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ANALYSIS

The Objectives of Stakeholder Involvement in Transdisciplinary Research. A Conceptual Framework for a Reflective and Reflexive Practise

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ABSTRACT

Transdisciplinary research is a well-recognised approach to address complex real-world problems. However, the literature on a central aspect of transdisciplinarity, namely stakeholder involvement, largely lacks a reflection on its objectives. In response, we present a framework defining four general rationales for stakeholder involvement: normative, substantive, social-learning, and implementation objectives. We demonstrate the applicability of the framework and analyse how the design and processes of three collaborative research projects dealing with sustainable land management in Southern Africa, Southeast Asia, and South America were affected by motivations to include stakeholders.

Our assessment indicates that at the projects' outset, many scientists pursued a normative rationale and saw stakeholder involvement as a burden. In the course of the projects, the substantive objective became more relevant as being closely linked to the core mandate of scientists. The projects also aimed for social learning and implementation processes, which, however, did not remain uncontested among team members. Overall, our study indicates that jointly negotiating, clarifying, communicating, and reflecting the underlying objectives of stakeholder involvement can help developing more effective interaction strategies and clarifying expectations. The conceptual framework can guide a systematic reflective and reflexive practise and support the planning and co-designing of future transdisciplinary research projects.

1. Introduction

There is growing awareness that today's urgent societal problems are characterised by increasing complexity, uncertainty, multiple values and high stakes, which challenge traditional academic knowledge production (Funtowicz and Ravetz, 1993; Newig et al., 2019; Nowotny et al., 2001). Transdisciplinary research is seen as a promising response to address such complex societal and sustainability challenges (Hirsch Hadorn et al., 2006; Lang et al., 2012). We refer to the concept of transdisciplinarity as defined by Jahn et al. (2012, p. 4), where transdisciplinary research is a reflexive approach that encompasses interdisciplinary collaboration among scholars plus the collaboration between academic and non-academic stakeholders concerned with a particular real-world problem in processes of mutual learning and integration. It aims to integrate different perspectives and bodies of knowledge in order to develop results that are scientifically valid and socially relevant (Jahn et al., 2012; Lang et al., 2012). Reflecting on and respecting the diversity of epistemologies, cultures, roles, and interests of all involved parties is a precondition for transdisciplinary research (Scholz and Steiner, 2015; Simon et al., 2018).

In this paper, we take a closer look at the objectives of stakeholder involvement in transdisciplinary research. We understand stakeholders

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as individuals, groups and/or organisations that are affected by or can affect the researched issue. Stakeholder involvement in transdisciplinary research has taken diverse forms, depending on the particular conception held by those involved, the specific project goal and frame, and the resulting project design. As a result, stakeholders become addressees of knowledge transfer, sources of information, and/or actively steering participants (Brandt et al., 2013; Mobjörk, 2010).

In the context of public decision-making, Arnstein (1969) introduced the "ladder of participation", arguing that real participation only takes place when the public is given sufficient power to negotiate their interests and putting this kind of interaction at the top of the ladder. The normative idea "the higher the better" has been questioned by various scholars suggesting that the intensity and form of stakeholder involvement should be adapted to the problem addressed, the research context and objective, the specific stakeholder group, the extent of agreement regarding values and knowledge, and the project phase (Hurlbert and Gupta, 2015; Neef and Neubert, 2011; Reed 2008; Reed et al., 2018). These views enable the development and application of a broader variety of methods and forms of stakeholder involvement (Newig et al. 2008; Schmidt et al., 2018; Stauffacher et al. 2008). However, to increase chances for engagement to be successful, the selection of approaches needs to be well-considered and informed by theory (Reed et al., 2018).

Reed (2008) emphasises that clarifying desired ends among scientists and stakeholders is critical for designing successful stakeholder involvement. Conversely, not articulating objectives carries the danger of pursuing diverging intentions and expectations, leading to limited impact of transdisciplinary research and disappointments among those involved (Schmidt and Pröpper, 2017; Spangenberg et al., 2018b; Spangenberg et al., 2015; Wesselink et al., 2011). The selection of stakeholders and involvement methods as well as the consideration of aspects such as interests, availability of time, resources, and capacities of stakeholders and researchers are critical in the project design (Görg et al., 2014; Reed 2008). However, while the involvement of stakeholders is considered a self-evident integral part of transdisciplinary research, in many projects it remains unclear which objectives drive the stakeholder involvement (Wesselink et al., 2011). This missing awareness is argued to be a fundamental reason why researchers and stakeholders frequently report that expectations regarding the involvement of stakeholders in research and decision-making are not met (Blackstock et al., 2007; Bracken et al., 2014; Reed 2008).

The aim of this paper is to (1) categorise the different rationales for involving stakeholders in transdisciplinary research, (2) show how such a distinction can guide a systematic reflective and reflexive process and planning in transdisciplinary projects, and (3) reveal benefits of a systematic reflection to the planning and implementation of transdisciplinary research. After presenting our methodological approach, we introduce a conceptual framework of objectives and then test it by applying it in a comparative analysis of the approaches and underlying rationales for stakeholder involvement in three collaborative research projects on sustainable land management.

