and methods

In this section, we present the database and methods used to generate our results, which were all derived from a three-year collaborative research project: TransImpact – Effective Transdisciplinary Research. The main overarching goal of TransImpact was to investigate whether certain practices or methods applied during the TDR process are able to potentially generate high levels of positive effects for society (cf. Bergmann et al., 2016; Lux et al., 2019). A more specific aim of the project was to identify how increasing transfer potential can be addressed strategically by TDR projects and, consequently, formulate appropriate methodological recommendations. The guiding questions for empirical analysis of several transdisciplinary projects (described below) were as follows:

- What approaches and methods did the analyzed TDR projects apply for enabling transfer of knowledge and results to other spatial contexts or further thematic fields? What experiences did they have?
- Which possibilities for further development of concepts and practices for generating greater transfer potential did actors of the analyzed-projects see?

3.1. Selection of case-study projects

TransImpact assembled a database of 75 completed TDR projects aimed at achieving societal effects (Jahn et al., 2012; Lang et al., 2012), of which 16 were selected for detailed analysis so as to assure great diversity in terms of a) topics in sustainability research and neighboring fields, b) funding bodies, c) lead institutions, d) research formats and methods. The 16 chosen TDR projects were then grouped into four thematic clusters, focused on problem definition, participation, knowledge integration, and transferability. (For detailed information on methods applied within TransImpact, see Appendix A; for a discussion of its overarching results, see Lux et al. in this issue.)

The present paper focusses exclusively on the thematic cluster of transferability. Four projects (see Table 1) were selected from the total

Table 1
Overview of projects examined by TransImpact regarding the transferability of their results.

	Project 1	Project 2	Project 3	Project 4
Topic	Municipal disaster protection, corresponding communication concepts and instruments	Public health for women in difficult life situations	Urban agriculture in growing cities of developing countries	Urban–rural land use conflicts
Project aim	Increasing resilience to disasters, empowerment of local authorities and (private) providers of critical infrastructure to cooperate more efficiently in crisis situations	Improving opportunities for socially disadvantaged women to experience positive health effects of physical activity	Development and testing of urban agricultural concepts for climate-optimized urban development and construction of productive open spaces.	Measures for achieving desirable settlement development in peri-urban areas in a Swiss rural area
Lead partner	University (interdisciplinary institute)	University	University	Non-university research institution
Main actors involved	Researchers, local authorities (i.e. fire department) and infrastructure providers (electricity, water, telecommunication). Advisory board with other municipalities	Researchers, local authorities, representatives of infrastructure providers (i.e. sports facilities) and of prevention facilities as well as affected women	Researchers (from Germany and partner country), authorities and non-governmental initiatives from partner country	Researchers, local and political authorities
Funding Scheme	German Federal Ministry of Education and Research	Miscellaneous	German Federal Ministry of Education and Research	Subnational environmental ministry
nApprox. duration	3 years	Series of ongoing follow-up projects since 2005 until today	3 + 5 years	3 years
Scale	Local (big city in Germany)	Local (mid-sized city in Germany, aiming at national "roll-out")	Local (megacity in northern Africa)	Local (region of Switzerland), with the aim to transfer to other regions
Significance of transfer	Growing awareness of transfer potential during the project, spontaneous imitation of partial results in other cities favored by local-problem pressures. Transfer via advisory board to another big city	Research question on transfer, transfer activities as integrative elements in research design; steady implementation of the concept in several contexts as part of the project aim, accompanied by a competence center	Theoretical reflection on transfer; elaborated concepts for transfer of knowledge and results; validation of transfer concept in cooperation with potential adapting city	Transfer not explicitly aimed at; transferable results regarding methodological procedures in TDR projects
New contexts	*Spatial:* One smaller city (partial adaptation of one element after event of crisis) *Thematic fields:* Adaptation of methodological procedures in the same community for criminality issues	*Spatial:* Several communities in diverse environments (rural or urban) *Thematic fields:* Adapting methodological steps in the original community for dementia prevention	*Spatial:* megacity regions in other countries (planned) *Thematic fields:* Adaptations between the pilot projects within the original project	*Spatial:* Adaptation within the region *Thematic fields:* Methods for other TDR processes
Main products	Newspaper and popular science articles, scientific articles, communication concept, user committee, software (alpha version)	Manual for adaptation of the elaborated concept; website and newsletter (existing up to now); newspaper and popular science articles, scientific articles	Scientific articles; comprehensive project report as a book; pilot projects	Scientific articles; Code of Practice (summary of results and recommendations for action); visualization techniques for the design of TDR processes; development of scenarios; steering approaches for land use
Main Societal effects	Learning processes and capacity building; participative method used in further areas; results will be used in the long term	Changing everyday practices and empowerment of affected persons; positive effects from societal integration of them and their families; adaptation of the concept in other municipalities; nationwide "roll-out" with the financing of a public institution	Network effects, one steady pilot project, capacity building with local partners and learning effects; sensitization of different actors to the problem and urban agriculture as an applicable concept	Insights regarding TDR process design; capacity building and network effects; shared problem awareness; spontaneous transfer to other contexts by persons involved

of 16 preselected ones by TransImpact, based on publicly available information and initial interviews with their respective coordinators regarding their interest in this topic. Achieving diversity in terms of the categories presented in Table 1 was also an important aspect of our sampling criteria. Two of the four analyzed projects dealt with sustainability research, with one working in the field of disaster prevention and management and the other in the field of health promotion. The remaining two projects were involved in urban issues related to rural or agricultural problems. Funding bodies for the projects were located at the federal, state and municipal levels. The duration of the projects varied greatly, ranging from three to ten years, including a nationwide roll-out, with support and funding from a public agency for one. Researchers and practitioners were involved in all projects. The institutional range of the scientific partners included both university and independent research institutes. The practitioners came from a variety of domains: politics and administration (federal and state offices, municipalities), private companies from various sectors (infrastructure providers, health insurance, municipal companies), and non-governmental organizations.

