Power and Empowerment in Transdisciplinary Research: A Negotiated Approach for Peri-Urban Groundwater Problems in the Ganges Delta

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Abstract. The co-creation of knowledge through a process of mutual learning between scientists and societal actors is an important avenue to advance science and resolve complex problems in society. While the value and principles for such transdisciplinary water research have been well established, the power and empowerment dimensions continue to pose a challenge, even more so in international processes that bring together participants from the global north and south. We build on earlier research to combine known phases, activities and principles for transdisciplinary water research with a negotiated approach to stakeholder empowerment. Combining these elements, we unpack the power and empowerment dimension in transdisciplinary research for peri-urban groundwater management in the Ganges Delta. Our case experiences show that a negotiated approach offers a useful and needed complement to existing transdisciplinary guidelines. Based on the results, we identify responses to the power and empowerment challenges, which add to existing strategies for transdisciplinary research. A resulting overarching recommendation is to engage with power and politics more explicitly from the inception of transdisciplinary activities, as a key input for problem framing.

Key words: transdisciplinarity, negotiated approach, stakeholder empowerment, peri-urban, groundwater management, Bangladesh, India

1 Introduction

Sustainable groundwater management faces various challenges that lend themselves well for transdisciplinary research, including the challenge of social participation and coordinated approaches between multiple actors such as scientists, government agencies and groundwater users (Barthel et al., 2017). This is also true for groundwater management in peri-urban areas. Peri-urban areas are spaces in transition that connect urban and rural environments and that show features of both (Allen 2003; Mc Gee 1991; Singh and Narain 2020). Here, rapid urbanization often results in an increasing pressure on groundwater resources as a source of water for both livelihoods and household uses. As dynamic spaces in transition, there is a large diversity and heterogeneity in the actors and interests in peri-urban areas, combined with institutional overlaps, voids and ambiguities (Allen, 2003; Gomes and Hermans, 2017; Narain and Roth, 2022).

In peri-urban areas, water-dependent livelihoods such as farming and fishing may still abound. Proximity to urban and industrial centres may create a spike in real-estate development, and new actors enter the scene. Migrants from more remote rural areas may be attracted by the proximity of urban centres for employment and opportunity, while urban residents and developers may be attracted by available spaces and land. These actors compete for, or threaten the quality of, existing (ground) water resources, such as larger industrial or agro-industrial users, urban water users, and waste (water) disposal activities (Narain et al., 2013; Gomes, 2019). Increased climatic variability, degrading surface water sources, land use change, coupled with unequal power structures, rules, norms and practices, create pressure on already stressed water resources and lead to uncoordinated overexploitation of groundwater aquifers (Narain et al., 2013; Hasan et al., 2019; Banerjee and Hermans, 2020). These increasing demands and pressures, for different users and purposes, are combined with often limited information and knowledge about the actual state of groundwater quantity and quality (Olago, 2019).

Power differences play a large role in the groundwater management in peri-urban areas. As highlighted by political ecology analyses around water governance, power is a key factor shaping differential access to resources (see Swyengedouw 2009; Bryant and Bailey, 1997). Periurban water resources tend to be reappropriated and reallocated, whereby some water users tend to get deprived of access to the resource (Banerjee and Hermans, 2020; Narain and Roth, 2022). The resulting lack of access to groundwater during critical periods affects the livelihood securities of the vulnerable and contributes to the incidence of poverty (Banerjee and Jatav, 2017; Butsch et al., 2021).

These combined features around groundwater management in periurban areas result in complex situations that match the classic definition of a a “wicked” problem situation, at the juncture where conflicting goals and equity issues meet with knowledge limitations and contested problem formulations (Rittel and Webber, 1973). Such complex or wicked problem situations are typically what transdisciplinary research hopes to engage with. Transdisciplinary research has been on the rise as a process of co-creation of knowledge by science and society to offer solutions for complex problems in human-water systems (e.g. Scholz and Steiner, 2015a, Krueger et al., 2016; Ferguson et al., 2018; Ghodsvali et al. 2019; Sapkota, 2019; Pohl et al., 2021). In this co-production of knowledge, stakeholder participation and empowerment, as well as dealing with

institutional ambiguity and informality, is part and parcel of the effort, albeit a very challenging one (Massuel et al., 2018; Ghodsvali et al., 2019; Van Breda and Swilling, 2019).

In transdisciplinary research, the differences in the types of knowledge and experiences that different groups bring to the table, are mixed with established structures for social interactions and the associated power and political dimensions (Jahn et al., 2012; Krueger et al., 2016; Brown, 2018; Pohl et al., 2021). Who is participating in the joint problem articulation and the research efforts, how are these participants selected and how do they report back to their fellow community members? What is needed for these various groups to effectively communicate with each other, and to appreciate the depth and breadth of each other's knowledge and experience? Especially when dealing with relatively vulnerable communities, not usually involved in research or decision-making, such as is the case for periurban communities, these issues of power and empowerment cannot be ignored. Glossing over critical power inequalities may not always be critical for researchers and the production of new scientific knowledge, but it will not help to resolve wicked problems in ways that are scientifically sound, equitable and socially sustainable.

In this paper, we look for strategies that help to address power differences and empowerment issues in transdisciplinary water research, for local groundwater management in peri-urban communities. This is done by complementing insights from the literature on transdisciplinary water research with a so-called negotiated approach for stakeholder empowerment (Leeuwis, 2000; Koudstaal et al., 2011). We contribute our insights from case experiences with transdisciplinary water research and stakeholder empowerment in peri-urban communities in Bangladesh and India. The next section summarizes the relevant literature on the combination of transdisciplinary research and approaches that help deal with power, empowerment and conflict. This is followed in subsequent sections by case experiences in the metropolitan areas of Khulna and Kolkata. The findings from these experiences result in suggestions for a more power-sensitive transdisciplinarity, after which we conclude with some final take-aways.