2. Methodological Approach

We conducted a narrative literature review – an expert-based synthesis of key literature (Greenhalgh et al., 2018) – on transdisciplinary research aiming to deepen our understanding on existing objectives for stakeholder involvement discussed by peer scholars. We compiled and categorised the objectives mentioned in the literature in Table 1. We then applied the resulting framework to three transdisciplinary research projects in Southern Africa (TFO), South America (INNOVATE) and South East Asia (LEGATO). All three projects were part of the Sustainable Land Management (LAMA) funding programme of the German Ministry of Education and Research (BMBF), Germany. Hence the results predominantly apply to this and related research fields. The group of authors developed and coordinated the involvement of stakeholders in the course of the respective projects.

For the ex-post analysis of objectives, each co-author summarized the approaches applied in their project to involve stakeholders and intuitively assessed the importance of objectives (see Fig. 1). Feedbacks gathered from other project members and discussions among the authors on their assessments and resulting adjustments happened in an iterative way. In the empirical analysis, we present each project's approaches for stakeholder involvement and reflect upon their underlying, partly changing and disputed rationales.

While we hold that our systematisation of rationales proposed in the next section is generic, we are aware that our analysis is a selective and subjective assessment of objectives pursued by project teams. However, aiming to raise the awareness for and deepen the understanding of different objectives for stakeholder involvement, this approach of a critical reflection has the strength to contribute to its conceptualisation based on situated knowledges. Being transparent about the necessarily perspective analysis of our cases, we contribute to the debate through informed arguments (Greenhalgh et al., 2018; Haraway, 1988). Our experience-based insights demonstrate that the framework can stimulate reflections in project teams and raise awareness for the existence and role of different rationales. By engaging in this self-reflection process, we also disclose the complexities and dynamics in science-society interactions.

3. Objectives of Stakeholder Involvement in Transdisciplinary Research

Discussions of rationales for stakeholder involvement emerged in the context of political decision-making processes and are based on a contribution by Fiorino (1990), who distinguishes substantive, normative, and instrumental arguments. Inspired by these categories and further literature, and driven by the goal of systematising the discussions in the transdisciplinarity literature, we propose the following objectives for stakeholder involvement in transdisciplinary research: (i) the normative, (ii) the substantive, (iii) the social-learning, and (iv) the implementation objective (Table 1).

The **normative objective** refers to the democratic principle that people should be given the opportunity to contribute to the processes of knowledge generation that affect them (Arnstein, 1969; Fiorino, 1990). It is the basis of research designs postulating that all those that are affected by or can affect the problem under investigation should have a voice when formulating, conducting and implementing transdisciplinary research (Lang et al., 2012; Pohl and Hirsch Hadorn, 2007). Stakeholder involvement becomes then an end in itself (Hage et al., 2010; Stirling 2008).

The **substantive objective** is to improve the quality and significance of research (Fiorino, 1990; Stirling 2008). It motivates a core methodological characteristic of transdisciplinarity, the exchange between and integration of the various bodies of knowledge, perspectives and approaches in order to co-produce a socially robust and holistic understanding of problems (Aeberhard and Rist, 2009; Jahn et al., 2012; Scholz and Steiner, 2015). This increases the context-specific relevance of research (Bracken et al., 2014; Hirsch Hadorn et al., 2006; Lang et al., 2012). The substantive rationale implies the acknowledgment that scientific knowledge is just one of many legitimate bodies of knowledge (Meppem and Bourke, 1999; Nowotny et al., 2001) and aims to give room to all those bodies of knowledge to co-design shared understandings and objectives (Stirling 2008; Wesselink et al., 2011).

The **social-learning objective** aims at an improved mutual understanding of different interests, potential conflicts, values and capacities. Participation can provide an opportunity for social learning. For this to happen, processes of sharing, negotiating and (self-)reflecting upon their multiple perspectives on the issue investigated among scholars and stakeholders have to be stimulated. Social learning can result in establishing new networks, the building of trust and identification of balanced solutions (Lang et al., 2012; Reed et al., 2010; Scholz

Table 1
Stakeholder involvement in transdisciplinary research: the four objectives and their principles with references to literature indicating aspects of the objective.

