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Transdisciplinary Sustainability Research in Practice: Between imaginaries of collective experimentation and entrenched academic value orders

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Transdisciplinary Sustainability Research in Practice

Between imaginaries of collective experimentation and entrenched academic value orders

Felt, Ulrike, Igelsböck, Judith, Schikowitz, Andrea, Völker, Thomas

> *"More inter- and trans-disciplinary research should nurture greater innovation and creativity, and make it more likely that research and innovation are directly targeted at solving societal challenges. This option can also lead to 'second order impacts' such as increasing trust in research and innovation and changing mind-sets."*
>
> (van den Hoven et al. 2013, 6)

Over the past decades, we have witnessed an increase in debates concerning the limited capacity of contemporary research to address complex societal challenges. In particular, in health- and environment-related areas, the constraints of knowledge production organized along disciplinary structures and their accompanying value systems and institutional logics have been emphasized (e.g., Funtowics and Ravetz 1993). The debates have led to calls for more cross-disciplinary engagement and the inclusion of societal actors and their knowledge and experience in diverse stages of research (e.g., Callon, Lascoumes, and Barthe 2001, Epstein 1996, van den Hoven et al. 2013). This move was motivated by the following three interrelated concerns: a *democratic concern* regarding who has the right to participate in defining problems and developing solutions; an *epistemic concern* regarding obtaining the adequate blend of knowledge and experience to identify and address the complex societal problems at hand; and a *legitimacy concern* regarding strengthening the credibility of science-driven solutions in the public domain through the integration of civic actors. As a consequence, some national and supra-national agents, such as the European Commission,[1] have established specific funding schemes to encourage the integration of extra-scientific actors into knowledge production cycles to assure more widely distributed and socially responsive (and potentially more responsible) forms of innovation.

Although a broad body of literature addresses new forms of knowledge production on a more general level, little is known about what this means in terms of concrete research practices in academic environments. This paper addresses this gap by providing an in-depth examination of an Austrian funding scheme for transdisciplinary

[1] Since the late 1990s, many NGOs in the environmental arena have been active in conducting and participating in research projects. Accessed April 20, 2015. http://ec.europa.eu/environment/ngos/index_en.htm

sustainability research, called proVISION, and its translation into projects and research practices. "Making knowledge available for solving the most urgent problems in provision for nature and society",[2] this funding scheme aimed to support research on "the adaptation to climate change and its consequences, suitable life and work models, responsible use of natural and industrial resources, and environmental protection." Transdisciplinarity should be "the guiding research principle"; in other words, "scientific work is carried out with non-scientific partners also involved in generating knowledge by contributing their way of approaching problems, expertise and experience to research" (ibid.). Investigating both the research program as well as the funded projects will allow us to address the broader imaginaries and values embedded in this approach to knowledge generation and to reflect on the translation process from an ideal to research practice.

We will begin by outlining our conceptual framing, revisit debates concerning new ways of knowledge production and reflect on how place may matter in research, particularly when engaging with societal actors. After presenting the data and methods, we will proceed with our analysis in two steps. The first step will focus on the funding scheme and the logic and values inscribed in it. The second step will investigate the different imaginaries of science-society relationships that are performed by the research participants and reflect on how they frame the potential knowledge relations performed in the projects. In the following discussion and conclusion, we will reflect the possibilities and limits of such a transdisciplinary approach to solving complex socio-scientific problems.

The Funding Scheme as a Technology of Entanglement

Because the funding scheme joins different actor groups and their respective social worlds in the framework of each project, we propose to conceptualize and analyze it as a 'technology of entanglement'. Different ways of knowing and being in the world should be 'admitted' to the realm of research to develop new types of problem framings, to perform a more integrated analysis and, finally, to reach more context-sensitive solutions to urgent socio-scientific problems. We thus observe efforts to rethink innovation by establishing an environment that supports more user-induced or community-based forms of innovation (Von Hippel 2005), which do "not derive from promoting a particular technological promise, but from goals constructed around matters of concerns and that may be achieved at the collective level" (Felt et al. 2007, 26-27). These forms of innovation also referred to as "collective experimentation" (Felt et al. 2007) link closely with more recent calls in the European policy arena for *responsible research and innovation* – which is captured in slogans such as "Design science for and with society"[3] – and *social innovation* (e.g., BEPA 2011), both imagined as better means of producing knowledge that matches societal needs.

Drawing on Akrich's (1992) approach to studying technologies, we carefully examine the 'script' embedded in a particular funding scheme – proVISION – as it defines

[2] proVISION Mission Statement. Accessed April 16, 2013. http://www.provision-research.at

[3] See e.g., EC policy document 'Responsible Research and Innovation. Accessed April 16, 2015. http://ec.europa.eu/research/science-society/document_library/pdf_06/responsible-research-and-innovation-leaflet_en.pdf

the "framework of action together with the actors and the space in which [they are] supposed to act" (Akrich 1992, 208). This also calls our attention to the fact that the 'users' – i.e., researchers and diverse societal actors – when engaging with the funding scheme may de-scribe it in particular ways, attempting to redefine or partly even reject the script. This work of redefining the script, as Akrich reminds us, should not be interpreted as a lack of understanding of the 'designer's' intention, but much rather as an expression of the proponent's specific cultural and institutional framing of the research and, more broadly, of science-society relationships. To obtain a more profound understanding of the issues at stake in transdisciplinary research, we therefore must analyze both the 'design' of transdisciplinary research programs (by the responsible ministry and other policy agents) and the 'users' (the researchers and societal actors) who participate in transdisciplinary projects.

In conducting this analysis, we aim to show how, why, where and when the entanglement of societal and scientific actors and their respective social worlds occurs or how, why, where and when gestures of purification are made, i.e., efforts to redraw the boundaries between scientific and societal realms. By investigating these moments and practices of (dis-)entanglement in transdisciplinary sustainability research, we will gain a greater understanding of the challenges of this type of research and identify what is needed – beyond any funding scheme – for this approach to knowledge generation to be successfully practiced.

