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An actor-specific guideline for quality assurance in transdisciplinary research

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ABSTRACT

Transdisciplinarity has a long tradition – both in terms of academic discourse and research practice. The proliferation of transdisciplinary research (TDR) has, however, only progressed moderately up until now. The main reason for this is the lack of a generally accepted quality standard for TDR. In addition to meeting the quality standards of excellence of 'normal science', TDR is supposed to respond to a variety of societal demands. Establishing a quality standard that incorporates these requirements would only be possible in the long-term as it calls for far reaching changes on both an institutional level as well as that of science as a whole. Building up a practice of quality assurance in TDR today lays the necessary foundation to bring about such changes. The aim of this paper is to present a ready-to-use quality guideline which we intend will contribute to that foundation. The guideline is customized to such TDR that aims to bring specific knowledge to bear on policy issues relating to sustainable development. The guideline addresses three groups of actors: researchers, program mangers or donors and policymakers. It shows these actors what they can do specifically to assure the quality of the transdisciplinary research process.

1. Introduction

In their seminal article in this journal in 1993, Funtowicz and Ravetz noted that in "research related to policy for risk and the environment, which is so crucial for our well being, there has been little effort of quality assurance of the sort that the traditional experimental sciences take for granted in their ordinary practice." (Funtowicz & Ravetz, 1993: 743). This observation was, of course, made at a time when practicing new forms or modes of research, like transdisciplinarity, was pioneering to say the least. More than 20 years, and a wealth of studies on the subject matter, later, however, it still holds true. In current research practice it is, to a large extent, upon the individual researcher to assure what might be called the extended quality profile of transdisciplinary research (TDR) (cf. Maasen & Lieven, 2006: 407): In addition to meeting the (disciplinary) quality standards of excellence of 'normal science', TDR is supposed to respond to a variety of societal or extra-scientific demands. Yet there is still no generally accepted quality standard that incorporates these requirements.

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It is this fact which, in our opinion, mainly obstructs the proliferation of transdisciplinarity (cf. Carew & Wickson, 2010: 1148).[1]

This becomes clear when considering that the career paths of individual scientists, as well as the reputation of entire research organizations, depend on adhering to what the relevant scientific community defines and acknowledges as good, valid and successful research. Accordingly, there is little incentive for scientists to engage in research where the accepted quality standards cannot be readily applied (cf. Blättel-Mink & Kastenholz, 2005). Establishing a new quality standard that extends beyond academia, however, requires far reaching changes on both an institutional level as well as that of the science system as a whole – changes which, being political in nature, will only be possible in the long-term. Building up a practice of quality assurance in TDR today lays the necessary foundation to bring about such changes. The aim of this paper is to present a ready-to-use quality guideline which we intend will contribute to that foundation.

1.1. The focus of quality assurance in transdisciplinary research

Quality assurance in science is generally directed toward processes and products. Although there are process-related standards of 'good scientific practice' in place – which can exist either as formal codes of conduct or as rules passed on among the members of a scientific community – the focus in mainstream science is on product evaluation by peer-review and bibliometric impact measurement. As we, and others, have argued elsewhere, these standards and procedures inherently apply to TDR as well, in so far as it does not set out to replace disciplinary practice but to enrich it (see Jahn, Bergmann, & Keil, 2012: 4, and references therein; Pohl et al., 2011: 3).

The maxim of product evaluation cannot, however, be transferred easily to the extended quality profile of TDR.[2] The fundamental difficulties in evaluating the outcomes of TDR have been intensively discussed (see e.g. Bornmann, 2012; Klein, 2008; Pregernig, 2007) so that we only need to recall the core questions here: what are the relevant categories of societal impact made by research, how can such an impact be measured on a scale that allows comparisons across different categories, and how can it be linked practically to a particular research project – especially when considerable time delays are likely to be the norm rather than the exception between the completion of a project and any possible societal impact? Apart from answers borrowed from disciplinary science – like linking societal impact to the extent in which, for example, a project report is "addressed outside of science" (Bornmann & Marx, 2013: 213) – these questions have been difficult to resolve.

As a result, there has been a shift in the literature from evaluating the products of TDR to evaluating entire transdisciplinary projects or programs (Bergmann et al., 2005; Defila & Di Giulio, 1999; Huutoniemi, 2010). Such evaluation schemes strongly focus on the quality of the research process. More precisely, the quality of TDR is measured against its success in facilitating dialog and learning processes between science and society and, not least, within academia itself (cf. Späth, 2008; Wiek, 2007). In order to achieve this, research processes have to be designed whereby the interests, the expectations and the knowledge of scientific and societal or political actors are systematically integrated. In other words: whereas in disciplinary research a good process is a means to an end, in TDR it is an end in itself. In line with others (Guggenheim, 2006: 413), we therefore hold that the main object of any future quality standard for TDR should be the research process.

There are a few reasons as to why such a quality standard for TDR has not yet been established. First, the intended plurality of transdisciplinarity, in terms of different "epistemologies" or "epistemic communities" (Miller et al., 2008) and areas of application, seems to render the definition of a generally accepted standard almost impossible. In line with this, most existing standards are specific to the organizations which carry out the research (Guggenheim, 2006: 419). Second, not least because of this plurality, a coherent transdisciplinary research community has yet to be encountered that has a distinct culture and tradition, out of which a standard like this would naturally emerge (cf. Öberg, 2009: 408; Wickson, Carew, & Russell, 2006: 1055). Third, there is a fierce debate about academic freedom, which some see threatened by subjecting science to extra-scientific quality standards–at least in Germany (Artmann & Borchert, 2013: 118) and in the United Kingdom, as the controversy there about non-academic impact criteria introduced by the Research Councils UK shows (cf. Duff, 2012; Holbrooke & Frodeman, 2012). Finally, it is argued that any generic quality standard would have to be based on a shared definition of transdisciplinarity (Evely et al., 2010: 442; Pohl et al., 2011: 4) – a definition which is not yet available despite a number of viable suggestions.

In developing this quality guideline, our approach in addressing these arguments is the following: we define transdisciplinarity as being "a critical and self-reflexive research approach that relates societal with scientific problems; it produces new knowledge by integrating different scientific and extra-scientific insights; its aim is to contribute to both societal and scientific progress; integration is the cognitive operation of establishing a novel, hitherto non-existent connection between the distinct epistemic, social–organizational and communicative entities that make up the given

[1] We note that the first special issue on transdisciplinarity in this journal also only touched upon the issue of quality of TDR. While Balsiger discussed the concept of discursive evaluation and asked how "quality standards of supradisciplinary research practices" can be maintained (2004: 416), Bruce, Lyall, Tait, and Williams (2004) studied how integration can be secured in interdisciplinary collaboration.