Objective	Principles	Literature references
Normative	Democratic principle that those affected should have a say › Giving all those affected a voice when formulating and refining the research question and implementing its process and outcomes.	Arnstein, 1969; Fiorino, 1990; Hage et al., 2010; Pohl and Hirsch Hadorn, 2007; Stirling 2008
Substantive	Improvement of the quality of research › Consideration of stakeholders' needs and perspectives increases the context-specific relevance; › Integration of all bodies of knowledge available allows a holistic understanding of the problem; › Linking stakeholder knowledge with scientific knowledge helps with identifying locally adapted solutions.	Bracken et al., 2014; Fiorino, 1990; Hage et al., 2010; Hirsch Hadorn et al., 2006; Lang et al., 2012; Meppem and Bourke, 1999; Pohl and Hirsch Hadorn, 2007; Reed 2008; van Kerkhoff and Lebel, 2006
Social learning	Stimulating processes of social learning to better understand and solve the problem › Bringing stakeholders together, enabling networks, trust and a shared understanding; › Empowerment by giving those marginalised a voice; › Awareness-raising about conflicting interests and reflecting on one's values and behaviour; › Consideration of one another's needs, norms and visions can guide transformation processes.	Blackstock et al., 2007; Bracken et al., 2014; Hage et al., 2010; Hirsch Hadorn et al., 2006; Lang et al., 2012; Nauen et al., 2006; Reed et al., 2010; Stirling 2008; van Kerkhoff and Lebel, 2006
Implementation	Increase of acceptance and legitimacy of the process outcomes › Engagement builds common ground and trust, which increases stakeholders' motivation and commitment to contribute to a joint process; › Giving stakeholders a voice and considering their interests leads to growing acceptance, legitimacy and ownership of the process and its outcome; › Increase in acceptance leads to increased impact and long-term usage.	Bracken et al., 2014; Fiorino, 1990; Hage et al., 2010; Hirsch Hadorn et al., 2006; Jahn et al., 2012; Lang et al., 2012; Pohl and Hirsch Hadorn, 2007; Reed 2008

and Steiner, 2015). It can eventually contribute to lasting behavioural change, empowerment and improved capacity to manage change (Blackstock et al., 2007; Hage et al., 2010; Hirsch Hadorn et al., 2006). Initiating social learning can be a very sensitive issue, challenging existing power structures and running the risk of prompting or fuelling conflicts between actors (Reed 2008).

The **implementation objective** aims to increase the legitimacy and impact of the research outcomes with regard to an aspired-to solution of the studied problem (Fiorino, 1990; Stirling 2008). Although envisaged solutions can be manifold and preferences and acceptability vary between actor groups, the experience of having had influence on the research process can create a feeling of ownership, increase trust and stimulate commitment among participants in the project and its outcomes. It motivates participants to spread the information derived. This may increase the impact of the research as outputs are more likely to be used and adopted even by agents beyond those involved in the project (Spangenberg, 2011). Finally, the ongoing involvement may lead to an increase of capacity regarding the use and implementation of new knowledge in the future (Bracken et al., 2014; Hirsch Hadorn et al., 2006; Lang et al., 2012; Reed 2008; van Kerkhoff and Lebel, 2006).

4. The Sustainable Land Management programme and the Three Project Cases

The LAMA programme (http://www.ufz.de/glues/) focused on interactions between land management, climate change and ecosystem services. It aimed at developing solution-oriented knowledge supporting sustainable land use through inter- and transdisciplinary research (BMBF 2008). It ran from 2009 to 2017 and funded twelve collaborative 5-year projects implemented by scientists from Germany in collaboration with scientists and practice partners of the researched countries. This paper reflects on three of the LAMA projects.

4.1. The Future Okavango (TFO)

The TFO project (www.future-okavango.de) supported stakeholders' decision-making by providing a better understanding of the socio-ecological system of the Okavango Basin covering parts of Angola, Namibia and Botswana. The improved system understanding was condensed into scenarios illustrating alternative future development pathways regarding land and water management. The project incorporated expertise in climate science, remote sensing, GIS modelling, hydrology, micro-biology, soil science, botany, anthropology, as well as environmental and institutional economics. Additionally, one subproject was specifically responsible for facilitating stakeholder integration and communication (Pröpper et al., 2015).

4.2. INNOVATE

The INNOVATE project (www.innovate.tu-berlin.de) developed land and water management options that are ecosystem-friendly and economically viable in the São Francisco watershed, which spans several states of Brazil. It focused on one of its semi-arid reservoir regions that was affected by involuntary resettlement due to dam construction in the 1980s (Siegmund-Schultze et al., 2018). The reservoir is managed with a focus on hydroelectricity generation, which affects the availability of water in the semi-arid downstream portion of the watershed. Scientists investigated the state and dynamics of farming and fishing and studied aquatic and terrestrial biodiversity and functions from a systems perspective, as well as interactions between ecological, socio-economic, and governance factors. Stakeholder integration and communication was the task of all project members, facilitated by the project coordination team.

4.3. LEGATO

The LEGATO project (www.legato-project.net) analysed the combined generation of provisioning, regulating and cultural ecosystem services in irrigated rice agriculture and their importance in the face of growing food demand, global change processes and increasing pollution in seven regions in the Philippines and Vietnam (Spangenberg et al., 2018a). While the mountain regions face the challenge of degrading rice terraces, both countries' lowlands face trade-offs between pesticide use and crop-production security. LEGATO analysed the driving forces causing degradation and developed, together with political and administrative decision-makers, farmers, traders and other stakeholders,