The Emergence of a New Knowledge Regime?

The emergence of programs such as proVISION is closely linked with the diagnosis that the cultures, practices and contexts in which contemporary research is conducted are undergoing significant changes. Referring to the image of a 'triple helix' (Etzkowitz and Leydesdorff 2000), analysts have been studying the progressive intertwining of academia, industry and the state and how knowledge infrastructures overlap and co-evolve, allowing new hybrid organizations to emerge at the interfaces. Other analysts – using the label of 'post-normal science' – have stressed the need for extended forms of knowledge production at moments when "facts are uncertain, values in dispute, stakes high and decisions urgent" (Funtowics and Ravetz 1993, 744). Here, the basic assumption of specialized knowledge production through the division of large problems into smaller, more easily manageable units is particularly challenged. Yet other authors – coining the notion of 'mode 2 science' (Gibbons et al. 1994) – have underlined the transformation of the relationship between science and society, with knowledge being increasingly produced and validated in contexts that are shaped by extra-scientific rationales and involve scientific and societal actors. The potential of what is labeled 'transdisciplinary knowledge production' is emphasized as making research more reflexive and 'socially distributed'. Societal values would be allowed to enter research, the aim being "joint problem solving that it is more than juxtaposition; more than laying one discipline along side another" (Nowotny 2007). Finally, more recent approaches that can be subsumed under the label of "responsible research and innovation" have called for "embedding deliberation on [aspects of societal concern and interest] within the innovation process." "[A]nticipation, reflexivity, inclusion and responsiveness" are identified as essential key-dimensions of any responsible knowledge production process and together form an ideal framework for raising, ana-

lyzing and responding to issues related to contemporary societal challenges (Stilgoe, Owen, and Macnaghten 2013, 1569).

However, although there is wide agreement on the general idea of opening research to society, several aspects of the abovementioned analyses have been questioned, and the debate continues. Critical voices emphasize that it remains unclear whether some aspects of the analysis should be understood as descriptive or prescriptive; they challenge the alleged rise of transdisciplinarity, reflexivity and the novel modes of quality control (for an overview, see Hessels and van Lente 2008, 758). Moreover, these voices stress the apparent lack of detailed empirical studies that examine the micro level of research practices and cultures and the differences between scientific fields and national contexts (ibid.). The few studies that engaged with the concrete practices of boundary-crossing research, however, were not conclusive regarding the degree to which these ideal(ized) imaginaries of transgressive research could be realized. Some of these studies even indicated severe difficulties. For example, in a study on an interdisciplinary training program for graduate students in the US, Hackett und Rhoten (2009) highlight that the program's explicit objective to "catalyze a cultural change in graduate education" and "produce creative agents for change" was hardly manifest in practice, which was viewed as mainly moving "within the paradigm of normal science" and "traditional academia" (ibid., 426). Finally, we need to consider that simultaneously with the introduction of the concept of more open and collective innovation also new public management ideals and tools have started to increasingly govern contemporary academic institutions. The result is "that quantitative measures of performance and benchmarking are diffusing rapidly and are having important structuring effects" (Lamont 2012: 202), potentially creating essential tensions between these two registers of expectations.

These and related findings indicate that to reach a more profound understanding of the complex dynamics at work concerning these new forms of knowledge production, careful investigation of the concrete intertwinements of imaginations, expectations, structures (institutions, programs, careers, etc.), people and values is needed. Thus, it will not suffice to simply understand transdisciplinary knowledge production as more context-driven, open, and inclusive. Rather, it must be conceptualized as a new type of 'transdisciplinary knowledge regime' (Felt et al. 2013) and analyzed accordingly. The notion of regime draws analysts' attention to the heterogeneous assemblages of the following: (1) ideologies and guiding myths – in our case, those of transdisciplinarity and sustainability – and the accompanying prescriptions for producing and validating knowledge; (2) institutions and their 'institutional logics', i.e., shared beliefs and practices (such as assessment schemes in academia); and (3) people – researchers, extra-scientific research partners and the actors who govern the research. However, regimes are always contested, both from the outside and from within and this should thus be understood as part and parcel of any new knowledge regime. By joining these different perspectives, we are able to gain a greater understanding of the intertwinements of the heterogeneous elements that are relevant to knowledge generation from the programmatic, over the institutional, to the social and value-related elements.

How Place Matters

Much of the writing on the changing approaches to knowledge production remains rather 'universalistic' in its statements regarding change. Insufficient attention is given to the importance of concrete 'localities' where knowledge is produced and distributed. Arguably, this particularly holds for sustainability issues, where matters of concern often take form through value structures deeply entangled with local self-understandings. Places always express the (power) relations of people inhabiting them; they are open to some while difficult to access for others; they allow for engagement, but also for distancing; they spawn or refrain specific kinds of collective action (Gieryn 2000; Felt et al. 2012). In this article, place also refers to a broader technopolitical culture (Felt, Fochler, and Winkler 2010), i.e., to historically entrenched ways in which technoscientific and societal developments are understood as being related to one another. Thus, shared, culturally rooted experiences with issues related to technoscience, sense-making narratives, experiences and recognized processes of non-expert participation as well as routine ways of assessing and handling knowledge claims – what Jasanoff (2005) calls "civic epistemologies"– must be addressed. In acknowledging place, we must also develop greater sensitivity to objects and scientific knowledge as carriers and expressions of certain cultural arrangements, values and power constellations. Thus, in our analysis, we must consider 'culture' in a double sense, namely, as a locally contingent way of framing sustainability as the broader issue at hand (which is evidently always related to more global performances of sustainability issues) and as a specific way of performing what we call 'knowledge relations'. 'Knowledge relations' refer both (1) to how relationships between actors are defined through the exchange of knowledge and (2) to different types of knowledge and how they are positioned towards one another.