[2] An important issue, which we cannot discuss in detail here, is the conflicts that may arise between meeting disciplinary and transdisciplinary quality standards at the same time. Such conflicts can develop in particular when advanced academic training, like doctorates, are part of a TDR project (cf. Mitchell and Willets, 2009).

problem context." (Jahn et al., 2012: 8–9) Although this definition does not yet represent the sort of consensus needed to base a generally accepted quality standard on, it contains elements which are considered to be constitutive of TDR by many scholars (Jahn et al., 2012). For our purpose here, this definition is particularly suited because it directly points to the above mentioned extended quality profile of TDR with its reference to scientific and societal progress.

Whereas we believe that the controversy about academic freedom is by and large a pseudo-debate, we suggest here that, because societal demands on science exist and are inherently justified, a quality standard which codifies and incorporates these demands will definitely preserve academic freedom. A standard creates procedural reliability and thus contributes toward simplifying and liberating research processes for all participants. Applying this argument, the quality guideline presented here is first and foremost an instrument for supporting communication and self-reflection vis-a-vis the appropriate means for quality assurance (cf. Fujigaki & Leydesdorff, 2000: 647). To that end it will be actor-specific: the guideline not only reaches out to researchers but also to program managers or donors and to those societal actors who participate directly in research projects. Finally, in order to deal with the plurality of transdisciplinarity, we design our quality guideline such that it becomes specific to a particular area of application (i.e. sustainable development) and to the societal realm in which the research should have an impact (i.e. policymaking) (cf. Klein, 2008: 117; Mertz et al., 2014).

1.2. The case of policy relevant sustainability research

"Sustainability Research" has become a common term, one found in the names of research programs, research institutions and specialist journals. But just like the term "sustainability" itself, it is not clearly defined. Within it one finds activities as diverse as, for example, investigating ocean currents in order to understand climate change and devising concepts for sustainable municipal energy supplies. Primarily because of this diversity, much like in transdisciplinarity, the quality issue in sustainability research has not been previously addressed systematically (Ziegler & Ott, 2011). As we have argued elsewhere (Jahn et al., 2012: 4), it is widely acknowledged that sustainability research requires a transdisciplinary approach (see also Hirsch Hadorn, Bradley, Pohl, Rist, & Wiesmann, 2006: 120). In line with our argument that, in order to establish a working quality standard for TDR, it is necessary to distinguish a particular area of application and of the research's societal impact, we focus here on what we call "policy relevant sustainability research" (PRSR). We define PRSR to be transdisciplinary research that aims at bringing specific knowledge to bear on policy issues relating to sustainable development. Consequently, and because of what we previously called "actor-specific", the quality guideline we propose for PRSR will address researchers, program managers or donors and policymakers. In comparison to other approaches of quality assurance in TDR, we consider this to be our guideline's main innovation (see Section 3.2).

The following section introduces the quality guideline for PRSR and the way it was developed. In Section 3 we will critically reflect on the range of our guideline's application and point out possible ways in which it can be improved further. In addition, we will briefly compare our guideline to selected similar approaches found in the literature. To conclude the article, we will relate the issue of quality assurance in TDR to the institutional dimension of the science-policy interface and indicate directions for further research.

2. An actor-specific guideline for quality assurance in policy relevant sustainability research

The quality guideline for TDR, presented in the following, was specifically designed for policy relevant sustainability research.[3] For its development, however, we chose an approach which can be used to design customized guidelines in other areas of sustainability research as well. The core of this approach consists of nine quality dimensions which we believe can be applied to any kind of transdisciplinary research that addresses issues of sustainable development. These dimensions were derived from recent literature on sustainability science and transdisciplinarity (see references below). They are introduced in Table 1. In the following, we will briefly characterize each dimension. In Section 2.1 we will show how we used them to define our quality guideline for PRSR.

The three dimensions in the first row relate to the specific quality of *problems* in the context of sustainable development (cf. Bettencourt & Kaur, 2011; Clark & Dickson, 2003; Kates et al., 2001). The dimension "systemic" highlights the fact that nature and society form strongly coupled complex adaptive systems which elude linear conceptions of development and control (Costanza, Wainger, Folke, & Maler, 1993: 545; Levin et al., 2013: 116–117). In line with this understanding of social-ecological systems as the epistemic objects of research (Becker, 2012), the dimension "scale spanning" acknowledges the importance of scale when investigating such systems (Manson, 2008: 776) and suggests that research has to pay particular attention to effects that might occur when different scales are crossed (the term "social scale" here refers to the standard distinction in the social sciences of a micro, meso and macro level of analysis). The third dimension "prospective" hints at the fact that complex systems are highly sensitive to small changes within the parameters that define them. Research, therefore, has to be mindful of sudden changes or surprises (Lubchenco, 1997: 492; Rockström et al., 2009) and has to account for those

[3] The description in this section follows that of Jahn and Keil (2013). Note that the quality guideline was developed in the context of the German science system; for this article, we have revised the guideline so that most of the parts particular to this context were removed or replaced by internationally more compatible equivalents.

Table 1
General quality dimensions of transdisciplinary sustainability research.

Quality of the research problems		
Systemic	Scale spanning	Prospective
Understanding of social-ecological systems, including feedback effects and temporal inertia	Consideration of different spatial, temporal, and social scales and of transition effects	Consideration of alternative development paths, critical thresholds and surprises
Quality of the research process		
Context specific	Integrative	Method-based
Relation to concrete problems and their respective action and behavioral contexts	Integration at epistemic, social-organizational, and communicative levels	Accountable, transparent production and evaluation of knowledge
Quality of the research results		
Critical-reflexive	Normative	Impact oriented
Uncertainty, ignorance, cognitive boundaries, impact assessment, role understanding	Maintaining the viability of societies, attention to current and future issues of justice	Usability of results, increased capabilities for action, safeguarding knowledge

Modified according to Jahn & Keil, 2013: 8.

by exploring different development paths that might lead to a desired future state of the social-ecological system under investigation (van der Leeuw et al., 2011: sub-section 'Integrating past, present, and future').

The second row comprises of those three dimensions that focus on the quality of the research *process*. Here, the fourth dimension "context specific" requires research to study cases of "real world-problems" (Klein et al., 2001: 4) or, in other words, to explore issues of sustainable development in the context of a geographically and historically specific social-ecological system. In doing so, the intentional behavior of key-players, as well as the aggregate "systemic behavior" (Ostrom, 2009: 422) of all agents, has to be analyzed. Integration is almost unanimously said to be both the key feature and the grand challenge of transdisciplinarity (Jahn et al., 2012: 3, and references therein). This is reflected in the fifth dimension "integration" (see our definition of integration in Section 1.1). In addition to the common emphasis on the integration of different forms and bodies of knowledge (both scientific and extra-scientific) in TDR, we highlight here the two additional levels of social-organizational and communicative integration (Bunders et al., 2010: 139; Jahn et al., 2012: 7): whereas the former refers to the different interests or values of all the subjects and institutions involved in the research process, the latter focuses on their respective means of linguistic expression and cultures of communication. The sixth dimension "method-based" simply expands on an established quality standard of traditional science to sustainability research: in order to ensure the integrity of the knowledge production process, research should draw on existing disciplinary or transdisciplinary methods (Bergmann et al., 2012) or should invent and document new, case-specific ones.