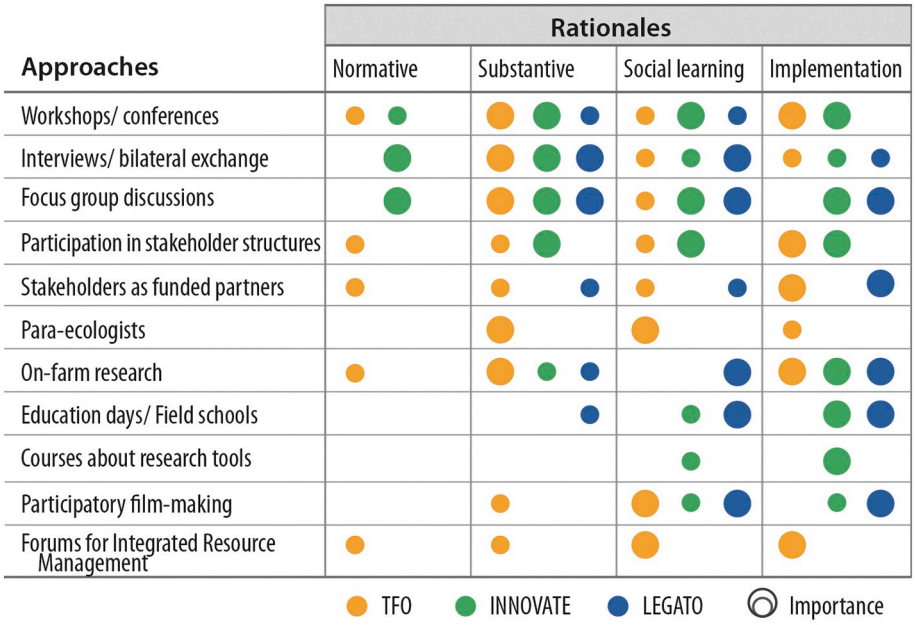

Fig. 1. Assessed importance of selected methods for fulfilling the objectives of stakeholder involvement in the three transdisciplinary projects.

proposals for how to counteract them, promoting ecological engineering as an adaptation approach. The team consisted of experts in geo-chemo-physical, biological, social and cultural sciences, most of them working with stakeholders.

5. Results

An initial impulse towards stakeholder involvement for all three projects has been the call for project proposals, which specifically requested transdisciplinary approaches (BMBF 2008). Since the understanding of transdisciplinarity remained vague in the call, many project members perceived transdisciplinarity as a new trend in science without clear operational implications. The call also demanded that projects should develop strategies for action, technologies and system solutions, which would be judged regarding their usability by stakeholders. In the following we present the stakeholder involvement of the three projects in the light of the four objectives. The analysis is summarized in Fig. 1.

5.1. Experiences of TFO

The TFO project largely evolved from previous research initiatives in Southern Africa and could build on existing contacts with researchers and stakeholders in the region. While stakeholders were formerly involved in a rather unstructured way (Falk et al., 2010), some partners saw TFO as a chance to embed stakeholders more comprehensively, mainly with the intention to increase the relevance and impact of the project (substantive and implementation objectives). The project's stakeholder analysis revealed at least 130 potential individual, group or organisational stakeholders. An engagement with all on normative grounds was impossible. A group of scientists of all involved countries developed a concept for facilitating stakeholder involvement and opted for a dual strategy focusing on higher-level decision-makers and local land-users (for a detailed review of the approaches, see Schmidt et al., 2013).

The latter, mainly subsistence farmers, are directly dependent on and influence the provision of ecosystem services while being barely heard in decision-making processes. Project introductory workshops aimed at increasing the legitimacy and acceptance of the project and its intentions in the local communities (implementation objective). This was supported by on-farm action research on conservation agriculture and the establishment of local Forums for Integrated Resource Management (FIRMs), multi-stakeholder platforms aiming to drive local development activities. At the same time, all these instruments served to better understand local stakeholders' perspectives and integrate farmers' and academic knowledge (substantive objective). The latter was supported by para-ecologists – members of the rural communities who were employed and trained by the project to support local research activities. The para-ecologists thereby bridged the gap between the communities and researchers and facilitated learning processes among them (Schmiedel et al., 2016). More explicitly, social learning was the aim of participatory filmmaking and the aforementioned FIRMs. The former allowed local community members to express their views on natural resource management issues and share them with the wider public. The latter facilitated interaction between local land-users, traditional authorities, local administration and TFO researchers. This process supported local communities' empowerment (Schmidt et al., 2018; Fig. 1). The effectiveness of the instrument to serve the objectives strongly depended on the individual researcher's awareness and interest. Especially junior scientists approached stakeholders for substantive purposes. However, many researchers considered stakeholder engagement to be the normative responsibility of the project management team, while the later saw its role in facilitating the whole team's interactions mainly to increase the relevance of the research (implementation objective).