The consideration of place also invites us to engage with Jasanoff's concept of 'sociotechnical imaginaries', which are defined as "imagined forms of social life and social order reflected in the design and fulfillment of scientific and/or technological projects" (Jasanoff and Kim 2009, 120). While capturing attainable futures, these imaginaries normatively prescribe the types of futures that should be attained; in our case study, being Austrian and conceptualizing and performing sustainability are mutually constitutive (Felt 2015). More concretely, these broader imaginaries frame what is viewed as "doable problems" (Fujimura 1987) and what types of solutions are developed.

Materials and Methods

This paper uses the data that were collected in the course of the research project 'Transdisciplinarity as Culture and Practice', which aims to develop an empirically grounded understanding of transdisciplinary modes of knowledge production, i.e., how the increasing demands of addressing societal problems and integrating heterogeneous actors into research plays out in practice. Explicitly encouraging transdisciplinary knowledge production in the field of sustainability research, the funding program proVISION –– which is run by the Austrian Federal Ministry for Science and Research –– provides the empirical basis for our analysis.

This paper builds on two major bodies of material. First, we investigated program documents (e.g., the homepage, calls for proposals, program presentations at diverse events), an interview and further conversations we had with the program managers, and the related policy papers concerning sustainable development. Second, we looked into materials related to 11 major projects that were funded by the program: semi-structured interviews with 30 project leaders and collaborators (senior researchers, early stage researchers and extra-scientific actors –– called Praxispartners in the program language –– from public administration, NGOs, the education sector, etc.), field notes from our participation in nine project meetings, project proposals and the diverse 'output' produced by the projects (websites, promotional materials, publications, project reports, presentations, etc.).

We collectively analyzed these different types of materials using a grounded theory approach, i.e., we coded the material and did a lot of memo writing (e.g., Strauss and Corbin 1998). But we also engaged with more recent methodological developments in form of Situational Analysis (Clarke 2005), which proved especially useful for mapping and understanding different types of relationships among heterogeneous actors.

Findings: (Dis-)Entanglement Imagined and Practiced

The Funding Scheme's Script

Investigating the funding scheme proVISION as a 'transdisciplinary knowledge regime' in the field of sustainability research in Austria, the following sections will examine (1) the institutional logics at work, (2) the guiding ideologies and myths and (3) the actors who are (expected to be) involved.

proVISION is meant to support projects investigating "the impact of climate change on ecosystems, regional development and quality of life" [4] and is one of two complementary funding schemes that are designed to implement Austria's sustainability strategy. The other funding scheme mainly focuses on technological innovations and is mainly run by the Federal Ministry for Transport, Innovation and Technology. Following this institutional logic, proVISION distinguishes itself from a 'merely' technological approach to sustainability by promoting social innovations and the inclusion of societal actors in the innovation process while simultaneously emphasizing that sound scientific knowledge should be the basis of its contribution to the overall sustainability strategy.

The program explicitly refers to international sustainability narratives and claims that a change in sustainable development is needed –– conceptualized as coordinated co-action of all relevant actors –– to counteract a global crisis that threatens all people. At the same time, the crisis identified on the global scale is imagined as not yet having

[4] provision was located initially at http://www.provision-research.at (Accessed April 16, 2013); with the renaming of the respective Ministry and a discontinuation of the program it has now been shifted in a strongly abbreviated version to http://wissenschaft.bmwfw.gv.at/bmwfw/forschung/national/programme-schwerpunkte/provision/ (May 12, 2015).

fully arrived in Austria. For example, a representative of the program made the following statement at a public event:

> *"Climate change, shortage of water resources, the oil catastrophe of Mexico, Fukushima, these are all examples, that all of us –– or most of us –– hopefully only know from the media. They show however that economic systems based on fossil energy, as we have them, endanger the base of life –– more specifically of our future generations."*

Statements such as this create awareness of a crisis 'out there' and the need for anticipatory action, while at the same time, constructing Austria as a place still advantaged compared to 'the others' in terms of consequences of non-sustainable behavior.

The visions of global problems are thus adapted to Austria's national identity, which is characterized by, among others, cherishing the ideal of living in an extraordinarily 'green' or 'natural' environment. This ideal is also performed through the program's visual discourse (Knorr Cetina 2001) in public relations materials, frequently showing idyllic images of Austrian landscapes (see some examples in Image 1). Although the global crisis is constructed as a potential future for Austria that must be prevented, there is also a pervasive belief that the moral economy that is at work in Austria will allow for adequate responses. The idea of being able to create a delimited Austrian space in a global world where certain developments can be kept out (Felt 2015) is palpable through both the program's discourse and the ways in which researchers and societal actors address issues at stake. Furthermore, in the program and above all in doings and sayings of researchers and Praxispartners, we find clear traces of a wider Austrian technopolitical culture (Felt, Fochler, and Winkler 2010) that cherishes a strong hierarchy between technical expertise and lay expertise.

Image 1: Examples of pictorial material used on the program's homepage

Indeed, guiding myths and ideologies, which comprise both cultural and epistemic components, play a crucial role in the effort of establishing a transdisciplinary knowledge regime. They become manifest in the nine guiding "research principles" that detail the requirements for projects to obtain funding. These principles not only capture the specific values and norms of this type of research but allow to position it

as "alternative to" yet not "in opposition to conventional science". Explicitly, proVISION is conceptualized as "a programme in another science mode, science mode 2, that has proved necessary as life today becomes more complex."[5] However, ambivalence and some tensions are palpable throughout the program. First, while normatively targeting a quite radical change in research culture, fears are expressed that this may come at the price of losing credibility and legitimacy in contemporary research systems. The program thus does not challenge the central stewardship of science in the provision of solutions; rather, it promotes a science that is more sensitive to complex societal problems.