Each of these four projects dealt with transfer in different ways, summarized as follows: 1) transfer not originally being an explicit project objective but, rather, growing attention for its potential emerging during project's duration; 2) consolidation of problem-solving approaches and transfer as an explicit project claim; 3) theory-based development of a transfer concept and its subsequent validation in other contexts; 4) transfer of TDR expertise and mediation of project results by individuals.

3.2. Empirical analysis

The empirical approach of TransImpact was qualitative and explorative, with strong participative elements (evaluative processes engaged in with collaborators of the analyzed projects from research and practice as well as with further TD experts). Project analysis took place through an iterative process of data collection, analysis and hypothesis building, based on empirical data and literature review findings, reflection on project insights with their participants in project forums and via discursive validation by experts. For each thematic cluster, a multi-step approach was taken (for more details see Appendix A). Research regarding the transferability cluster was conducted from November 2017 to November 2018 along the following steps:

1) A case study approach was employed for analyzing the reports, publications and supporting questionnaires of each project, based on a preliminary conceptual understanding of the topic regarding (a) project-specific framework conditions, (b) applied methods and procedures regarding transfer, and (c) realized, positive intended and unintended effects as well as negative unintended effects. These analyses were then summarized in case descriptions. The main interest of project analysis was not to assess their societal effects per se but, rather, to understand which procedures and efforts undertaken during the projects might be connected to these effects. Preliminary conclusions in this regard were summarized across the four case studies.

2) In a second step, these preliminary conclusions were discussed during a two-day project forum in March 2018, which supported in-depth discussions with participants from the analyzed projects, enriching the available empirical material. Two to five partners from each project participated, one being the coordinator and at least one being a practitioner.

At the project forum, we first introduced and discussed our preliminary conceptual understanding of transfer with all participants. Thereafter, participants in respective working groups discussed project visualizations based on the analysis elaborated by the TransImpact team. The visualizations (see Appendix B) served as a stimulus for participants to assess our interpretations and to reflect upon their own approaches and processes. In addition, the visualizations enabled identification of structural specificities or conditions for successful

transfer, beneficial processes and procedures as well as confirmation or falsification of our assumptions. The overall aim was to capture in depth the processes of the studied projects that are likely to have led to their respective generation of transfer potential.

Group discussions were also conducted at the forum concerning various aspects of our conceptual understanding, such as suitable preparation of knowledge for transfer and feasible "vehicles" and "paths" for its delivery. During the last session of the two days, the participating partners of the analyzed projects and the TransImpact team jointly reflected on the forum's results. Discussions during the forum were documented via notes on flip charts and detailed minutes. After the forum, content analysis of the empirical material allowed preliminary generalizations to be made by identifying key issues, which were then discussed in iterative reflection loops by the entire TransImpact team.

3) The results of the first two steps were presented and discussed at a one-day workshop called discursive validation platform among 25 TDR experts. The main idea of this workshop was to obtain feedback from experienced TD researchers to supplement the limited data set of case studies as well as to broaden our expertise concerning the conceptual and theoretical underpinnings of TDR. Preliminary results were sent in advance to two experts, who commented critically on them, with their remarks commencing initial discussion among the entire group regarding our results. Further discussion took place in plenums, focussing on the theoretical framework and central findings, as well as in smaller groups (world cafés), which focused on recommendations for effective research practice. Documentation of the discussions took place via notes on flip charts, which were visible to all participants, and detailed minutes. The empirical material was assessed via content analysis. Preliminary results generated in the project forum and reflected upon within the TransImpact team were once more enriched or revised based on critical comments from the TDR experts and supplemented by existing literature regarding the topic.

4) The enriched and summarized results were then documented in the form of a project report, which has also served as a basis for further publications. Selected central findings have been published via the online platform www.td-academy.org (so far only in German).

To sum up, the empirical research conducted by TransImpact can be characterized as a steady and iterative enrichment of both our empirical basis and conceptual understanding of transfer. Between the empirical steps, new insights from the exchange with experts as well as from further literature review were reflected upon within the research team, using different methods of knowledge integration (e.g. co-writing, commenting on texts and presentations, group discussions).

4. Results

In this section, we show our empirical results at two levels, in terms of: 1) conceptual understandings of transfer, which have been summarized in a conceptual model (Section 4.2) and 2) recommendations for transfer-related methods and procedures within TDR practices (Section 4.3). First, we present our central findings that emerged during the project, in the manner described in Section 3.2.

4.1. Central empirical insights

This section presents our three central findings. First the actors involved in transfer processes were repeatedly emphasized, in both the project forum and discursive validation platform, as being important for successful transfer. Transfer usually takes place via a combination of different result formats and mediation. In addition, the relevance of the adapting *pick-up context* – a term introduced by the participants of the project forum – was highlighted. Reflecting on the experiences of the studied projects revealed that transfer takes place in interactions between originating and pick-up contexts and not simply through projects providing results (as e.g. publications, handouts, guidelines or products).

Second, the participants of the project forum also emphasized the responsibility of actors in potential pick-up contexts. For successful transfer, such actors need to search for, recognize and pick up existing knowledge and results. Transferability was understood to be more of an external attribution from the perspective of actors in other contexts rather than a self-attribution of those working on original projects. Actors in potential pick-up contexts are also considered responsible for reflecting upon provided knowledge and making efforts to adapt it to their own contexts. In the validation platform, it was said that it is advantageous if actors from the originating context support adaptation and modification, which, however, must ultimately be accomplished by those in the pick-up context.