On a sub-national and national scale, stakeholder engagement was strongly driven by implementation motivations. TFO established a funded collaboration with national NGOs which could feed project results into decision-making processes even beyond the end of the project. Their embeddedness in (sub-)national networks, and their capacity to mediate between stakeholder groups, further contributed to social-learning processes. The NGO partners were also important for substantive reasons given their experience in accessing local knowledges and perspectives. Additional policy impact was achieved through participation in multi-stakeholder land-use planning processes in Namibia. In this case, government bodies approached the TFO team and expressed demand for the project's expertise. National level stakeholders were further invited to two project conferences, driven by the implicit normative thinking that a project needs to conduct stakeholder workshops. However, some team members valued the stakeholder

interactions at the conferences from a substantive and implementation perspective (Fig. 1).

On the transboundary level, the TFO team identified the Permanent Okavango River Basin Water Commission (OKACOM) as a strategic partner who could potentially support the intended policy-making impacts (implementation objective). OKACOM is an advisory commission on transboundary resource management established by the riparian countries. It formally endorsed TFO; TFO in turn aligned its project outcomes with OKACOM's Strategic Action Plan. This highly strategic initiative only partly met expectations and the project team struggled to coordinate with the commission (Schmidt and Pröpper, 2017).

Interviews with stakeholders at all levels served to learn about their visions regarding possible future pathways in the basin in order to integrate these into TFO's scenario development (substantive objective). The scenario-building process stimulated social-learning processes by integrating and communicating different perspectives. The scenarios together with a range of other outputs (final report, data management system, GIS-based Decision Support System, calendar and film in local languages; see Pröpper et al., 2015) were presented, discussed and distributed in a range of final workshops with the intention of supporting decision-making processes (implementation objective) (Fig. 1).

5.2. Experiences of INNOVATE

The INNOVATE consortium emerged from previous disciplinary projects. The initial science partners felt the need to study soil and water management in a more interconnected and interdisciplinary way, resulting in the design of INNOVATE. Constellation analysis was used as a bridging method to engage partners – among disciplines and with stakeholders (Rodorff et al., 2013). Non-science and science participants jointly mapped and discussed information, resulting in a joint understanding of all involved (substantive and social learning objective).

The normative rationale played an immanent role for several researchers in their interaction with stakeholders during interviews, focus-group discussions, workshops, and a project conference where stakeholders were key players in panels. Other researchers struggled with the cognitive and temporal requirements needed for a transdisciplinary approach and, at the outset of the project, paid little attention to stakeholder interactions. In the course of the project, an increasing number of project members came to comprehend their research in a more society-embedded way. It became clear that stakeholders were not only intrinsically connected with the research topics (and therefore needed to be involved; normative objective). They could contribute to the research in a considerable way improving eventually the relevance and quality of research outcomes (substantive objective). Moreover, they felt rewarded by becoming more confident that their research will have some meaning and impact beyond their academic achievements (implementation objective) (Fig. 1).

Participating in existing organisations such as the multi-stakeholder river basin committee, a group with relatively high influence, provided a platform to better apprehend and stimulate the discourses on water allocation (substantive and social-learning objectives). Many methods and activities that were designed by the project finally served more than one objective: Interacting in interviews, conferences, focus groups, or workshops for the Constellation Analysis allowed capturing stakeholder knowledge and triggering exchange (substantive and social-learning objective). The implementation rationale was immanent in the aforementioned interactions, albeit to varying degrees, and generally gained in importance towards the end of the project. The continuous collaboration helped to build mutual trust and interest. Bilateral and group follow-up discussions on partial research results facilitated, for instance, exploring management options to achieve a more ecological river flow through adapted reservoir management (substantive and implementation objective). Experimental on-farm research benefitted substantively from stakeholder collaboration and focused more on implementation issues. Education Days spread information in an interactive way to a broad group of people, and training courses on research tools targeted small numbers of participants. Both methods developed stakeholders' capacity to apply the research tools and findings (implementation and social-learning objectives). With similar intentions, joint video-making helped to connect stakeholder practices and study results, which stimulated the exchange about experiences, and supported the spreading of innovative techniques (Fig. 1).

Implementation was a contested concept in the project. Some project members worried about being instrumentalised by the donor to eventually act as extensionists that support the implementation of new research content that was beyond their scientific mandate and expertise. Allowing a broader definition of implementation made the concept more accessible and feasible. It became clear that the project would not provide ready-made packages of technology to be transferred and implemented. Instead, the scientists gained an understanding that they can be facilitators in a transformation process. Various moments of critical interaction with stakeholders, either in person or through video and written text, were seen as valuable contributions to transformation.

Many of the aforementioned methods allowed an active engagement of stakeholders through which – as explicitly confirmed by some stakeholders – their own discussions gained a new drive and led to the deliberation on new aspects, the consideration of different perspectives, and the contemplation of new approaches (implementation and social-learning objectives). Eventually, scientists used their understanding of the system and leverage points to develop demand driven interventions (implementation objective). For instance, they supported the conservation of the Caatinga biome by discussing potential land-management innovations with a regional development agency and providing and sharing evidence for the threatened biodiversity e.g. with a research note containing species lists. These interactions were complemented by a comprehensive open-accessible book for stakeholders, which summarises research results and recommendations for action (Siegmund-Schultze, 2017).