Second, tensions are also visible through the simultaneous call for the international orientation of research and the care that should be given to "the local". On the one hand, the program refers to international strategies and agreements that promote sustainable development, to research programs in other countries and to international academic debates concerning new modes of knowledge production. The statement "research for sustainable development needs internationalization" (ibid.) captures this move. On the other hand, the importance of locality is emphasized, with the strong claim that "research projects that focus on the provision for nature and society and that aim for practical implementation must be localized" (ibid.). In particular, collaboration across scientific borders should take place with local actors to find adequate solutions.

Third, while stressing a commitment to embrace a broader set of knowledge and expertise –– thus, to follow the idea of transdisciplinarity –– distinctions between science and society are drawn in describing the goals and desirable outcomes of research. The strong appeal to care for extra-scientific rationales for the achievement of the "common good" through "improve[ing] living and environmental conditions" is situated next to assessment rationales that call for "maximizing efficiency" and to contribute to "a Europe capable of competing" (ibid.). This combination is referred to as a 'double dividend' (ibid.). Similar co-presences of seemingly opposing ideals can be found in other parts of the texts, i.e., the call for more democratization and opening-up coexists with the call for the production of highly specialized, countable and accountable 'products', such as internationally peer-reviewed publications in ranked journals.

Finally, an additional set of principles that addresses societal involvement views citizens as important knowledge agents –– captured in slogans such as "Sustainability needs citizens" (ibid.). At the same time, these citizens are described in other places as in need of adequate information before they can "participate in decisions concerning science and research policy" (ibid.). Thus, we observe tensions between a framing that is inspired by the enlightenment ideal that attributes the dominant role in guiding societal choices to science and a framing that is inspired by a deep commitment to engage with societal actors as knowledge agents.

This leads us to the third element in the "transdisciplinary knowledge regime", namely, the prescribed groups of actors, their relationships and their potential types of agencies. The scientific actors and Praxispartners are the two significant actor categories that are expected to collaborate in any project. However, their roles remain quite distinct. The scientific actors are considered key agents in knowledge generation, and

[5] proVISION Accessed April 16, 2013. http://www.provision-research.at

the funding rules identify them as the only eligible project leaders; thus, they also control the funding. The Praxispartners are framed as the beneficiaries of the knowledge that is produced. Although partly admitted as partners, in some cases, the Praxispartners are requested to 'prove' their commitment to the issue at hand by further financially investing in the project.

In this way, a clear boundary between science and society is redrawn, while privileged moments of boundary transgression remain possible. Scientific actors are supposed to step "into the realms of social practice", as the web page states, and "invite" extra-scientific actors to temporarily cross the border to "contribut[e] their way of approaching problems, expertise and experience to research" (ibid.). Thus, scientists are conceptualized as the ones integrating different kinds of knowledge and consequently producing new knowledge better aligned to societal value orders. Scientists are, then, expected to communicate their knowledge in a manner that empowers societal actors to make informed choices. Praxispartners, while being perceived as holding specific and well-delimited knowledge/experience and as in need of scientific knowledge, they are not considered to have the capacity to independently produce complex sets of new and 'objective' knowledge. This is also reflected in the fact that no funding is foreseen for Praxispartners.

De-scribing the Program – Practicing Transdisciplinarity

Having shown some of the ambivalences and tensions inherent in the program, we now will explore how research is practiced in the proVISION projects. Concretely, we will investigate the relationships between scientific and societal actors in the processes of producing knowledge. Which knowledge relationships can be reasonably performed within such projects by different actors is nourished by wider often tacit 'science-society models', i.e., by the ways in which societal and scientific arenas become entangled in issue-specific ways (Marres 2007). Analyzing these 'models' allows us (1) to understand how participants interpret the script of the funding scheme and transform it into something that makes sense to them; and (2) to reflect on roles available for different actors and their respective 'room to manoeuver'.

Three prevalent ways in which science-society interactions are imagined and practiced by the project participants emerged from our analysis. They are identified as a result of an investigation of the project's design and the different narratives provided by the project participants. These ways are described as clearly separated ideal-type 'models' merely for analytical purposes. These 'models' allow us to elaborate on the dominant ideas concerning how science and society should be entangled or remain separate in the projects. However, they are enacted in a situated manner, i.e., projects or participants may refer to different models in different situations. This indicates the multiple ways in which researchers and societal actors de-scribe the program's script and inhabit the research space that the script opened.

(1) The Linear Translation Model (Fig. 1.): In the first model, scientific and societal arenas are conceptualized as largely separated and situated at two ends of a spectrum of 'knowledge arenas', ranging from the production of knowledge to the consumption/application of knowledge. In this model, the researchers a powerful actors in

shaping what is to be regarded as a societal problem. Knowledge is produced on the science end of the spectrum and then is translated to society. This happens either directly or in a multi-step process in which communication specialists or knowledge brokers (Meyer 2010) translate scientific knowledge into specific contexts of application. The model thus builds on two widespread linear models: one in science communication which identifies the transfer of information from experts to non-experts as the key-problem (Wynne 1991); the other in innovation studies, which assumes a linear translation chain from basic research to applied innovations (Godin 2006). Societal actors are not understood as knowledge agents; rather, they are viewed as in need of scientific explanations/information.