Finally, the three dimensions of the third row mainly address the quality of research *results*. The seventh dimension "critical-reflexive" represents an insight that was one of the main forces in fundamentally re-thinking the relationship between science and society (Nowotny, Scott, & Gibbons, 2001): dealing with complexity requires us to shift our focus from what we know to what we do not know; in the epoch of the Anthropocene, uncertainty and ignorance are no longer mere scientific technicalities but "social and cultural products" (Smithson, 1993: 142). In this shift, the role of scientific expertise is also changing: the time-honored 'truth speaks to power' is making way for more modest and inclusive models for the interaction between science and society, like the "framing model" – of which the Intergovernmental Panel on Climate Change is a prime example – and the "extended participation model" (Liberatore & Funtowicz, 2003: 149; see also Weiss, 2002: 380–381). Sustainability research has to reflect upon the (new) roles of the different scientific and societal actors involved in a given transdisciplinary process and needs to establish a culture of critique concerning the knowledge produced and its use in supporting a claim or concern (Jahn, 2013: 32). The eighth dimension "normative" requires research to acknowledge that sustainable development is a normative model at its core. This means, in particular, that all actors involved have to be explicit in how they interpret this core and how they use this interpretation to formulate research goals and to justify why they have either accepted or rejected a particular research result. Finally, the ninth dimension "impact oriented" stresses that TDR ultimately aims at enhancing societies' capabilities in dealing with urgent problems. A major requirement here, especially to donors, is to think beyond project episodes by, for example, supporting measures to actually implement the research results. In line with what we previously called the extended quality profile of TDR, "impact oriented" also means that, in generating knowledge and integrating results, societal demands of accessibility and usability have to be accounted for.

These nine quality dimensions can now be translated into actor-specific quality guidelines for different *impact-types* of sustainability research. For illustrative purposes, we suggest a distinction between policy relevant, societally relevant and scientifically relevant sustainability research. By distinguishing between these three impact-types, the broad spectrum of sustainability research can be covered. For example, climate research into arctic ice cores can be treated as sustainability

research which is primarily aimed at new scientific knowledge. The main actors that a corresponding quality guideline would explicitly address are researchers and program managers or donors. Developing measures to advance the spread of sustainable consumption patterns within given population groups, on the other hand, is an example of research which is aimed more at societal impact. Here, in addition to the groups of actors mentioned above, a specific quality guideline would also have to reach out to, for example, non-governmental organizations or citizens' initiatives. Finally, helping municipalities in formulating and implementing strategies to make a transition into a renewable energy supply is, essentially, exemplary for a type of sustainability research which is concerned with contributing to innovative policymaking–the case we fully develop below.

In practice, close relationships will exist between these three types of sustainability research. For example, it is hardly possible to formulate a sensible and effective strategy for increasing energy efficiency if the need for changes in patterns of consumption and use is not addressed. Transdisciplinary projects, in general, will not work toward just one type of impact, but may pursue several at once. The distinction made here between the three types should, therefore, not to be taken as a sharply defined classification. Many elements of the quality guideline for PRSR that we are presenting here would, for example, have to be part of a quality guideline for societally relevant sustainability research. Our impact-typology should rather illustrate a key insight gained from our empirical analysis and our own research practice. Any TDR project should clarify what types of impacts it is aiming for; this clarification would then be the prerequisite for identifying those actors who should directly contribute to quality assurance. In other words: quality standards for sustainability research must address the various actors involved in order to achieve effective results.

2.1. Method for developing the quality guideline

The method used for developing the quality guideline consisted of three consecutive steps. In the first step we analyzed six completed research projects, addressing topics in the thematic area "Sustainable City". According to our actor-specific approach, we selected the projects according to three criteria: first, they had to represent a diversity of research institutions (universities as well as independent research facilities); second, they had to cover different funding agencies (government departments, foundations and municipalities) and third, policymakers had to have been involved in the research process.[4] The database for analyzing the projects selected this way consisted of publicly available project documents. We analyzed these documents with the help of three questionnaires – one for each of the three groups of actors (for detailed information see Jahn, Guske, Jacob, Keil, & Petschow, 2014: 25–30). In line with our main premise that good quality TDR fosters dialog and "mutual learning" (Scholz, 2001: 118), our first key question was: "What characterizes research constellations that facilitate learning processes among the scientists, policymakers and program managers or donors involved, and where are the barriers to this learning most likely to arise?" Drawing on the pertinent literature (see Section 3.2), as well as reflecting on our own research experience, we broke this question down into sets of sub-questions for each actor group. In order to prepare the guideline's reference to sustainable development, we then used the nine general quality dimensions (see Table 1) to expand the questionnaires as follows: for each dimension we asked what the actors would have to do to properly address that dimension? This resulted in an additional set of questions for each group of actors.

The result of this first project analysis was a draft version of the quality guideline. In a workshop with the selected projects' researchers, program managers and policymakers, we cross-checked our analysis and discussed whether the quality guideline represented the experiences and expectations of the participants. A key topic of the workshop was also to find out if the guideline's language was clear and intelligible. On the basis of the workshop results, we revised the first draft version of the guideline.

The second step aimed at verifying whether the revised quality guideline would also apply to a largely different thematic area. We used the criteria and the questionnaires, developed in the first step, for this purpose and selected and analyzed another five completed research projects in the area: "Risk and Precaution in the case of New Technologies."[5] The analysis was complemented by telephone interviews with the principal investigators of the five projects. We then used the results of the analysis and the interviews to cross-check the quality guideline and to clear it of any issue-specific elements. The feedback of the interviewees was also used to further improve the overall presentation and linguistic compatibility of the guideline.

Finally, we put the quality guideline up for discussion at expert meetings with key players of the German science system (representatives of research funding agencies, large research institutions, government departments and advisory boards). The main purpose of the meetings was to subject the guideline to the scrutiny of individuals who had a broader perspective on the issue of quality assurance in sustainability research and who were not involved in any of the projects that we had analyzed to develop it. Again, we used the results of the meetings to further refine our guideline.

[4] All projects selected were carried out by German research institutions and only addressed national issues of sustainable development. Three projects worked on municipal climate protection and adaptation strategies, two explored options for water sensitive or health-promoting urban development, respectively, and one developed planning tools for communal infrastructure and land requirements. A detailed description of these projects and their analysis can be found in Jahn et al. (2014).