5.3. Experiences of LEGATO

LEGATO's stakeholder interaction was not driven by normative considerations. The weight of other objectives was not reflected upon ex-ante in the project consortium and varied depending on the local circumstances and the individual scholars involved. Before finalising the application for funding, a core group of researchers presented draft research questions and project goals to putative stakeholders. Requesting feedback allowed the alignment of the project focus with stakeholder concerns, increasing the relevance of the project and avoiding the need to rephrase research questions later. The pre-project interactions also built confidence among different groups that their input was taken seriously (substantive objective) and that the project results would be of practical relevance to them (implementation objective).

A bottom-up and continuously revised stakeholder analysis was driven by the questions of whom to involve for which purpose. Stakeholders were categorised using an interest-influence matrix (see Spangenberg et al., 2018b). Driven by the substantive objective, collaboration was sought with high-interest stakeholders in order to improve the quality and significance of the research. In contrast, high-influence stakeholders were selected with the intention of raising their level of interest, driven by implementation motivations. However, while the team managed to discuss the project with provincial governors and senators in the Philippines and with provincial ministers and party chairs in Vietnam, their attention was either very short-lived (Philippines) or predominantly shaped by perceived usefulness for own political ambitions. Strong collaboration was sought with farmers as they were identified as high-interest/high-influence stakeholders in most locations. The project's ability to conduct participatory and applied research and knowledge sharing was easier with top-level political

endorsement rather than mere toleration. Selected stakeholders were invited to annual project conferences and additional workshops to foster mutual learning (substantive and social-learning objectives) (Fig. 1).

The project members further observed that at some sites, farmers tended to be interested but not very influential, due to the national political culture and local societal structures. At these sites, the project initiated discussions with high-influence administrative and political leaders to facilitate social learning, thus paving the way for high-interest but low-influence stakeholders to take action. The facilitation, and a focus on cultural ecosystem services, helped to secure farmers' support in implementing the ecological engineering practices promoted by the project (Tekken et al., 2017).

LEGATO maintained openness to adapting research priorities to new issues whenever stakeholders formulated respective interests. For instance, the project integrated into the work plan new threats (e.g. damage by giant earthworms) or new demands (e.g. support eco-tourism development) identified by stakeholders. This increased the chances of the project generating knowledge which would be used by stakeholders in making better-informed decisions (implementation objective) (Fig. 1). Approval by the funder was obtained in cases where this adaptation of research questions had financial implications.

The project reached more than 600 farmers in a series of focus-group discussions. Focus-group discussions are a powerful tool to support social-learning objectives and successful social learning was considered a condition for improving implementation probabilities after the termination of the project support. Similarly, farmer field schools and training sessions in ecological engineering-based agricultural practices, as examples of on-farm action-research, facilitated mutual learning of scientists and stakeholders (substantive objective). For instance, adapting ecological engineering to local circumstances based on farmers' advice facilitated discussions and learning about local invasive species and about trade-offs between intensive and alternative farming practices in terms of yields, groundwater pollution, and hazard exposure by both farmers and scholars (substantive, social-learning and implementation objectives) (Fig. 1). A detailed description of the project's stakeholder approaches can be found in Spangenberg et al. (2018).

6. Discussion

One of the key motivations of the paper is to test the applicability of our framework and to demonstrate its capability to generate additional insights. The project analysis confirms the applicability of different rationales for stakeholder involvement in transdisciplinary research. The framework can be readily used by scholars involving stakeholders in projects to plan and reflect on the interaction (see Table 1). In a next step, we prove that the application of the framework gives new insights about stakeholder engagement in transdisciplinary projects and draw lessons across the cases. This is demonstrated by reflecting on and discussing the research experiences along the four objectives introduced in the framework.

The **normative objective** was the least important rationale in the projects analysed (see Fig. 1), even though it often drives the debate on the changing role of science in society (Nowotny et al., 2001). It played a role in TFO and INNOVATE at the very beginning of the projects. We sensed an unspecific moral obligation among the scholars to interact with affected stakeholders when addressing real-world challenges. On this ground, many scientists supported the idea that systematic stakeholder involvement should be carried out by the project from the outset, but only a minority considered it an integral part of their individual research activities. When it became clear that radically following a normative rationale would overstrain project teams and stakeholders and lead to deluded interactions, a softer interpretation was chosen: Diverse stakeholders were actively invited and their participation enabled through adequate methods. As such a process runs the risk of excluding by including (Spangenberg et al., 2015), space needs to be opened for the engagement with a fair access and representative range of stakeholders.

In our projects, **substantive objectives** were the best entry point for gaining scientists' support for stakeholder engagement. Especially more formalised interaction methods such as participatory modelling and scenario-building were well accepted by researchers. Here, stakeholders have less influence on the methodical process and outcome which makes them less contestable for the researchers within academic assessment schemes (Schmidt and Pröpper, 2017; Siew et al., 2016). This supports the finding by Newig et al. (2019) that applying structured methods of knowledge integration enhances the chances of highly scored academic output and citations in transdisciplinary research. Substantive objectives were also addressed in the course of well-established approaches and common research activities such as interviews or bilateral exchange – also in the context of on-farm research – as well as project workshops, conferences and focus-group discussions (Fig. 1, see also Newig et al. 2008).