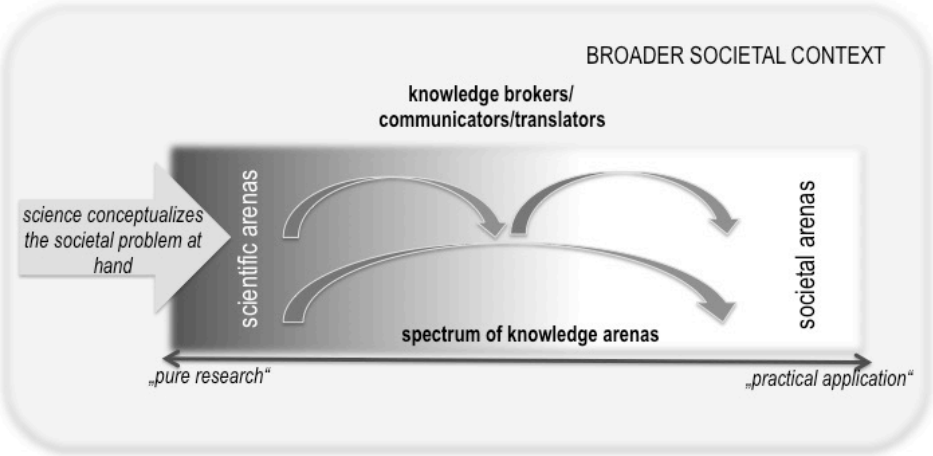

Figure 1: The Linear Translation Model (Model 1)

We find traces of this perspective in frequent performances of 'information events' for specific segments of 'the public' and narratives concerning the need to 'simplify' the results for users. As one of our interviewees indicated,

> *I think, the biggest problem was to make them understand that this is somehow related to that and that this is related to that. […] that was rather the difficulty; [….] this is a relatively complex system that needs to be represented in an understandable manner. (Researcher_Int17)*

This statement indicates that one set of actors knows how things *are*, whereas the other actors must understand the appropriate simplifications.

How are societal actors imagined and integrated into research that is predominantly organized with this model? Societal concerns/problems are often considered to be pre-existing and out-there, such as for example the existence of specific unhealthy nutrition styles or a set of specific local consequences of climate change. These pre-existing problems are then used as the 'factual starting point' for research. However, we also find cases in which the objective is to question widely shared and culturally entrenched assumptions, such as, for example, Austria's self-image as having predominantly "green agriculture". Again, other projects begin from commissioned work, with both researchers and extra-scientific partners agreeing to their specific roles as

knowledge producers and knowledge consumers. In this commissioned work, although the societal problem is initially formulated by societal actors, it then appropriated by scientists and transformed into a scientific problem to be processed without further external intervention. In short, extra-scientific participants are predominantly viewed as users of scientific solutions (e.g., Callon 1986), whereas scientists' authority in epistemic issues remains unquestioned.

To nevertheless achieve the program's demand of integrating societal actors, research processes are transformed into linear task sequences, with communication activities often framed in terms of an 'add-on' duty that must be fulfilled. This transformation keeps societal actors present but largely outside of the core of knowledge production and maintains the established epistemic boundaries: scientifically sound data are produced and the corresponding analysis is delivered; subsequently, applicable solutions are generated as a specific set of translations for the extra-scientific partners or specific publics.

Even though non-scientific actors were kept close but out, we simultaneously found references to the general importance of transdisciplinary knowledge production. The core concern then was to assure the societal 'compatibility' ('Anschlussfähigkeit') of the knowledge that is produced by scientists, which makes it necessary to adequately design communication and dissemination processes. As a consequence communicators of different kinds are partners in such projects. These communicators are either researchers who specialize in this activity or professional knowledge brokers who solely devote their attributed project time to this well-defined task. 'Entanglement work' is thus delegated to a clearly delimited set of actors who are typically not directly involved in the project's knowledge generation activities.

Interestingly, this model is used by scientists, extra-scientific actors, and knowledge brokers alike and allows heterogeneous partners to work on the same project while remaining quite disentangled. Scientists are able to inscribe themselves into the narrative of transdisciplinary research while they continue to mainly produce classical scientific output. However, this model also works well for some extra-scientific partners who feel comfortable with their role as knowledge consumers and do not want to get invested into the knowledge production process. They expect to obtain results or applications 'delivered to their door' and leave the responsibility for knowledge production to the researchers.

(2) The Delimited Neutral Arena Model (Fig. 2.): In the second model, the research arena is also imagined as delimited from the problem-related societal arena. However, societal actors are regarded as quite strongly related to, as gatekeepers of or even as speaking for the 'object of inquiry' –– the problem to be solved. They are also viewed as holding specific expertise or some type of experiential knowledge or having access to data that enables a better (scientific) understanding of the impending problem.

Mutual engagement then occurs at specific moments and in specific settings in the overall research process. Such arenas of interaction are frequently conceptualized as 'neutral' in the sense that working together is imagined as not intervening in the core of knowledge production. Engagement with societal actors occurs quite frequently during data collection or in co-designing dissemination formats. At certain

moments, the project partners are thus considered more or less "on the same level", yet described as contributing, as one interviewee put it, in a "more distanced manner through only delivering data" (P01_f04: 230). Scientists and societal actors are conceptualized as the gatekeepers of their respective territories. Framed in this manner, engagement with the respective other is conceptualized as a 'win-win situation'.

Such neutral arenas of entanglement could be interpreted as 'trading zones' (Galison 1999), where heterogeneous collaborators meet to exchange data and experiences without necessarily sharing the same understanding of the exchanged goods or the exchange process itself (ibid., 138). Yet, while Galison describes how in an interdisciplinary context, such trading zones could develop into a new field with its own shared repertoire of problems, methods and theories, in the case of our transdisciplinary projects the establishment of long-term collaborations remained the exception. Rather, our interviewees discussed returning to their respective territories and using the 'traded goods' to follow their own agendas. The construction of such 'neutral' (temporal) zones of encounters thus allows the coexistence of disciplinarity and transdisciplinarity (see Fig. 2.).