Third, in the experiences of the projects, both generalized and context-specific knowledge is usually combined in the various results produced for transfer purposes (e.g. manuals or leaflets as well as scientific articles). The participants in the project forum agreed that it is, thus, not always a clearly defined, precise set of results that is usually transferred but, rather, something "coarse" and "fuzzy". It was also suggested that no particular kind of result is, per se, better or worse suited for transfer. Rather, participants emphasized that a combination of different types of results is decisive. It was also pointed out that different means of transfer need to be combined for a given project, instead of just one way. All participants agreed on the importance of clearly defining target groups. Accordingly, results need to be comprehensible and attractively designed for their anticipated audiences.

These ideas from the project forum were confirmed by participants in the discursive validation platform. Based on these insights, it can be summed up that results alone are not enough to guarantee transfer, and whether transfer takes place or not will end up largely being decided in the pick-up context rather than the original one. Transfer can only be deliberately addressed from the originating context if well-defined pick-up contexts are already known. Nevertheless, even if such contexts are not precisely identified beforehand, projects can still approach transfer strategically and initiate processes intended to promote it (e.g. draw attention to the project or involve actors with knowledge of various contexts). One TDR researcher remarked that one should not only trust in generating good results but also be attentive to opportunities to improve transfer throughout the whole project. Moreover, there is not one key point in a project's history that is decisive for transfer of knowledge and results; rather, there are many moments that may present opportunities for improving transfer. This perspective differs from the conventional idea of running a project according to its timetable from beginning to end and only then considering transfer options in its concluding phase.

Overall, our study reveals that, in their respective projects, members of the TDR community have been engaged in developing conceptual ideas and testing appropriate approaches for enabling transfer of knowledge and results to other contexts. Our central empirical findings show fruitful parallels to innovative transfer concepts, such as the concept of knowledge exchange, which points to the complexity of research use in practice (cf. chapter 2.1).

Next, we present a conceptual model iteratively developed by the TransImpact team, based on these central insights.

4.2. Conceptual model of transfer to other contexts

The preliminary conceptual model was initially built based on the TDR literature concerning generalization, translation and packaging (see Section 2) and was enriched iteratively via our central empirical findings, presented in the previous section.

Transfer of knowledge and results is schematically represented in Fig. 1 as a complex reciprocal process that includes the following three central aspects of our empirical findings: First, *generation* of knowledge as well as *processing* of results into various formats (e.g. publications, handouts, guidelines, products, good practices) in the context of origin. Second, *mediation* and *interaction* between the originating context in

which a given project is embedded and other contexts where knowledge is needed and may be picked up. Third, *appropriation* within pick-up contexts, where transferred knowledge will be utilized and adapted for actors' own purposes.

4.2.1. Generation and processing of results in originating contexts

Our analysis of the four selected TDR projects reveals that they have generated different forms of knowledge (e.g. scientific, expert, practical, experience-based) among those involved as well as methodological insights concerning the design of transdisciplinary processes. Such knowledge forms do not seem to have been generated isolated from each other in the projects but, rather, emerged in the form of complexes. The participants in the project forum as well as the validating experts agreed that, for successful transfer, knowledge should be provided in a variety of formats and mediated to potential pick-up contexts, where it can be enriched, adapted and modified by actors there. The results of the four TDR projects generally contained and combined several forms of knowledge (e.g. generalized and context-specific) and usually also provided knowledge concerning both process design (e.g. TDR design, methods, expert knowledge) and problem-solving approaches (scientific findings, but also ideas, intentions and concepts leading to them). The experts of the discursive validation platform articulated that the accessibility of TDR results for other contexts depends on being adequately processed. It was also pointed out that it would be very helpful if results intended for transfer were to be worked out together with representatives of potential pick-up contexts or at least be commented upon by them.

However, in our understanding, selecting knowledge to be provided for potential transfer is a challenge for at least two reasons. First, it is very difficult to predict from within the originating context which aspects of the newly generated knowledge will be considered useful in pick-up contexts. Second, our analysis has shown that knowledge cannot be "neatly" isolated for transfer from the generated complexes. The knowledge needed for successful transfer can only be partly identified and made explicit beforehand. Knowledge can become explicit when it becomes accessible through reflection in conscious processes of explanation by actors either from the original or pick-up contexts. The discussions in the project forum suggested that collaboration between contexts is beneficial for the ascertaining of relevant knowledge for various contexts and their needs. Otherwise, potentially relevant knowledge is likely to remain tacit.

This can be the case, for example, if a product is created but the process of its development and the knowledge that fed into it have not been documented. Therefore, such knowledge can be bound to implemented solutions or incorporated in artefacts, such as instruments or products, but not be explicit to those outside of the original production context. Moreover, knowledge can also remain partly or entirely implicit (e.g. know-how or tacit knowledge, Polanyi, 1967) and is often embodied in actors themselves rather than in material objects. Our empirical data (e.g. perception of something "fuzzy" being transferred) point in the direction that knowledge remaining implicit plays a relevant role in transfer processes. This perception has already been addressed in the literature on knowledge use (see Section 2). Several authors have emphasized that exclusive focus on explicit forms of knowledge may lead to overlooking the relevance of relational (generated in interaction) and reflective knowledge (generated in dialogue, forcing reflection upon one's own thinking and values) and their interrelations for successful transfer (Park, 1999; Chapman et al., 2017; van Kerkhoff, 2006). This idea leads to the importance of considering the central role of people involved in transfer processes.