[5] The five projects explored health aspects of nanomaterials, options for developing pharmaceuticals on the basis of renewable resources, European policies for organic products outside the energy sector, the debate about climate engineering and environmental issues in the context of electromobility.

Table 2
The structure of the quality guideline for PRSR. The complete requirements profiles for the three groups of actors are presented in Annexes A–C.

Programm managers or donors (Annex A)	Researchers (Annex B)	Policymakers (Annex C)
Phase I—Preparing a program or call for proposals: 26 questions	Phase I—Planning a research project: 27 questions	Phase I—Participating in the application for a research project: 15 questions
Phase II—Monitoring an ongoing program or project: 7 questions	Phase II—Implementing a research project: 11 questions	Phase II—Participating in the execution of a research project: 7 questions
Phase III—Evaluating a program or call for proposals: 5 questions	Phase III—Evaluating a research project: 5 questions	Phase III—Utilizing a research project: 4 questions

2.2. The quality guideline for PRSR

The quality guideline for policy relevant sustainability research is presented in Annexes A–C. It consists of so called requirements profiles, one for program managers or donors (Annex A), one for researchers (Annex B) and one for those policymakers (Annex C) who participate directly in the transdisciplinary research process. The profiles, in turn, are made up of "reflective" (Mertz et al., 2014: sub-section 'Mapping landmarks of quality and drafting a road map') or "strategic" (Wickson et al., 2006: 1055) questions which guide the respective actors as to what they should do specifically to assure the quality of the research process.[6] We consider our approach of explicitly addressing different actors to be the main innovation of our quality guideline (see Section 3.2). Table 2 gives an overview of the guideline's structure. We chose to present the requirements profiles in the form of questions because we believe this best supports the intended use of the guideline as an instrument for self-reflectively communicating adequate, project-specific means of quality assurance (cf. Öberg, 2009; Pohl et al., 2011). In Section 2.3, we give an example of how a requirements profile can be used in practice.

The requirements profiles indicate which of the nine general quality dimensions of sustainability research a particular question refers to. For example, the question for researchers: "Do you identify relevant policymakers who are willing to participate in the research and do you clarify whether the institutional and financial conditions exist to enable their active and continuous participation?" belongs to the dimension 'context specific' (see Annex B, Q6). We note that not every individual requirement refers explicitly or directly to sustainable development. The requirements profiles are specific to sustainable development in the sense that we derived them by using the nine general quality dimensions as described in Section 2.1. This does not imply, of course, that a particular requirement cannot also be relevant for other areas of application. We believe, however, that when one starts with another area of application different requirements profiles could arise.

Each requirements profile is, moreover, divided into three subsequent temporal phases. The researcher's profile, for example, has three sets of questions for the planning and implementation of a research project and the evaluation of its results (the above example question is from the phase "Planning a research project", cf. Table 2). This temporal structure again underlines the importance of processes in the quality assurance of TDR. The beginning of a process is particularly crucial in this respect because mistakes in setting the course can often only be corrected later with great effort (see Section 2.3 for the example of developing a joint problem description). Each requirements profile has, therefore, a clear focus on the early phases of the process.

It should be noted that a question that refers to the realization of a quality assurance measure in a subsequent temporal phase is not repeated in that phase. If, for example, researchers announce that they are assessing the impact of a project's policy recommendations in their proposal, then the actual implementation of this assessment in the course of the project is simply assumed. We also point out the fact that not all of the nine general quality dimensions are represented in each of the three temporal phases. So, for example, the dimensions "systemic," "scale spanning" and "prospective" are particularly relevant to the phases "Preparing a program or call for proposals" or "Planning a research project". As one moves forward in time, the remaining six quality dimensions generally increase in importance.

2.3. Usage of the quality guideline

In the following we give a specific example of how researchers can use their requirements profile practically. Similar examples for program managers or donors and policymakers can be found in Jahn and Keil (2013: 14–19).

In the academic discourse on TDR, it is repeatedly stressed that a common problem description accepted by–as in the case considered here – both researchers and policymakers, is crucial (cf. Jahn et al., 2012: 4–5; Scholz, Spoerri, & Lang, 2009: 172). Usable research results can, in most cases, only be achieved if the policy problem is described as exactly as possible and translated into a scientifically viable question. Here, the crucial assumption is that policy problems arising within the context

[6] Within the scope of this article, we cannot provide a detailed account of how we arrived at a specific requirement (for details see Jahn et al., 2014: 25–30). The procedure was generally as follows: when we identified something in the empirical analysis of a particular project that was crucial for the success or failure of mutual learning or for dealing with the general quality dimensions of sustainability research, we tagged it as a candidate requirement. We then checked the other projects for similar hints. A candidate requirement would only enter a final profile if we could make sure that it was not specific to the original project.

Table 3
Example of how researchers can use the quality guideline for PRSR by focusing on preparing a common problem description with policymakers (the questions in the left hand column are taken from the requirements profile for researchers in Annex B).

Requirement	Implementation (examples)
Q7: Do you coordinate the formulation of the given policy problem with the policymakers involved (and, if necessary, with the program managers or donors as well) or does your project's implementation plan include a procedure for reaching such an agreement?	– make contact with potential policymakers as early as possible before application and hold a workshop on "Common Problem Description" (include program mangers or donors if possible) – if there are no resources for a workshop, design the project's implementation plan in such a way that a common problem description can be achieved during the research process – agree on the relevant points of the implementation plan with the policymakers before the application – work with proven concepts and methods for determining a common problem description
Q8: Do you translate the given policy problem into scientific research questions?	– review the relevant state of knowledge and relate it to the common problem description – identify gaps in the current state of knowledge and (with the help of models, hypotheses, theories, etc.) translate these into questions to be worked on with scientific methods – include here, as far as possible, the entire research team and identify possible sub-questions for individual disciplines – inform the policymakers before the application (ideally in a second workshop) of the scientific questions identified or provide for such an information transfer in the project implementation plan
Q24: Do you differentiate between the project's scientific and practical knowledge goals and do you carry out and justify a corresponding weighting?	– before the application invite the policymakers to disclose their own goals for the project in the context of the problem description identified – determine what potential lies in the scientific questions identified and develop this into appropriate scientific project goals (e.g., peer reviewed publications, presentations at conferences, theses, follow-up projects, etc.) – determine the extent to which the project has rather more practical than scientific relevance and provide this assessment to all participants
Q25: Do you assess the expected contribution of the project to resolving the given policy problem?	– clarify with the policymakers what degree of achievement of their project goals will count as success for them – assess how realistic the expectations of the policymakers are and, if necessary, adjust these together with them
Q19: Do you provide for a procedure – in cooperation with the participating policymakers (and, if necessary, with the program managers or donors) – which permits, in the course of the project, a revision of the problem description in the light of new knowledge?	– set revision points in the implementation plan at which the current state of knowledge can be applied to the scientific questions identified – provide for a procedure that allows for any necessary modifications of the scientific questions identified and thus of the common problem description (provide for participation of the policymakers)

of sustainable development are, as a rule, not clearly determinable due to their complexity (see Table 1, quality dimension "systemic"). Therefore, if this process of joint problem description remains implicit, or is omitted entirely, then policymakers and researchers may have different expectations of what can, or is, to be achieved by the research. A high potential for conflict may then develop which may break out during the research process and, in many cases, may no longer be resolvable by then. For researchers, therefore, it is pivotal that this question be dealt with when planning a project.