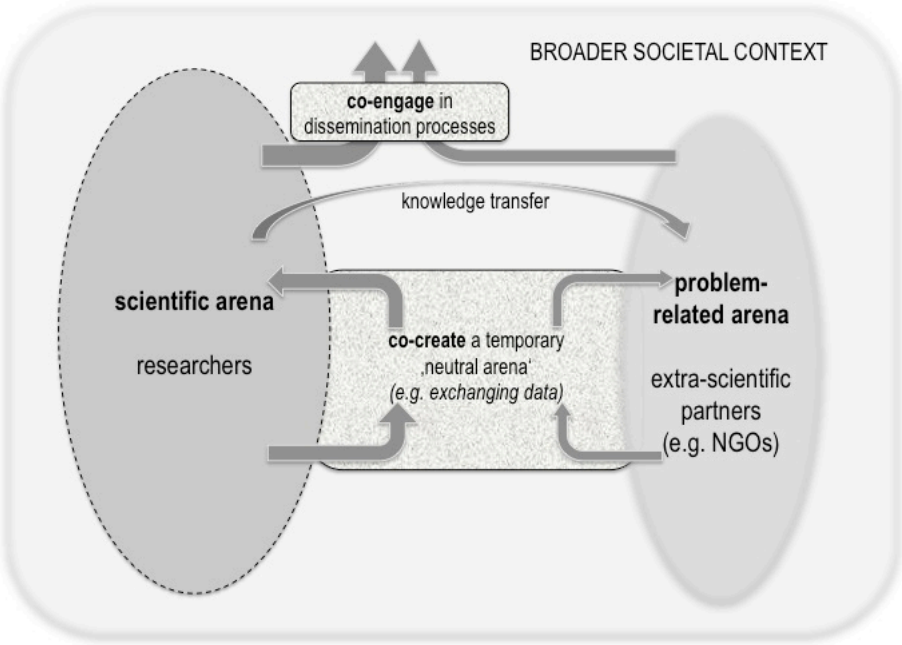

Figure 2: The Delimited Neutral Arena Model (Model 2)

Interviewees referring to such a model showed however rather diverse navigation strategies, varying in the degree of engagement with societal actors. Some of them seek advice concerning how scientific knowledge could be best communicated and which formats would yield the greatest impact. In doing so, societal actors are considered to have particular expertise concerning societal wants and needs and how findings must be represented to gain acceptance. They perform a kind of 'reality check' for scientists. As one interviewee would put it: to assure that

> *[…] the whole thing is realistic, [a Praxispartner] would need to deliver the so-called framework conditions […], what would be possible and make sense agriculturally speaking or from a practice point of view. (Researcher_Int21)*

Societal actors, in turn, could mobilize such moments of transdisciplinary engagement as a validation of their data through scientists, as participation in 'firsthand data production' allows for deeper insights than usual. Thus societal actors would know, for example, the basic assumptions inscribed or the decisions made during the process of data production. Thus, they would feel as though they were better able to estimate how a particular set of data should be interpreted. They could also selectively use the models and formats of representing the data that are developed by the scientists. Such combinations of heterogeneous actors could be conceptualized as a strategic alliance with the common goal of convincing specific publics of a scientific analysis and, thus, of fostering the overall legitimacy of science in the pursuit of a specific goal that is at least partially co-defined by societal and scientific actors.

(3) The Temporary Shared Epistemic Arena Model (Fig. 3.): Here, the research arena as functionally delimited but partly overlapping with the problem-related arena when addressing the tasks of producing, reflecting and integrating knowledge. In this model, societal actors are conceptualized as knowledgeable agents. Their knowledge and expertise are often understood as tacit, incorporated in practices, situated (e.g., 'regional expertise') and in need of translation through processes of interaction with researchers. The researchers are imagined as being able to extract, integrate and interpret the extra-scientific actors' knowledge. However, joint reflections regarding the research topic are considered essential to increase scientists' understanding of complex knowledge-related problems. Our interviewees often describe these interactions as moments of 'mutual learning' or emphasize that all participants can co-evolve through the collaborative knowledge production processes.

> *This project is the one in which we […] were so far able to realize this theoretical definition [of transdisciplinarity] to the greatest extent. Thus, methodological alignment, alignment in terms of the substance of work takes place. The process is open to the actors. The actors can influence the process, can co-shape the process. (Researcher_Int23)*

Moreover, scientists feel obliged not only to exchange data (similar to the second model) but also to co-produce answers to the partners' needs and to provide them with applicable solutions to problems. Joint knowledge production ranges from the development and elaboration of the research question to methodological decisions to the interpretation and evaluation of the findings.

However, from the beginning, the temporary restriction on the coexistence of actors from the two arenas is clear in the shared arena model. For all partners involved in the project, this common space is a temporal construction based on a shared interest in a problem and its solution, which is combined with a certain amount of opportunism (in the sense mentioned by Knorr-Cetina (1981)) in terms of funding possibilities. Thus, the shared epistemic arena is seen as a temporary space and is not meant to work in or act from beyond the concrete case. In this sense, the encounters that we observed

remained case-specific and did not develop into more sustained transdisciplinary collaborations.

Given the temporality of the setting, a 'shared epistemic territory' does not indicate that both actors can become equally powerful in this context. In fact, what questions are discussed and what types of collaboration can occur remain strongly defined by the scientists. In the cases where we observed such shared epistemic work, researchers often have to persuade the extra-scientific actors in the first place to engage in this type of common knowledge work rather than straight forwardly searching for a practical solution of a problem at stake. For the researchers these practical problems would often be described as not sufficiently interesting from a scientific point of view and thus not worth investing. Once leaving this temporary shared epistemic arena, the scientists (are expected to) engage in purification work by translating their experiences, knowledge and reflections into an adequate scientific form that would counted as tangible output in their respective academic communities. These findings – packaged in a specific manner and imbued with more academic authority – are then both 'packaged' for use for the extra-scientific actors and communicated to broader audiences. This process of academic validation reflects the authority of science which is acknowledged by the societal actors and strategically used in pursuit of their agendas.