4.2.2. Mediation and interaction between contexts

We have seen from our empirical data that successful transfer without exchange between originating and pick-up contexts is possible, if TDR results are processed and designed in appropriate ways. However, as already mentioned, our empirical data also suggests that
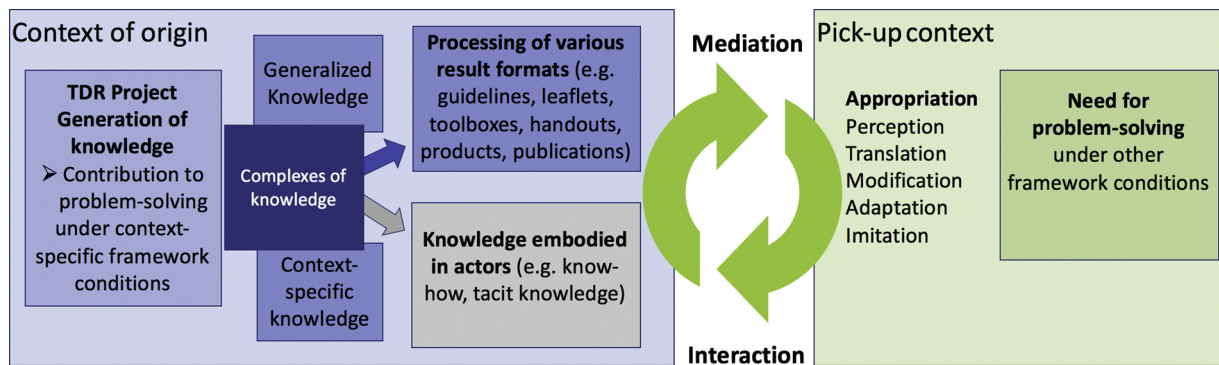
Fig. 1. Model of transfer of knowledge and results to other contexts.

such appropriate ways are generally not easy to foresee. Therefore, direct exchange between contexts seems to be an important means for fostering transfer potential. The TDR experts involved in the discursive validation process agreed that a clear definition of the target group and relevant ways of addressing this target group are decisive for successful transfer. Actors from originating contexts involved in transfer processes can play an important role as carriers of embodied knowledge and mediators of different knowledge forms to other contexts. Meanwhile, actors from pick-up contexts also have a key role to play in the exchange of knowledge to facilitate appropriation in their respective contexts. They pick up existing knowledge and reflect, modify and adapt it to their respective contexts. Moreover, experience gained from pick-up contexts can also be iteratively used in contexts of origin to further enrich results, for instance. In one of the analyzed projects, for example, a manual for concept application in other contexts was re-edited based on experiences from different contexts. In this vein, there was a consensus among project forum participants that shared responsibility between contexts is important for successful transfer. The validation platform confirmed that generating transfer potential during the conducting of original projects may depend on cultivating an ability to become aware of contexts with potentially supportive actors.

4.2.3. Appropriation processes in pick-up contexts

One of the critical remarks concerning our results articulated in the discursive validation platform was that different ways of adapting knowledge in pick-up contexts need to be addressed – an opinion that was confirmed by other participants of the platform. However, due to limitations on the scope of our study, we had not intended to carry out detailed analysis of such adaptation processes. Instead, the elements proposed in our model refer to appropriation processes that were perceived as being possible and relevant by the participants of the analyzed projects (perception, translation, modification, adaptation, imitation). The literature on knowledge exchange and utilization provides several conceptions regarding how and to what extent knowledge gets used (e.g. Fazey et al., 2013; Chapman et al., 2017). Discussing knowledge utilization, for example, appropriation processes can be described in wide-ranging ways: from simply perceiving and understanding information, to referring to information and results in other contexts while making efforts to address problems, to using new knowledge for specific purposes, such as decision-making (e.g. Crona and Parker, 2012).

Although transfer can only be predicted, controlled and influenced to a limited extent, actors in originating contexts can strategically address development of transfer potential for their work. Participants from the discursive validation platform confirmed the three central aspects outlined above (provision of results, mediation, appropriation in pick-up contexts), which need to be considered in their interdependence and combination. At bottom, our results suggest that generating transfer potential for other contexts is a complex and comprehensive task.

In the following section, we present three primary recommendations regarding how project teams can work towards shaping TDR processes to increase the transfer potential of their knowledge and results to other contexts. The recommendations formulated here seek to synthesize the suggestions from participants of the project forum, supplemented and confirmed by the members of the discursive validation platform.

4.3. Recommendations for addressing challenges of transfer to other contexts

Our three recommendations for improving TDR transfer to other contexts are built upon the interdependent strategic components of our model. When it comes to generation of transfer potential, there should be a focus beyond the immediate project context, with the aim of identifying potential pick-up contexts and drawing their attention to the project and its results. At the same time, internal dynamics that may foster transfer potential, including actor constellations and tentative results, need to be closely monitored. How and to what extent the following guidelines can be taken up and whether a project should invest more in support of intermediaries or in provision of results needs to be decided at the level of the individual project.

4.3.1. Recommendation 1: process results adequately

As we have seen above, a great variety of project results can be regarded as potential products for transfer. Therefore, they need careful processing. Knowledge can be stored in different forms, which should address the different needs of possible pick-up contexts as well as a variety of likely ways of appropriation. For processing of results, two questions should be considered: What combination of knowledge forms should be transported? and What forms of appropriation should be targeted? Knowledge and results can be provided in formats such as excursions, books, guidelines, workshops or software that allow different forms of appropriation as reflection, imitation, testing or applying solutions. From the perspective of the context of origin, however, results can hardly ever be generated to perfectly fit different contexts. Consequently, transfer cannot be reduced to mere replication of results.

As mentioned above, our study participants agreed on the importance of clearly defining target groups. Those who are involved in appropriation in pick-up contexts should feel that their needs and concerns are being addressed through careful design of transfer results. Definition of target groups as well as quality features for good processing, such as ways of increasing comprehensibility or creating appealing visualizations, have already been addressed and discussed in the literature (Defila and Di Giulio, 2006; Bergmann et al., 2012).