This focus on a common problem description, however, provides one possible way of accessing the requirements profile for researchers. It can be examined with respect to which requirements relate precisely to this point. Once such requirements are identified, they can be prioritized and approached by asking: "What do we need to do as researchers to adequately implement this specific requirement?" Table 3 illustrates this approach. Here, five individual requirements were identified which are of special importance for the successful determination of a common problem description while planning a project. Although the planning phase was singled out here, it is clear that communication with the policymakers concerning the project's problem description is also important during the implementation and evaluation phases of a research project.

3. Discussion

3.1. Range of application of the quality guideline for PRSR

A major barrier for the introduction of a generic quality standard for TDR, which we have not mentioned above, is limited resources. Adhering to additional quality demands involves costs, both in time and money, for everyone involved, but especially for researchers. Certainly not all research projects can afford such costs – especially because, in project funding,

the allocation of additional resources for quality assurance is still the exception rather than the norm.[7] Given the scope of the three requirements profiles, and the fact that working with these involves intensive communication and coordination, this resource problem also applies to the quality guideline for PRSR presented here. It is unreasonable to require any small-scale project – for example a consulting project on some particular aspect of environmental legislation – to fully deploy the guideline as a matter of course. Instead, we suggest considering it in its entirety only for projects with the following characteristics:

- the participation of at least two research institutions (or two departments within one institution) with different disciplinary backgrounds and at least one policymaker. This represents, in our view, a minimum project complexity at which the challenges of transdisciplinary collaboration start to set in;
- research personnel resources consisting of at least 24 person months and a total project duration of two years or more; as experience shows (Hunecke, 2011: 110), for projects of this size 10 percent of the overall budget has to be allocated for 'integration work', i.e. work which is in the focus of quality assurance in TDR;
- program mangers or donors have expressed the demand for research aimed at supporting policymaking for sustainable development and provided the necessary resources for the implementation of transdisciplinary quality assurance measures.

Projects with these characteristics can, in principle, fully employ the quality guideline for PRSR. This assessment was confirmed by the participants of the expert meetings held in the course of its development (see Section 2.1). Besides the problem of limited resources mentioned above, the concern was raised that systematically following the guideline might curb the flexibility of the research or even threaten its inherent open-endedness. Although we cannot fully remove this concern, we note that the requirements profiles do not make any presuppositions as to how a project should prioritize the listed questions (see Section 2.2 for an example of how a priority setting like this can be done in practice). In fact, it is possible that particular questions do not apply at all to a given project. For example the researches' question: "Do you coordinate the formulation of the given policy problem with the policymakers involved (...) or does your project's implementation plan include a procedure for reaching such an agreement?" (see Annex B, Q7) is less relevant if the policy problem is precisely predefined by the policymakers or the donors (e.g. in the case of research commissioned by a government department). In such cases the actors are, ideally, required to justify and document why they discarded a certain set of questions. In this context, we must emphasize that we do not see the requirements profiles as being set in stone. Instead, we consider the guideline to be a tool that should be developed further by applying it in as many real world settings as possible.

The three characteristics we have introduced at the beginning of this section will not apply to the majority of projects that represent today's rich practice of policy relevant sustainability research. For such small-scale projects we suggest the requirements profiles be used as what Carew and Wickson (2010) call "pick and mix lists" (Carew and Wickson, 2010: 1149): they should form a collection of knowledge from which the relevant actors can draw, depending on their needs and the resources available to them. In order to guide the actors in 'picking' questions, we have distinguished so called 'key questions' in the three requirements profiles (see Annexes A–C, questions labeled 'KQ'). The nine key questions for each group of actors were identified by the participants of the workshop and the expert meetings described in Section 2.1. Reflecting upon these questions was regarded as the least any PRSR project could do in order for it to address the special quality requirements of transdisciplinarity in a meaningful way.

As we have emphasized above, the quality guideline presented here is supposed to allow communication about and self-reflection upon the question of what each of the three groups of actors can, or should, do in order to assure the quality of PRSR.[8] The guideline, therefore, mainly focuses on measures of quality assurance which should be taken in preparing and implementing a research process – a feature that is also indicated by the distribution of the questions among the different temporal phases of the requirements profiles (see Table 2). Evaluation can be defined as the systematic, criteria-based comparison between set targets and performance (cf. Defila & Di Giulio, 1999: 5). Following this definition, our guideline is not, unlike other approaches (see Section 3.2), centered on the evaluation of PRSR projects – although there are some questions in the requirements profiles that directly address the evaluation of research results.

Finally, we note that the quality guideline for PRSR presented here is not a tool that should stand alone. It has to be supplemented by guidelines on issues like, for example, conflict resolution mechanisms (cf. Bardwell, 1991; Bergmann et al., 2005), process design and transdisciplinary methods (cf. Bergmann et al., 2012; Hirsch Hadorn et al., 2008), science-policy interface management (van den Hove, 2007) and cross-cultural communication (Roux, Rogers, Biggs, Ashton, & Sergeant, 2006).

[7] Quality assurance is traditionally thought to be the task and responsibility of a mature scientific community. It therefore comes as no surprise that targeted funding for quality assurance is not high on the donors' agenda. However, it has to be kept in mind that, in transdisciplinarity, a community like this does not yet exist and, due to its heterogeneity, probably never will in a way described by disciplinary science. For the project-based transdisciplinarity we know today, therefore, it has to be accepted that extended quality assurance is a 'work package' that does not come for free.

[8] Note that we conceive that this process of communication and self-reflection should take place among the actors involved in the research (i.e. researchers as well as program managers or donors and policymakers). Independent individuals can, but do not have to, be consulted for quality assurance of the kind proposed here.

3.2. Comparison with other approaches to quality assurance in TDR

In recent years a number of articles have been published that discuss the issue of quality of TDR from a practical perspective. It is not possible to do all of them justice here (for an overview we refer to Klein, 2008). In order to put the quality guideline presented in this paper into some kind of context, however, we will briefly compare it to three approaches we find to be particularly interesting.