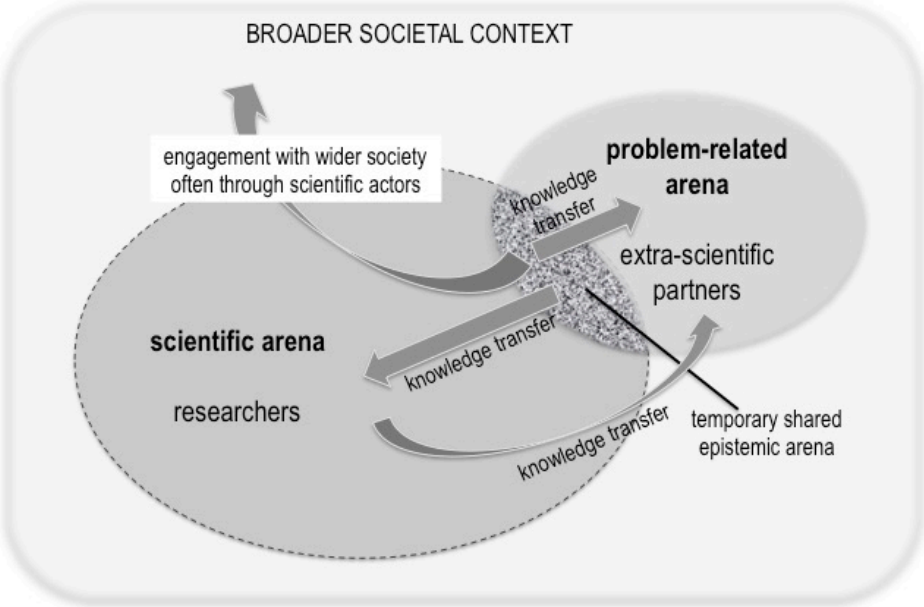

Figure 3: The Temporary Shared Epistemic Arena Model (Model 3)

Navigation through this transdisciplinary knowledge landscape thus involves selectively engaging in well-bounded spatiotemporal episodes in which some form of common work and/or exchange seems possible. This engagement is often referred to in the interviews as oscillating between 'going into' and 'going out of' the shared arena, with the arena often also holding a material connotation, e.g. referring to a specific geographic region, the location of a case study, a specific participation context in

which the research is located. In this case, the researchers enter the shared arena for joint reflections with the actors and then distance themselves again to translate these reflections into their own epistemic 'world'. Thus, the interaction is conceptualized as neither a continuous nor a permanent form of co-work and is imagined as occurring in shorter segments of time.

Discussion and Conclusions

The paper began by questioning how the opening of research to societal actors was written into a funding scheme and identifying some of the tensions that this created. By focusing on the ways in which researchers translated the programmatic prescription into their projects' architecture and practice, we elaborated three different often tacitly performed science-society models at work. These models represent specific perceptions of when and how entanglement between societal and scientific actors and their respective values and concerns should/can occur. However, we also emphasized that the research participants did not necessarily embrace only one particular model; rather, they would strategically switch between the models to advance an argument. Finally, even if projects envisage a specific form of engagement with societal actors, individual researchers did develop rather individual strategies to navigate the transdisciplinary knowledge spaces. Some researchers aptly drew on the more or less transdisciplinary networks that are inherent to the projects without personally engaging in any of the entanglement activities. They managed to create and inhabit strictly disciplinary niches or move along niche trails in an environment where other scientific and societal actors were more engaged. When interviewed, they often conceptualize 'the project' as being transdisciplinary implying that not all participants must subscribe to or practice this ideal. As one of our informants put it:

> *[…] in my everyday life, I usually do not work in a transdisciplinary manner. I have to write papers, and they are for specialized journals or professional circles. (Researcher_Int18)*

Researchers subscribing to this understanding often see themselves as 'purely epistemic agents' who hold a specific methodological expertise. For example, they feel responsible 'only' for the development of a certain tool or a specific indicator (including transferring and reconfiguring data from their *Praxispartners*) and do not feel responsible for the entire problem-solving process, which is framed as a more integrated knowledge process.

Throughout the analysis, it became obvious that the efforts to entangle scientific and societal arenas and to keep them separate, as well as matters of facts and matters of concern (Latour 2004), coexisted in often uneasy relationships. We have observed how the normative imaginations of more open forms of knowledge production, of democratizing innovation, and of putting in place "collective experimentation" (Felt et al. 2007) met numerous substantive but often implicit and unaddressed forms of reluctance or resistance. Against this backdrop, we close this paper with the broader issues that were identified based on the performance of transdisciplinary sustainability research in this context.

First, we return to the contradictions and tensions that are visible in the researchers' accounts of their practices. We encountered two different modes of ordering research (Law 1994) and related definitions of 'high-quality' research when considering the program script and the researchers' work environments. One mode concerns opening to society and triggering a deeper, open-ended and reflexive engagement between science and society. In this view, high-quality sustainability research requires a broader set of actors who are involved in the different steps, from defining the problem to developing solutions. Thus, we witness a reordering of values in research, which indicates the need to rethink the ways in which society can relate to and be integrated into the production of scientific knowledge. The other mode of ordering conceptualizes good research as following the 'new public management' logic, with competitiveness, efficiency and top publications as the key indicators of quality. Competitive project acquisition, highly coded outcomes and a high degree of specialization are considered indicators of success in this framing. The investment in time and resources that is necessary to perform knowledge production in more hybrid, collective ways has little room in an environment where classical academic accounting is prioritized. Thus, we observe tensions between broader societal valuing of research, i.e., considering research in terms of its contribution to the public good, and acknowledging the complex processes through which people value scientific knowledge and technological realizations and evaluating research, i.e., following disciplined thinking and complying with the values that are important in research systems and funding schemes, which predominantly focus on narrow indicators when assessing people and knowledge (Lamont 2012, Felt et al. 2013a).