4.3.2. Recommendation 2: identify and support intermediaries

The participants of the project forum agreed that every project participant transfers knowledge – partly subconsciously – to other contexts, in some way. In order to create greater transfer potential, it is

thus important to be able to recognize potential intermediaries and support them in their role. Intermediaries can be project participants or external actors who have the capacity to link contexts together. External intermediaries can be active in a given project environment or work as professional knowledge brokers, who can be defined as "persons who facilitate processes to foster mutual learning among research, policy and practice" (Maag et al., 2018: 1), such as consultants or representatives of associations. Actors from pick-up contexts can also act as intermediaries through collecting and mediating knowledge from other spatial or thematic areas.

Discussions in the project forum revealed that intermediaries can take over a variety of tasks, especially the following: 1) providing general information about a project and promoting its (intermediate) results to potential pick-up contexts; 2) identifying experiences and knowledge from a TDR project that may prove helpful for pick-up contexts; 3) translating knowledge gained in a project into terms appropriate for other contexts, while also advising on, supporting and accompanying its appropriation there; and 4) participating in implementation of processed results in pick-up contexts. The TDR experts in the discursive validation platform emphasized that being an intermediary requires specific competences, such as being able to extract and translate usable knowledge for certain target groups and support effective appropriation in pick-up contexts. In the ideal case, intermediaries have connections to science and practice. To identify promising intermediaries, methods that are used also for other purposes in TDR, such as actor or constellation analysis, can be helpful.

4.3.3. Recommendation 3: identify and address potential pick-up contexts

For the transfer of results beyond immediate project contexts, it is essential to begin identifying and actively addressing possible transfer contexts during the entire duration of a given project and, if possible, beyond its completion. Here, it could be helpful to consider the following aspects:

Problem situation: Where does a similar problem situation exist? Where is a need for problem solving? To what extent are other contexts already sensitized to the societal problem(s) at hand?

Target groups: What are the characteristics of potential target groups? Are there other transdisciplinary projects, researchers or practitioners dealing with similar problems? Are the targeted actors affected by the problem, or are they decision-makers who want to contribute towards solving it?

Possible pick-up contexts: How are possible pick-up contexts structured? In what kinds of framework conditions are they embedded?

For addressing other contexts, a range of activities, with different levels of actor involvement from pick-up contexts, is possible:

1) Communicating interim results or highlighting good practice in public spaces (e.g. at workshops or conferences). All analyzed projects produced, for example, leaflets intended for practitioners and presented their interim results at academic conferences and non-academic public events; Project 2 also published a newsletter twice a year and even announced a public competition to gain interest from potential pick-up contexts.
2) Reflecting jointly with actors from potential pick-up contexts on results and experiences in terms of the similarities and differences between the respective contexts. For example, members of Project 1 reflected on their interim results with actors from another context during a workshop; this exchange resulted in partial transfer of the interim results to the other context.
3) Processing of results for particular contexts in direct dialogue with actors from potential pick-up contexts in order to better enable and more effectively prepare transfer materials. Project 3 organized, for example, a workshop with actors from another megacity in order to discuss its developed transfer concept and the suitability of its results for transfer.
4) Supporting adaptation of knowledge under different appropriation

conditions and processes in pick-up contexts. For instance, Project 2 founded a competence center to accompany and evaluate transfer feasibility and effectiveness to various contexts.

Overall, it is important to note that our three recommendations are interdependent and are not intended to be hierarchized, as there is no single "correct" order for addressing them. For example, intermediaries can help to establish contact with potential pick-up contexts. But they can only transfer knowledge successfully if they have processed results to present, which adequately address the needs of potential pick-up contexts. In order to convey TDR results well, knowledge of similarities and differences between originating contexts and potential pick-up contexts can be of great advantage. To ensure this, information concerning potential pick-up contexts is required, which can be provided by intermediaries who are in contact with various actors in different contexts. This wealth of interconnections shows that effective transfer is a task that requires a comprehensive perspective which can encompass the interplay between a variety of knowledge and results, actors and their different contexts, capacities and needs.

5. Discussion

As we have explained, considering transfer as a comprehensive task as well as taking into consideration our recommendations may increase potential for achieving meaningful societal effects. Yet, it should also be clear by now that transfer can only be partly controlled or steered by the context of origin. The unpredictable characteristics of appropriation processes have also been mentioned in the literature, such as by Davies et al. (2008:190): "Whether and how new information gets assimilated is contingent on local priorities, cultures and systems of meaning". Consequently, appropriation cannot be reduced to mere replication. We agree with Trevithick (2008: 1230) that the "interpretive use of an idea in a new context is in itself a minor act of knowledge creation".

The TDR experts involved in our study emphasized that transfer can and must already be addressed during the project period itself. There was a consensus at the project forum that the creation of transfer potential depends on becoming aware of possibilities beyond a given project's context and to recognize potential windows of opportunity. Sometimes for example, framework conditions, such as legal restrictions or regulations are altered, which can lead to a shift in the general perception of a problem and open up new possibilities for transfer. However, windows of opportunities are unpredictable, and the adaptivity of a project to react to such chances cannot be fully planned in advance (Biggs et al., 2008).

At the same time, projects need to be considered in their wider context with respect to their framework conditions. Every project has its own history and is embedded in a complex field, with various societal actors, discourses, political views and possibilities to act within it. A key result of the empirical analysis of 16 case studies by TransImpact was that framework conditions are of great importance for fostering – or hindering – the potential (societal) effectiveness of TDR (Lux et al., 2019). Our study on *transferability* has confirmed the importance of recognizing and trying to understand the framework conditions of the originating context of a given TDR project. This endeavor helps to get aware of different framework conditions and histories of coping with the problem at hand in possible pick-up contexts. According to the literature, awareness of potential pick-up contexts also means giving careful consideration of their similarities (Adler et al., 2017) as well as evaluating institutional, political and sector-based boundaries (Polk, 2014). However, it should also be noted that looking beyond a given project's context might be difficult to reconcile with the overriding need to concentrate on its specific objectives.