Feedback from scientists regarding such encounters indicated an increased acknowledgement and appreciation of stakeholders' contributions to the generation and interpretation of research results in the course of the projects, indicating learning processes among researchers. However, given the diverse culturally shaped epistemologies and ontologies underlying the different bodies of knowledge, knowledge integration remained a real challenge (see also Brugnach et al., 2017; Scholz and Steiner, 2015). Our experiences support the demand to incorporate processes of self-reflexivity regarding the limits and contributions of everybody's knowledge in transdisciplinary research (Rosendahl et al., 2015).

The funding agency expressed clear expectations regarding the generation of **implementable** outcomes. Fig. 1 indicates that the project members gave it highest priority and made considerable efforts using diverse approaches in this regard. The objective was generally supported by large parts of the research teams, motivated by the idea that their research should have a real-world impact. Many stakeholders also clearly called for tangible, mostly technical solution to be implemented through the projects. Collaboration with capable and legitimate stakeholders regarding implementing changes either as funded partners or by engaging in existing structures was the consequence in all cases (see Fig. 1). Additionally, all pursued the joint development, testing and training of applicable innovations on the local level (e.g. through on-farm research or field schools). Finally, almost all project activities, although possibly primarily following another rationale, additionally served the implementation objective. Involving stakeholders and giving them a voice simultaneously aimed at increasing acceptance and ownership of project outcomes for future application.

At the same time, discussions in the teams revealed irritations regarding the unclear and ambiguous role and mandate of scientists in transdisciplinary projects (see also Felt et al., 2016). Dealing with contested issues of resource management and distribution, the focus on implementation created hesitation among some researchers about becoming entangled in unpredictable socio-political dynamics.

Such concerns were even more pronounced for **social-learning** objectives. This was one reason why mainly project members specialised in facilitating stakeholder involvement expressed this as an explicit target. Supporting social-learning processes is a way to indirectly trigger change in social systems, influencing politically contested or socially conflicting power constellations (Reed et al., 2010). As this can stir up conflicts the projects cannot control, social learning remains a very delicate venture (Siew et al., 2016) and requires mediation and conflict-resolution expertise (Brugnach et al., 2017). To reduce such risks, our cases initiated social learning in small familiar settings such as in focus-group discussions and used more indirect approaches like participatory filmmaking (Fig. 1). The feedback received by stakeholders indicated that efforts supporting social learning were highly appreciated and have led to new insights and networks (Spangenberg et al., 2018b).

Our experience-based analysis of the three cases show that raising awareness for the kind and multitude of potential objectives is strongly needed in research practise as all three projects started the process of stakeholder interactions in a little reflected way. Rationales for involvement were only implicitly considered in the planning phases. This is all the more remarkable as the scientists involved chose the methods in their disciplinary fields with great care in order to use the most powerful instrument to answer their research questions. For many members of the project teams, stakeholder involvement was novel, and in the first place driven by the need to meet formal requirements stipulated by the funder. This is similar to what Wesselink et al. (2011) observed for public participation, and whose quality is often neither sufficiently defined nor evaluated (Siegmund-Schultze et al., 2019). In the course of the projects, the teams became more aware of the benefits of joint reflection about why to include which stakeholder in what way. Especially junior researchers increasingly recognised that a well targeted stakeholder interaction can improve the value and relevance of their research. As a result, they expressed the intention to integrate stakeholders also in future projects at an earlier stage and in a more target-oriented way, going far beyond what scientists are typically prepared for. This shows that ex-ante guidance was lacking in our cases but seems to be crucial to upgrade the practice of stakeholder involvement in research projects from the outset. Our framework is one tool to offer such guidance.

In the three projects analysed, the deployment and choice of methods was not based on the deliberate optimisation of outcomes for each objective, but rather on past experiences, contexts, research questions, skill compositions and pragmatic considerations within the projects. As a result, similar objectives were pursued with different methods, and similar methods applied for different objectives (see Fig. 1). The successful conduct of the projects testifies that such flexibility is feasible and no unambiguous relation between objectives, methods, and outcomes can be observed. However, the purpose of the interactions seems to play a role regarding how specific approaches are implemented and how results are interpreted and used. Starting stakeholder interactions without ex-ante reflection on objectives, the projects chose common and multipurpose interaction approaches (such as workshops, focus groups, participation in stakeholder structures) and adjusted them to the needs emerging during project implementation. This approach worked well for project activities, however, not without ambiguities over objectives for stakeholder involvement surfacing ex-post in the project teams. Consequently, it is plausible that ongoing reflections starting from the outset of the projects would have revealed potentials for optimising method choices and transdisciplinary collaboration. Doing so could ease the irritations felt by scientists regarding their role in transdisciplinary work, reduce wrong expectations and thus disappointments on all sides, and consequently enable more fruitful stakeholder involvement.