One of the earliest and most elaborate attempts to operationalize quality assurance in TDR that we know of, was made by Defila and Di Giulio (1999). Designed in the context of the Swiss Priority Programme Environment (SPP), the authors' approach consisted of "catalogs of criteria" (Defila and Di Giulio, 1999: 8) for the ex-ante and ex-post evaluation of inter- and transdisciplinary SPP research projects. Similar to the guideline we present here, these criteria were formulated as questions. Upon close inspection, the quality aspects they address overlap, to a certain extent, those covered by our requirements profiles (a finding which is particularly true where Defila's and Di Giulio's criteria address the core issue of integration). The main differences to our quality guideline are that Defila and Di Giulio focus on evaluation and that their criteria are not actor-specific, or, more precisely, they solely address researchers' activities (research proposals and products).

The same is true for the approach proposed by Bergmann et al. (2005) (full disclosure: the authors of this paper were institutionally involved in the process that led to the development of the Bergmann et al. approach). Based on the concept of "formative evaluation" (Bergmann et al., 2005: 7) their approach aims to enable learning processes for both researchers and evaluators to take place during the ongoing transdisciplinary research project. The quality criteria these authors suggest for TDR are also formulated as questions and, again, do overlap the quality issues that we have covered. Their application should support the design of interventions that help improving performance when targeted objectives get out of reach. With respect to this essential objective, our guideline is comparable with formative evaluation. The Bergmann et al. approach, however, is neither explicitly actor-specific nor is it tailored to a particular area of application and societal impact of TDR (the latter also extends to the approach by Defila and Di Giulio discussed previously).

Without explicit reference to TDR, Blackstock, Kelly, & Horsey (2007) developed a framework for the summative evaluation of what they call "participatory research for sustainability" (Blackstock et al., 2007: 728). We chose to include their approach in this discussion because it is the only elaborate evaluation framework, we know of, that, like our quality guideline, focuses on sustainability research. The framework Blackstock et al. introduce is supposed to "guide the design of evaluation of participatory research" (Blackstock et al., 2007: 727) and in particular to select suitable evaluation criteria. The criteria the authors come up with for the specific case they studied (coastal management in North-East Australia) seem to cover similar quality issues as our requirements profiles. Yet again, as Blackstock et al. focus on evaluation, their criteria do not explicitly distinguish between the different participating actors. However, we believe that a systematic comparison between their approach and those grounded in transdisciplinarity would reveal productive synergies.

4. Conclusions

Drawing on an analysis of several research projects, as well as on interviews and discussions with scientists, program managers, donors and policymakers, we have developed a quality guideline for transdisciplinary research that aims to support policymaking for sustainable development. For the first time our guideline addresses these groups of actors with individual requirements profiles. The profiles consist of questions that empower the actors to communicate and reflect upon effective measures to assure the quality of the research process. Our approach differs from most others we have found in the literature by singling out concrete areas of application and societal impact of transdisciplinarity, as well as being actor-specific. In contrast to others, moreover, our guideline does not focus on the evaluation of transdisciplinary projects or programs. We suggest, however, that it form a suitable basis for the development of a corresponding evaluation framework.

Transdisciplinary research, and PRSR in particular, operates at so-called science-policy interfaces. These interfaces are more or less institutionalized in most countries. In Germany, for example, an almost impenetrable network of advisory boards, departmental research agencies, specialized research funding bodies and private consultancies has evolved during the last few decades. Analyzing the rationale of such institutional structures (cf. van den Hove, 2007), we believe, is crucial for generally advancing the issue of quality assurance in transdisciplinarity. An understanding like this would help to answer the question of how a proposed quality standard for TDR and its corresponding evaluation frameworks can best be established within these structures.

From this perspective, quality assurance in transdisciplinary research appears to be a political issue in its own right. Any quality standard that has been successfully tested in research practice and that is easy to use and flexible enough to cover a wide range of applications and contexts will only make inroads if major players not only from science but also from politics and civil society support it. For this to happen, an open debate is needed, in which the interests and values of all parties involved are placed on the table. In order to successfully participate in such a debate, we believe it is pivotal for science as a whole to rethink and proactively realign its relation with society by finding a new balance between autonomy and a critical openness for societal demands.

In order to achieve this, science can benefit from a large body of existing literature on the quality of new modes of research. Our impression, however, is that the relevant discourses about inter- and transdisciplinarity, sustainability science, team science, participatory research or post-normal science largely run parallel to each other. It is our conviction that exchange and systematic comparison between these different discourses would be beneficial, not only in terms of quality

assurance but also with respect to creating a momentum for the proliferation of a critical and self-reflexive transdisciplinarity.

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Annex A. Requirements profile for program managers or donors

See Table A.

Table A
Requirements profile for program managers or donors (modified according to Jahn & Keil, 2013). The term "policy problem" refers to the task of policy making for advancing sustainable development in a particular context (e.g. increasing energy efficiency in the heat supply of residential buildings). The term "policy area" describes the larger policy context of the given problem (e.g. energy supply). The term "applicant" includes individual researchers, single research facilities, and consortia of research institutions. The abbreviation 'KQ' stands for 'key question' (see Section 3.1 for explanations).