The TDR experts involved in our discursive validation platform emphasized that not every project is able or expected (e.g. by funding organizations) to achieve the same goals with regard to generating transfer potential. As the different scopes of the analyzed projects show,

the ability to design appropriate methods and procedures for transfer depends, amongst other reasons, on the overall goals of a project. Is a project more concerned about understanding a central problem in a specific context (e.g. Projects 1 and 4) or with contributing to problem solution on a wider societal scale (e.g. Projects 2 and 3)? Development of transfer potential might further depend on the nature and scale of a problem: How complex and well known or widespread is the problem? Depending on the answers to such questions, available resources within projects are distributed with different weights for particular project tasks. Projects 2 and 3, for example, provided resources for explicit conceptual work to be done on transfer as well as for concrete activities addressing potential pick-up contexts. Our understanding of the interdependencies between project goals, problem definitions and transfer endeavors could be deepened through further research.

Additionally, the social processes associated with transfer as well as the characteristics of appropriation in pick-up contexts need to be considered in more detail in further research. Since our empirical research was focused exclusively on analysis of originating contexts, our findings on the characteristics of potential pick-up contexts are restricted to this perspective. Further empirical research on interconnections between originating and different pick-up contexts is essential for developing the model further.

In light of TransImpact's empirical study of TDR projects, we can say that several approaches that go beyond the above-outlined linear understanding of transfer have already been applied in practice. Nonetheless, the discussions revealed a great need for practical advice on how to generate transfer potential during a project efficiently. Findings generated from the perspectives of pick-up contexts themselves would be particularly beneficial for this purpose. Moreover, further empirical investigation on the effects of TDR transfer efforts could make a meaningful contribution to the discourse. Currently, project participants rarely have the opportunity or resources to evaluate the effects of their transfer efforts after their projects have been completed. The projects analyzed by TransImpact emphasized the advantages and learning effects gained through retrospective reflection on their own research. At this point, we would like to highlight parallels between the discourse on transfer and the discourse on fostering societal effects in TDR. Similar to other societal effects, successful transfer cannot easily be traced back to the concrete efforts made towards building a project's transfer potential, as such effects are considered to emerge from complex and non-linear communication processes, which are influenced by further actors, situational factors or further intermediate steps (e.g. Walter et al., 2007; Kaufmann-Hayoz et al., 2016; Krainer and Winiwarter, 2016; Maag et al., 2018; Lux et al., 2019).

The discourse on how transfer to other contexts can be fostered could benefit from familiarization with studies on the societal effects of research as well as from a wide range of related discourses in different areas and disciplines which highlight social, dialogical and interpretative means of knowledge exchange (e.g. Fazey et al., 2013) and the complexity of research use (e.g. Davies et al., 2008). In this vein,

Hoffmann et al. (in this issue) refer to the social and relational nature of knowledge utilization being beneficial for rethinking approaches to bridging the knowledge–action gap in TDR. These and other related concepts could help us to better understand what happens in contexts that are picking up knowledge or results from originating contexts.

6. Conclusions

As we have argued here, transfer of transdisciplinary research (TDR) results is difficult to trace back and can only be controlled to a limited extent beforehand by transdisciplinary projects. One can nevertheless approach transfer potential systematically and strategically. Based on our empirical results, we have developed a model that considers the processing of results, mediation and interaction with other contexts, and appropriation in pick-up contexts to be three interdependent aspects of transfer. From a practical TDR project perspective, developing transfer potential usually requires more than merely developing and packaging generalized knowledge. We propose that conscious reflection upon three central components of the transfer process – processing results adequately, supporting intermediaries and interacting with pick-up contexts supporting appropriation there – is important for actors involved in TDR projects seeking to create greater transfer potential. Moreover, our results suggest that conceptualizing transfer should be done in a comprehensive rather than piecemeal manner addressing only one of the three recommendation. The societal and historical embeddedness of all potential actors involved define the general conditions shaping the possibilities and limitations of transfer for a given TDR project. Thus, we conclude that careful planning and consideration of the different possibilities and needs of a given project are necessary for providing appropriate transfer strategies and fostering receptivity for TDR results. Since the conceptual approach presented here has an explorative character, more comprehensive research, especially on appropriation processes in pick-up contexts, is necessary.

Declaration of Competing Interest

The authors declare that they have no known competing financial interests or personal relationships that could have appeared to influence the work reported in this paper.

Appendix A. Overview of TransImpact's empirical approach

The research project "TransImpact – Effective Transdisciplinary Research" investigates whether the application of certain practices or methods in transdisciplinary projects is able to foster societal (and scientific) effects. With this research question, TransImpact aims to broaden the empirical basis for understanding how effects evolve in TDR. Furthermore, its empirical approach is dialogue oriented: presentation and discussion of preliminary results with TD experts not only improved the results of TransImpact via validation but also supported community building among scientists, stakeholders and funding institutions.

The first step in TransImpact was to select suitable case studies for the analysis. Sixteen finalized transdisciplinary projects were selected as case studies out of a database of about 75 projects collected via a snowball system in the German-speaking TDR community (Germany, Austria, Switzerland) from February to June 2016 and complemented by the database of the MONA-project (see Newig et al. in this issue). The TransImpact database collected projects that fulfil the following criteria:

- conducted in a transdisciplinary research mode (self-statement),
- preferably completed between 2010 and 2016 to allow reflection on the effects (exceptions were possible)
- main partners of the project (esp. project coordinators and particular practice partners) willing to cooperate with TransImpact

Table A1
Clustered overview of case studies selected for TransImpact.