An outcome of this tension is (1) the fact that in each of the described models, engagement between scientific and extra-scientific actors mostly occurs in rather delimited, temporary ways. It did not involve durable knowledge relations that cross the science-society boundary or lead to a lasting blurring of boundaries among different forms of knowledge and experiences. This (non)engagement is closely tied to the ways in which the project output was valued: scientific output was considered key for maintaining one's academic standing, and the output that addressed extra-scientific partners was, at best, 'also valuable'. (2) The researchers developed different strategies for addressing these tensions depending on their career stage, their concrete institutional embedding and the predominant values there, and the role that the transdisciplinary project played in their overall research portfolio. For example, early stage researchers attempted to establish themselves and depending on disciplinary assessments, tended to choose niche strategies, whereas more established researchers at least considered the option to engage with extra-scientific rationales on a deeper level (Felt et al. 2013).

This observation leads to our second closely related reflection. Despite the fact that the issue of participation and empowerment is at the top of proVISION's agenda, participation remains limited to what Wynne (2007) calls 'invited publics'. Extra-scientific actors can only participate in sustainability research if they receive an invitation by a scientific partner and agree –– at least to some degree –– with the scientific partner's framing of the problem. This prerequisite becomes obvious in the researchers' narratives regarding having carefully selected 'their' societal partners so that they can fulfill specific roles in the project. When we speak of empowerment, we must therefore also carefully consider the roles of who can empower and who is to be em-

powered. Thus, we agree with Wynne, who emphasizes that the "implicit boundaries of [non-scientific] agency and involvement […] set and enforced in the very discursive-practical routines which are allowed" (ibid., 104) strongly determine the degree of inclusiveness of these settings. These boundaries also determine the types of problems that can be addressed and the solutions that can be developed. In this sense, contributing to the 'public good' always also includes defining the 'good publics' to be involved and addressed. In this context, we can argue that extra-scientific actors' concerns are even in explicitly transdisciplinary projects quite often "translated into more domesticated terms and then said to have been addressed" (ibid., 105). Despite the strong discourse of opening-up towards societal actors, we observed an equally strong tendency within mainstream academic culture to perform boundary work toward extra-scientific rationales.

This tendency is also reflected in the fact that collaboration beyond the project is most of the time –– if at all –– exclusively imagined with specific academic partners who appear as an asset to acquire future funding or to publish together; extra-scientific partners are rarely perceived as longer-term research partners. Imaginaries about a potential shared 'life after the project' thus could also be understood as framing the (fragile) relationship between scientific and extra-scientific partners within the project.

Third, societal values, norms and concerns enter the research process through the dense deployment of tacit collective imaginations regarding sustainable development in Austria. These imaginations describe attainable futures and prescribe the types of futures that should be attained, which in turn also frame the research in important but often unacknowledged ways. Scrutinizing how broader sociotechnical imaginaries (Jasanoff and Kim 2009) related to sustainability issues frame research in terms of defining problems and developing potential solutions will remain a significant challenge to be addressed in further research. In our case, these sociotechnical imaginaries were captured by the pictorial material and the narratives on the specific role of sustainability in configuring "Austrianness" (Felt 2015). Thus, we argue that we witnessed within the program's framework moments when knowledge orders and soci(et)al orders became co-produced (Jasanoff 2004), and it seems essential to more explicitly reflect on sustainability imaginaries and the ordering force that they exert.

Finally, we want to look at our observations through the lens of the notion of reflexivity, which has become central to the analysis of the changing modes of knowledge production (Nowotny, Scott, and Gibbons 2001). Nowotny, Scott, and Gibbons (2001) already pointed to the fact that there "remains a danger that any call for greater 'reflexivity' is reduced to a mere 'after-thought'" (ibid., 239) and that we rather tend to go for structural fixes than to open-up spaces of negotiation. The introduction of ethics committees as an answer to the need for increased reflexivity in biomedical research can be considered one such example for a structural fix – reflexivity gets outsourced to such committees and returns to research through forms that must be completed. In a similar manner, transdisciplinary projects create delimited spaces where new science-society relationships are probed; however, these arenas are structured by deeply entrenched pre-inscribed social and knowledge orders. The ideal of collective experimentation to find innovative solution is thus often reduced to more ritualized information and communication events. The temporal limitation of projects further

encourages the performance of pragmatic solutions, as investing relational work in such temporal encounters between different social worlds does not seem to be sufficiently rewarding. In addition, because wider societal knowledge orders have deeply established asymmetries, virtually all involved actors assume that scientific knowledge is superior to and more powerful than any other forms of knowledge; thus, even if it would be possible, scientific expertise gets rarely challenged.

It would thus be rewarding to reconsider the transdisciplinary research program and the research practices developed in it using Andy Stirling's (2006) distinction between reflexivity and reflection. Reflection "refers to the mode of representation, understanding and intervention […] in which attention extends to a 'full range' of whatever are held to be broadly salient attributes" (ibid., 5) of the problem at hand. Reflexivity, however, extends beyond this and pays "attention not just to the representation of the [problem] to the subject, but also to the way in which the attributes of the subject help constitute the representation of the object and how these representations themselves can help recondition the subject" (ibid., 5f.). In that sense, we can argue that most of the sustainability research projects that we observed displayed an increased degree of reflection, whereas reflexivity largely remained at the margins. As a consequence, and returning to the beginning quote, simply establishing a transdisciplinary project funding scheme may be insufficient to "nurture greater innovation and creativity, and make it more likely that research and innovation are directly targeted at solving societal challenges" (van den Hoven et al. 2013, 6). Thus, to meet societal challenges through new types of knowledge production, less temporalized research structures and a more radical rethinking of both the knowledge regimes and privileged knowledge relations is needed.

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