7. Conclusions and Outlook

The ex-post analysis of the three projects from different continents suggests that an explicit specification of the different objectives and a systematic reflection upon them together with stakeholders at an early phase of project planning would have created the potential for improving the effectiveness and efficiency of transdisciplinary collaboration. We see multiple benefits of an ongoing joint reflective and reflexive practise throughout transdisciplinary projects regarding the objectives of stakeholder involvement: (i) an increased transparency in the research preparation and conduct, (ii) gains in efficiency by working more systematically, and (iii) clarified expectations of both the researchers and the stakeholders. The framework proposed here provides a conceptual distinction and can guide such processes of reflection in project teams.

Our reflections presented show that a more targeted reflective and reflexive process may be vital to fully reap the benefits of stakeholder activation and involvement. It would have to start with the selection of the stakeholders depending on what they represent: a spectrum of knowledge (substantial), legitimate blocking or influential implementation power (instrumental), different perspectives, values, capacities and power relations (social learning) or all those having a stake (normative) (Hage et al., 2010; Spangenberg et al., 2018b; Wesselink et al., 2011). At the same time, the choice of who becomes involved, and thus who is heard and who receives access to new perspectives and knowledge, will empower or exclude certain actors and thus interfere with or reproduce existing social, economic and political power structures (Brugnach et al., 2017). This can lead to opposition or the withdrawal of stakeholders from the process, biased knowledge input, and the undermining of implementation. Being conscious and transparent why certain actors are included can help to design processes in a way that mitigates obstacles in the stakeholder landscape. This presupposes the acceptance of researchers to be stakeholders themselves and requires respective processes of reflexivity on their role and possible impact (Meppem and Bourke, 1999; Rosendahl et al., 2015; Spangenberg, 2011).

We discussed the issue from the perspective of academic project members who plan and implement the stakeholder involvement. Nevertheless, also stakeholders need to have good reasons to engage in the process, otherwise they will invest their resources (time, know-how) in processes more supportive to their goals. Not being aware of or ignoring stakeholders' desired ends and modes of engagement can consequently lead to disappointment and participation fatigue (Bracken et al., 2014; Reed, 2008; Mobjörk, 2010) that may even jeopardise future transdisciplinary endeavours (Wesselink et al., 2011). In all our cases, the motivations for stakeholders to become involved in such processes and in what form turned out to be diverse (Bracken et al., 2014) and sometimes conflicting (Schmidt and Pröpper, 2017; Spangenberg et al., 2018b).

Clarifying objectives can support the joint development of an impact pathway hypothesis, a shared plausible description of how the intended objectives would be achieved and where they would lead to (Nauen et al., 2006). Koontz et al. (2019) have shown that outcomes and impacts are hardly assessed in collaborative conservation research, but need to be known to make evidence-based decisions on approaches in future initiatives. The same refers to transdisciplinary research, where well-defined objectives eventually make it easier to monitor to which degree project goals have been achieved, despite the complexity of the processes and the intangibility of some objectives (especially social learning). Thus, we see a need to develop innovative monitoring methods for the different rationales.

As procedures of joint reflection help planning and implementing more effective, efficient and accepted stakeholder processes, they should be anchored more firmly in future funding mechanisms to enable the scope to negotiate objectives and respective approaches among researchers and stakeholders (Bracken et al., 2014; Schmidt and Pröpper, 2017). The funder of our projects took first steps towards this, including a funded pre-project phase that allowed the joint development of goals and processes with stakeholders which proved to be highly valuable (Schmidt et al., 2018; Siew et al., 2016). The next step would be the development of funding rules which give stakeholders and researchers shared responsibility for conceptualisation and planning research and stakeholder involvement as well as flexibility for managing tensions that may arise (Görg et al., 2014; Schmidt and Neuburger, 2017). This would contribute to strengthen stakeholders' role and ownership in transdisciplinary processes on the one hand, put pressure on the academic system regarding the education and training of sustainability scientists, and trigger long-term transformations in the academic skill, value and norm system (Benner and Sandström, 2000; Felt et al., 2016; Spangenberg, 2011).

Finally, clarifying and acknowledging the different rationales among researchers and stakeholders is prompting debates about the changing role of science in society and vice versa. These roles often

remained ambiguous in our cases. It requires strong awareness on the part of scientists regarding their role as change agents and the acknowledgement of other actors' knowledge and legitimacy to co-design the research process (Bracken et al., 2014; Rosendahl et al., 2015). Considering the historically grown entrenched structures involved in doing research (Spangenberg, 2011) and the well-established image of science as supreme knowledge-producer (Fiorino, 1990), such a shift is certainly challenging to both the researchers and practitioners involved. Our experiences indicate, however, that transformations start to take roots.

A reliable assessment of the claimed benefits of reflecting on objectives from stakeholder engagement is methodologically difficult. We see it as a future field of research on transdisciplinarity to share experiences of embedded processes of reflection on objectives of stakeholder engagement from different context, funding setups, and other societal and sustainability challenges. The authors would highly appreciate the sharing of readers' experiences in the use of the framework.

Declaration of Competing Interest

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

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