No	Lead Partner	Topic	Funding Scheme	Approx. duration
Cluster problem definition: The description of the everyday life problems to be addressed (joint problem framing) shall impact positively on the potential for societal effectiveness generated via TDR. Research questions: which parameters have to be considered and which methodological options exist to foster potential for societal effectiveness already during the phase of problem description and project planning?				
I	Non-university research institution	Land management and regional economies	National research ministry	3 years (plus follow-up project)
II	Non-university research institution	Material optimization and recycling	EU research framework programme	3.5 years
III	University	Local supply in rural areas	European Regional Development Fund	4 years (incl. 1 year pre-phase)
IV	Non-university research institution	Water supply & consumption	Contract work (industry)	2 years
Cluster participation: Participation of actors from business, civil society, and politics offers the possibility to comprehend the problem under review in its full scope and complexity. Participation shall be a key factor for societally relevant TDR and a successful implementation of its findings. Research question: with which methodological design can participative processes strengthen effects of TDR?				
V	Non-university research institution	Climate adaptation (various fields)	National research ministry	5 years (plus follow-up projects with some of the initial partners)
VI	University, but interdisciplinary faculty	Hospital management	National research ministry	6 years funded, 3 further years with self-funding in the beginning and the end
VII	Non-university research institution	Education for sustainable development	National research ministry	2 years
VIII	Non-university research institution	Climate mitigation (consumption)	National research ministry	3 years
Cluster knowledge integration: In order to solve complex societal problems, the knowledge of various scientific disciplines has to be collated and linked with knowledge and experiences from everyday life. Successful knowledge integration shall be important for the effectiveness of TD research. Research question: How can knowledge integration be carried out methodologically that findings from research will be effective?				
IX	University	Nature protection	National environmental ministry	5,5 years (incl pre-phase)
X	University	Water management for water supply	National research ministry	4 years
XI	University	Climate adaptation (water management)	National research ministry	3,5 years (incl pre-phase)
XII	Non-university research institution	Energy transition	Regional environmental ministry	1 year
Cluster transferability: It was supposed that TDR can be particularly effective if it generates findings that are relevant beyond the individual case under review and can be adapted in other spatial or thematic areas. Research question: How can transferability be anchored within the research process?				
XIII	University, but interdisciplinary institute	Disaster protection	National research ministry	3 years
XIV	University	Public health	Miscellaneous	Series of follow-up projects from 2005 onwards
XV	University	Urban agriculture	National research ministry	3 + 5 years
XVI	Non-university research institution	Urban-rural land use conflicts	Subnational environmental ministry	3 years

The sample of case studies was selected with the aim of gaining a broad diversity of topics in sustainability research and neighboring fields, funding institutions (e.g. public/private, EU/national/regional), lead partners (university, non-university), and research formats and methods. For our analysis, the 16 case studies were grouped into four thematic clusters (problem definition, participation, knowledge integration, and transferability).

The grouping was based on publicly available project information and a first introductory interview with the respective coordinator. Criteria for assigning a case study to one of the thematic clusters were:

- the topic of the cluster was explicitly addressed in the case study (or difficulties with addressing it were stated),
- sufficient project documentation was expected as a sound basis for the case study analysis and fruitful discussions during analysis,
- coordinators showed interest in the cluster topic.

The thematic cluster topics are four central characteristics of transdisciplinary research (cf. Section 1.1 in Lux et al., in this issue.) (Table A1).

A multi-step approach to analyze these selected projects as case studies was conducted consecutively from June 2016 to September 2018 in each thematic cluster. The average time spent on dealing with the topic clusters was 10 months, so the topic areas were partly processed parallel to each other.

1) *Case study approach*: For each case study, an explorative analysis was carried out based on a review of project-specific documents (proposal, final report, major publications), a telephone interview with the coordinators and support questionnaires based on the understanding of societal effects of TDR (cf. Section 1.2. in Lux et al., in this issue) and on the preliminary conceptual assumptions regarding the cluster topics. The following guideline with main categories was used in the analysis:

(a) the specific parameters of these cases,
(b) applied methods and procedures, in particular with respect to the cluster topic,
(c) results and products (academic and non-academic publications, products beyond publications, networking, presentations etc.), and
(d) any positive intended and unintended effects plus any negative unintended effects.

The coordinators received a more comprehensive questionnaire containing questions related to (a)–(d). Additionally, other scientific partners and the practitioners who agreed to participate in step 2 (see below) received a short questionnaire focusing on

- motivation to participate in the analyzed project,
- duration of participation in the analyzed project,
- role regarding the project aim and in particular the TransImpact cluster topic,
- perceived effects of the analyzed project in the respective individual and professional environment,
- assessment of the project results and effects in terms of individual expectations.

The insights gained from this analytical step were summarized in a case description that included a tentative assessment of effects (based on the heuristic in Section 1.2 of the main text), indications of specific methods applied and relevant context factors that may foster or hinder societal effects.

The TransImpact team summarized preliminary conclusions across the four case studies in four steps: (i) co-writing and a one-day working-group discussion within the core analysis team, where the case studies were compared for similarities and differences, and preliminary assumptions regarding the link between methods and procedures used and the effects achieved were formulated for each thematic cluster; (ii)

reflection on the case descriptions in the whole team, in group discussions and by commenting on texts; (iii) insights structured and visualized in terms of relating methods and procedures to effects as well as recognized significance of the respective cluster topic in the project design; 4) conception of the thematic *project forum* (step 2, see below) in the whole team, by discussing the methods and commenting the working material (structured and visualized results of analysis) and presentations of the preliminary conceptual understanding of the cluster topic as well as of the conclusions based on the case study approach.