Phase I—Preparing a program or call for proposals

Q1: Do you consider the environmental, social and economic aspects of the policy problem? *(systemic)*
Q2: Do you ask the applicants to justify which dimensions or systemic aspects of the policy problem will not be examined (in terms of dealing with complexity)? *(systemic*, KQ)
Q3: Do you outline the relevant levels of action (e.g., municipal, regional, national or global) related to the policy problem in the call for proposals? *(scale-spanning, KQ)*
Q4: Do you align your own goals to the fact that a research process is principally open-ended? *(prospective)*
Q5: Do you indicate potential conflicts or synergies arising between your own actions and those of others with respect to the policy problem indicated? *(prospective)*
Q6: Do you identify the societal actors and policymakers relevant to the given policy problem? *(context-specific)*
Q7: Do you clearly formulate what kind of knowledge or information research is expected to deliver with respect to the given policy problem? *(context-specific)*
Q8: Do you assess the temporal development of the corresponding policy area and do you adjust the timing of the program or call for proposals accordingly? *(context-specific)*
Q9. Do you ask the applicants to specify the policy problem from a scientific perspective or to adapt it to the consulting needs of those policymakers who are supposed to participate in the research? *(context-specific)*
Q10: Do you request the applicants to include policymakers in the research process and do you give pointers indicating the expected form of participation? *(integrative)*
Q11: Do you consider subsidies for integration efforts and do you ask the applicants to submit an elaborated integration concept? *(integrative, KQ)*
Q12: Do you consider a two-stage application procedure which supports the development of a common problem description–in particular one negotiated between applicants and policymakers–and do you make adequate resources available for this? *(integrative, KQ)*
Q13: Do you request the applicants to provide an overview of the relevant state of knowledge and the methods to be used? *(method based)*
Q14: Do you provide for the possibility of developing a cross-disciplinary, problem specific methodology? *(method based)*
Q15: Do you ask the applicants to select an integrative research approach and to apply specific quality criteria (if available) for the approach chosen or else to name their own? *(method based)*
Q16: Do you provide for measures to promote a "learning research process" (for example, information events during the application phase, goal setting activities, review points, cross-cutting activities, monitoring research)? *(critical-reflexive, KQ)*
Q17: Do you ask the applicants to make a preliminary assessment of the consequences of implementing the policy recommendations developed? *(critical-reflexive)*
Q18: Do you require the applicants to determine the various roles researchers and policymakers will play during the project and to consider the potential for conflict? *(critical-reflexive)*
Q19: Do you explicate your own understanding of sustainability and do you apply it to the given policy area? Do you refer to relevant existing sustainability goals (e.g., in the context of a national sustainability strategy)? *(normative)*
Q20: Do you ask the applicants to refer to your own understanding of sustainability and to justify possible deviations from this? *(normative)*
Q21: Do you indicate which kind of sustainability knowledge (system, orientation or transformation knowledge) should be produced? *(normative)*
Q22: Do you clarify and communicate your own expectations concerning the form and usefulness of the research results? *(impact oriented)*
Q23: Do you ask the applicants to provide an estimate of the potential benefit of the research to both policymaking and science? *(impact oriented; KQ)*
Q24: Do you require the applicants to provide a knowledge transfer strategy? *(impact oriented)*
Q25: Do you earmark the possibility of funding subsequent implementation projects and do you define performance criteria for the granting of such projects? *(impact oriented, KQ)*
Q26: Do you ask the policymakers to declare their readiness in principle to implement the project results? *(impact oriented)*

Phase II—Monitoring an ongoing program or project

Q27: Do you identify current policy developments relevant to the given policy problem and do you communicate this to the researchers? *(prospective)*
Q28: Do you communicate changes in policymaking priorities and in the temporal development of the given policy area promptly? *(context-specific)*
Q29: Do you support opportunities for networking with other projects covered by the program or with relevant policymakers? *(integrative)*
Q30: Do you implement the measures funded to support a learning research process and do the researchers make use of them? *(critical reflexive)*
Q31: Do you consider the possibility of revising the goals of the program or call for proposals in light of new scientific knowledge? *(critical-reflexive, KQ)*
Q32: Do you support the policymakers participating in the program or project (logistically, financially) in preparing a subsequent implementation project? *(impact oriented)*

Q33: Do you review the specified success criteria for deciding on the financing of a subsequent implementation project? *(impact oriented)*

Phase III—Evaluating a program or call for proposals

Q34: Do you require the researchers to describe the limits of the research results or policy recommendations developed? *(critical-reflexive)*
Q35: Do you evaluate the program or call for proposals upon completion with regard to the possible improvement of future funding measures? *(critical-reflexive, KQ)*
Q36: Do you ask the researchers to describe the contribution of the research to achieving the goals set by the program or call for proposals? *(impact oriented)*
Q37: Do you support the policymakers in implementing the research results or the policy recommendations (logistically, symbolically)? *(impact oriented)*
Q38: Do you require the researchers to safeguard the new knowledge produced during the project and to make it easily accessible? *(impact oriented)*

Annex B. Requirements profile for researchers

See Table B.

Table B
Requirements profile for researchers (modified according to Jahn & Keil, 2013). The term "mutual learning" is used as introduced by Scholz (2001: 118). The term "integration concept" denotes a concept that outlines how cooperation among the scientific disciplines involved as well as between scientific and extra-scientific actors is organized. The abbreviation 'KQ' stands for 'key question' (see Section 3.1 for explanations).

Phase I—Planning a research project

Q1: Do you show which theoretical understanding of "system" (i.e. a concept of the interaction between nature and society) is in play and how you aim to investigate systemic relations within the context of the policy problem? *(systemic)*
Q2: Does your proposal explain which dimensions or systemic relationships within the context of a policy problem will not be studied and how this reduction of complexity should be dealt with in the course of the project? *(systemic, KQ)*
Q3: Do you identify adjacent policy areas and do you show how potential synergies or conflicts should be included and studied? *(scale spanning)*
Q4: Do you provide for an explicit procedure that helps to ensure the open-endedness of the research project in view of the given policy goals? *(prospective)*
Q5: Do you develop an approach with which to study the consequences of implementing the policy recommendations? *(prospective)*
Q6: Do you identify relevant policymakers who are willing to participate in the research and do you clarify whether the institutional and financial conditions exist to enable their active and continuous participation? *(context specific, KQ)*
Q7: Do you coordinate the formulation of the given policy problem with the policymakers involved (and, if necessary, with the program managers or donors as well) or does your project's implementation plan include a procedure for reaching such an agreement? *(context specific, KQ)*
Q8: Do you translate the given policy problem into scientific research questions? *(context specific)*
Q9: Do you identify the social groups relevant to the given policy problem and do you show how you aim to take their knowledge as well as possible conflicts of value and interest among them into account? *(context specific)*
Q10: Do you align the research concept with the time line of the policy action plan such that, for example, short-term, medium-term and long-term goals can be distinguished? *(context specific)*
Q11: Do you provide reasons which justify the composition of the project team regarding the scientific and technical expertise needed to work on the given policy problem? *(integrative)*
Q12: Does your proposal include an elaborated integration concept with defined integration goals, and are the costs of the integration efforts adequately accounted for in the resource planning? *(integrative; KQ)*
Q13: Do you show how the participating disciplines will work together to produce the knowledge needed and how they will work together with the participating policymakers? *(integrative)*
Q14: For two stage application processes: When applying for the first stage, do you explain how the identified policymakers should be involved in the research process and how a common problem description will be developed by the start of the second phase? *(integrative)*
Q15: Do you select an integrative research approach and do you vet it for its suitability for dealing with the problem as described? *(method based)*
Q15: Do you survey the relevant existing pool of knowledge and do you identify already existing methods for working on the given policy problem? *(method based)*
Q16: Do you show to what extent it might be necessary to develop new methods for working on the given policy problem? *(method based)*
Q17: Do you explain which existing quality standards you apply or else do you introduce your own standards? *(method based)*
Q18: Does the project's implementation plan provide for measures that support mutual learning within the project team as well as between the team and the participating policymakers? *(critical-reflexive, KQ)*
Q19: Do you provide for a procedure–in cooperation with the participating policymakers (and, if necessary, with the program managers or donors)–which permits, in the course of the project, a revision of the problem description in the light of new knowledge? *(critical-reflexive)*
Q20: Do you reflect upon your own role and that of the participating policymakers and do you present this clearly in the proposal? *(critical-reflexive)*
Q21: Do you clearly present your own understanding of sustainability and do you relate it to the given policy problem? Do you justify differences, where present, vis-à-vis the understanding of the program managers or donors? *(normative)*
Q22: Do you show which kind of sustainability knowledge will be produced (system, transformation or orientation knowledge) and do you justify deviations from the program managers'/donors' or the participating policymakers own assessments? *(normative)*
Q23: Do you develop a strategy for the transfer of knowledge, do you present it in the proposal and do you outline how it should be implemented? *(impact oriented, KQ)*
Q24: Do you differentiate between the project's scientific and practical knowledge goals and do you carry out and justify a corresponding weighting? *(impact oriented)*
Q25: Do you assess the expected contribution of the project to resolving the given policy problem? *(impact oriented)*
Q26: Do you set your own success criteria for the project (as far as possible in concert with the participating policymakers) or do you refer to those given by program mangers or donors? *(impact oriented)*
Q27: Does your research design include resources that can be used to deal on short notice with incidental policy consulting needs? *(impact oriented)*