2) *Project forum for in-depth discussion with participants of the case-study projects*: In each cluster, 2–5 science and practice participants from each case study met in a project forum with the TransImpact team in order to comment on and enrich the analysis with undocumented but relevant experiences. Moderated discussions were carried out in three steps:

- Reflection on the preliminary conceptual understanding of the cluster topic to obtain a common understanding (plenary),
- Reflection on and enrichment of the analysis results regarding methods and procedures used and the effects achieved for each project (group discussions),
- Discussion of conclusions based on the case study approach regarding the link between methods applied and effects achieved related to the cluster topic (plenary and group discussions).

Discussion and reflection were motivated by different methodological elements, for example in the form of visualizations to provoke hypotheses, small group discussions, etc. The aim was to reveal similarities between the case-study projects and consensus among their participants, along with contradictory experiences. The discussions were documented via notes on flip charts and detailed minutes. Additionally, first conclusions regarding appropriate procedures and methods for future TDR were jointly drawn. Thus, the backward-looking focus of steps 1 and 2 was translated into a forward-looking discourse during these project forums.

After the project forum, the TransImpact-team worked out preliminary generalizations by identifying key issues for the cluster topics in five steps:

- Group discussion on the central findings within the entire team immediately after the event,
- Analysis of the documented empirical material by the core analysis team: categories were developed and related; conceptual preconception was reframed
- Key issues identified in the analysis were iteratively compared with the first findings directly after the forum;
- Discussion and reflection of the reprocessed key issues within the whole team
- Reflection on the key issues, finalization of the conceptual framing for the validation platform (see below) by commenting and discussion on preparatory texts within the whole team.

3) *Discursive validation:* In a third step, the insights and conclusions gained at the project forums were presented to further TD experts for discursive validation. At the beginning of the project, a data base with about 200 experts from German-speaking countries was established. The database mostly contained scientific experts who had long-term experiences with TDR and had published articles on methodological questions (at least in one of the cluster topics). Representatives from funding bodies who support TDR and practitioners with their wealth of experience in TD projects were also part of the database. For each validation platform, a group of TD experts was selected for their specific expertise in the topic of the cluster. A number of 25–35 experts participated at each validation platform, depending on interest and time availability. While some of the experts attended almost every platform, others participated only at one event.

The main idea was to get feedback to the preliminary results from experienced TD researchers to balance the limited data set of 16 case studies analyzed in TransImpact, and to broaden the expertise about conceptual and theoretical underpinnings of TD. The preliminary results were sent in advance to two experts, who commented critically on them at the event. Their critical remarks formed the introduction to the first discussion on the results. During the validation platform, participants were invited to give their critical appraisal of the results. Approval, consent and dissent were documented and incorporated into our reflective and iterative preparation of the results after the event (see Step 4).

During the validation platform, further discussion was taking place in the plenum focusing on the theoretical framework and central findings, and in smaller groups (world cafés) focusing on major fields in which a future project team can engage in the adaptive shaping of one important aspect of TDR processes related to the respective cluster topic. Within the focus groups, the moderation aimed to achieve consensus on central requirements and recommendations for carrying out effective TDR. Opposing opinions were also documented. Documentation took place via notes on flip charts which were visible to all participants, and in detailed minutes.

The empirical material from the validation platform was analyzed in detail. Preliminary results from the project forums were supplemented or revised based on the comments of the validation platform in seven steps:

- Group discussion on the central findings within the entire team immediately after the event,
- Analysis of the documentation material and reflection on existing literature regarding the cluster topic by the core analysis team: categories were verified, re-related and enriched with new insights, generalizations redefined;
- One-day working group discussion on key issues that arose during analysis of the discursive validation event; iterative comparison with the first findings directly after the project forum,
- Working up of a first draft for redefinition of the results by co-writing within the core analysis team,
- Discussion and reflection on the first draft within the whole team,
- Rewriting and proceeding for publication on the online platform www.td-academy.org and for scientific publication
- Quality control and finalization of the online version of the main results and recommendations with corresponding methods.

4) *Documentation and publication*: The overall results for each cluster, cluster-specific requirements for how to support potential for (societal) effectiveness, and a collection of methods and procedures addressing these requirements were documented on the online platform www.td-academy.org (so far only in German). After completing the four thematic clusters, the TransImpact team applied a cross-cutting perspective and summarized the relevant framework conditions. Furthermore, recommendations on how to support potential for (societal) effectiveness with certain methods and procedures were reorganized into fields relevant for facilitating adaptive shaping of TDR processes.

Appendix B. Visualization based on project analysis of project structures regarding dealing with transfer to other contexts. Original working material (prepared only in German) for respective group discussions at the project forum

Project 1

Project 2

Project 3

Project 4
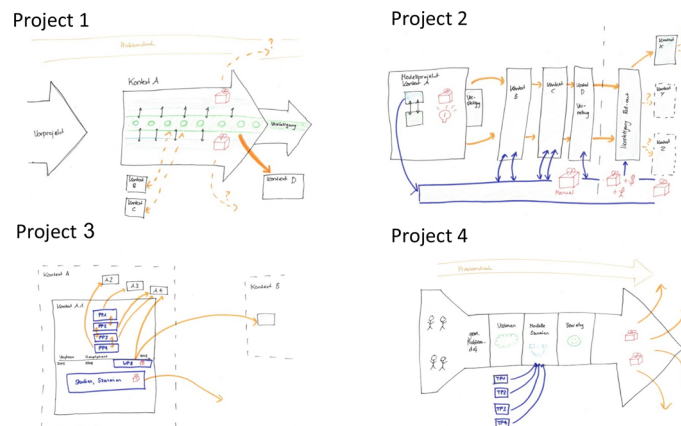
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