Phase II—Implementing a research project

Q28: Do you study the extent to which the policy recommendations developed are compatible with relevant developments in other policy areas? *(scale spanning)*

Q29: Do you examine the conditions for implementing the policy recommendations developed and do you adjust their design if necessary? *(context specific)*
Q30: Do you regularly review the success of cooperation within the project team as well as with the participating policymakers and do you adjust the integration concept if necessary? *(integrative)*
Q31: Does your project provide for a continuous transfer of knowledge among the participating disciplines and between the project team and the participating policymakers? *(integrative, KQ)*
Q32: Do you take advantage of offers by program managers or donors to share experiences with other projects or with relevant policymakers? *(integrative)*
Q33: Do you evaluate the knowledge produced following recognized methods or those that were specifically developed for the given policy problem? *(method based)*
Q34: Do you explicitly translate the scientific results into practical solutions to the given policy problem? *(method based)*
Q35: Do you regularly check compliance with any additional quality criteria that you may have applied? *(method based)*
Q36: Do you carry out measures supporting mutual learning and do you check their effectiveness? *(critical-reflexive)*
Q37: Do you systematically disclose the disciplinary or departmental premises, hypotheses, paradigms, etc.? *(critical-reflexive)*
Q38: Are your project's outcomes temporarily and linguistically compatible with the needs and expectations of the participating policymakers and do you regularly check this during the course of the project? *(impact oriented, KQ)*

Phase III—Evaluating a research project
Q39: Does your final report clearly present the potentials and limits of the practical and scientific knowledge gained in the project? *(critical-reflexive, KQ)*
Q40: Do you evaluate the entire project in terms of the success or failure of integration? *(critical-reflexive)*
Q41: Do you assess whether the practical knowledge goals are achieved and to what extent the results can be transferred to other policymakers or policy areas? *(impact oriented)*
Q42: Do you assess whether the scientific knowledge goals are achieved and generalized beyond the context of the problem studied? *(impact oriented)*
Q43: Do you work up the system, transformation or orientation knowledge produced in the project and do you save it in appropriate media and formats? *(impact oriented)*

Annex C. Requirements profile for policymakers

See Table C.

Table C
Requirements profile for policymakers (modified according to Jahn & Keil, 2013). The abbreviation 'KQ' stands for 'key question' (see Section 3.1 for explanations).

Phase I—Participating in the application for a research project
Q1: Do you communicate ongoing policy projects (possibly at different policy levels or within different policy areas) which stand in relation to the proposed project? *(scale spanning)*
Q2: Do you set your own targets for the principally open-ended research process broadly enough and can you communicate unexpected research results internally? *(prospective*, KQ*)*
Q3: Do you identify and communicate the conditions for actually implementing the policy recommendations to be developed by the project to the researchers early on? *(context specific, KQ)*
Q4: Do you explicitly communicate your own policy goals to the researchers? *(context specific)*
Q5: Do you commit your own financial and human resources to ensuring ongoing involvement in the research project or do you indicate the need for appropriate additional resources (to the program mangers/donors or researchers)? *(integrative, KQ)*
Q6: Do you actively participate in the formulation of a joint description of the policy problem? *(integrative)*
Q7: Do you accept the researchers' method-based procedure for producing, integrating and evaluating knowledge? *(method based)*
Q8: Do you reflect your own role in the research project and, where necessary, do you explain it to the researchers? *(critical-reflexive)*
Q9: Do you take into account the extent to which the project is compatible with your own structures and processes? *(critical-reflexive)*
Q10: Do you clearly communicate your own understanding of sustainability or do you explicitly refer to the sustainability concept of the program managers/donors or researchers? *(normative)*
Q11: Do you communicate your own sustainability goals related to the given policy area? *(normative)*
Q12: Do you assess which kind of sustainability knowledge (system, transformation or orientation knowledge) you need for your own policymaking? *(normative)*
Q13: Can you confirm a basic willingness to implement the expected project results? *(impact oriented)*
Q14: Do you define distinct success criteria for the project in consultation with the researchers? *(impact oriented, KQ)*
Q15: Do you communicate your own expectations regarding the form and usefulness of the project results to the researchers? *(impact oriented)*

Phase II—Participating in the implementation of a research project
Q16: Do you promptly inform the researchers about potential synergy effects or conflicts with your own new policy projects or those of others? *(scale spanning, KQ)*
Q17: Do you communicate changes in your own policy, institutional or temporal framework, as well as in your own goals early on in the course of implementing the project? *(context specific, KQ)*
Q18: Do you actively participate in the research process or do you appreciate offers by the researchers to participate? *(integrative)*
Q19: Do you accept uncertainties, ranges of variation, and alternative solutions as an integral part of research? *(critical-reflexive)*
Q20: Are you willing to revise the original project goals in light of new knowledge produced during the research process? *(critical-reflexive)*
Q21: Do you regularly check during the course of the project whether options for implementing the policy recommendations arise? *(impact oriented, KQ)*
Q22: Do you timely consider applying for an implementation project or do you launch an internal process to implement the results of the research? *(impact oriented, KQ)*

Phase III—Utilizing a research project

Q23: Do you evaluate the costs of participating in the research process in relation to the impact on policymaking and do you communicate your evaluation to the program managers or donors? *(critical-reflexive)*

Q24: Do you review or, if needed, revise your own sustainability goals or your own sustainability concept in light of the project results? *(normative)*

Q25: Do you assess whether the project results have had an impact on policymaking and do you communicate your assessment to the researchers and the program managers/donors? *(impact oriented)*

Q26: Do you adequately safeguard the knowledge generated and do you make it available for your own policymaking practice (possibly in consultation or cooperation with the researchers)? *(impact oriented, KQ)*

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