2. Transdisciplinary research and stakeholder capacity development for peri-urban groundwater management

2.1 Transdisciplinary research

2.1.1 Core concepts and known challenges in transdisciplinary research

Transdisciplinary research is a process of mutual learning among scientists across disciplines and societal actors aimed at creating knowledge that benefits both scientific praxis and discourse, as well as societal problems (Jahn et al., 2012; Lang et al., 2012; Scholz& Steiner, 2015a). There are various conceptualizations of transdisciplinary research, which describe transdisciplinary research as a process whereby science and society interact to develop new knowledge (Max-Neef, 2005; Jahn et al., 2012; Lang et al., 2012; Brandt et al, 2013; Seidl et al., 2013; Scholz & Steiner 2015a; Brown, 2018; Cundill et al, 2018; Djenontin & Meadow, 2018; Fam et al., 2018). With its emphasis on co-creation of knowledge between scientists and local actors outside academia, it is closely related to, and for many practical purposes often indistinguishable from participatory

action research (Whyte et al., 1989; Bradbury, 2015) and other participatory, interactive and community-based approaches (Lang et al., 2012). When it comes to human-water systems, transdisciplinary water research has been explored by Krueger et al., (2016) to see where and how water knowledge is produced in society. Transdisciplinary water research has been used for instance as means for more systemic learning on water security issues (Steelman et al., 2015) and of stakeholder engagement for broader impact of water scarcity modelling (Ferguson et al., 2018). Transdisciplinary water research has also been studied for its role in food-water-energy nexus research to support the achievement of sustainable development goals (Ghodsvali et al., 2019).

All these approaches use a systematic method of inquiry to assist societal actors in improving their actions for addressing societal problems (Bradbury, 2015), while generating methodological innovations and new empirical and theoretical knowledge related to the problem field (Lang et al., 2012). In this interaction, different actors bring in their own perception of reality, thought-styles, roles and practices of communication, whereby (scientific) knowledge is combined with understanding rooted in deep experience (Max-Neef, 2005; Jahn et al., 2012; Pohl et al., 2021). In this process, three types of actors play a key role: i) Stakeholders such as local water users and other people directly related to the water resource, but also NGOs or companies; (ii) legitimized decision-makers such as policy advisors, government officials and elected political representatives; and (iii) the science community with scientists from academia, applied research institutes and think-tanks (Seidl et al., 2013; Scholz and Steiner, 2015a).

Transdisciplinary science generally distinguishes three main phases, each of which has various challenges: problem framing; co-creation of solution-oriented knowledge; and re-integration of knowledge with scientific and societal practice (Jahn, et al., 2012; Lang et al., 2012; Brandt et al, 2013; Scholz & Steiner 2015b; Steelman et al. 2015). Table 1 shows an illustrative list of these phases and their challenges, based on Lang et al. (2012) and Steelman et al. (2015).

INSERT TABLE 1 AROUND HERE

2.1.2 The role of societal stakeholders in transdisciplinary research

Table 1 shows that many of the key challenges relate to the interactions between the different types of actors and the representation of their interests. It starts from the very first phases, with potential lack of awareness, ownership and legitimacy. This is also is in line with Jahn et al. (2012), Klenk and Meehan (2015) and Pohl et al. (2021), who reflect on integration in transdisciplinarity. Without further scrutiny, the concept of integration in transdisciplinarity easily conceals problems with differences in values, knowledge and power (Klenk and Meehan, 2015). Ghodsvali et al. (2019) observe that fewer papers report stakeholder engagement in transdisciplinary water nexus research beyond the instrumental levels, and take this as an indication of the challenges involved.

Some noteworthy exceptions are present though. Brown (2018) describes experiences with collective learning to enable local communities to cope with sustainability challenges. The used transdisciplinary approach was modelled after the experiential

learning cycles of David Kolb, modified for use in collective social learning processes (Brown, 2018). Process structure and open learning attitudes are identified as the two critical ingredients. Krueger et al. (2016) discuss fairness and competence as two important criteria for participation in transdisciplinary co-production of knowledge. Fairness signals the need for everyone with an interest to participate, and to be recognized as valid voices in the process. Competence emphasizes the use of clear rules and procedures in the participation process (Krueger et al., 2016). Cundill et al. (2018) similarly stress the importance of careful process design in their experiences with a global transdisciplinary research initiative, taking into account the influence of legal agreements, power asymmetries and institutional values and cultures.

When it comes to complex and wicked societal problems, knowledge, learning, capacity and power are intertwined (Rittel and Webber, 1973; Brown, 2018: 285). This limits and complicates joint problem solving (Jahn et al., 2012; Klenk and Meehan, 2015) and makes open dialogue, participatory modelling and scientific knowledge limited as source of undisputed solutions (Barnaud et al., 2010). The questions, assumptions and scenarios included in scientific studies will need to reflect those of societal stakeholders, making them inherently subjective and suited for some problem framings but not others (Godinez-Madrigal et al., 2020). Therefore, transdisciplinarity requires approaches that help navigate the dimensions of power and fairness in the interactions within and between the various groups of scientists, government agencies and societal water users.

2.2 Power, empowerment and negotiated approaches for the co-production of knowledge

2.2.1 Power and empowerment in transdisciplinary research

Transdisciplinary scholarship is not blind to the issues of power and fairness. For instance, it recognizes the need for, and difficulties in, establishing a safe platform for joint learning and discovery (Jahn et al., 2012). It also recognizes the importance of representation of different types of stakeholders, including local water users and community stakeholders (Seidl et al., 2013; Scholz and Steiner, 2015a; Dyer et al., 2014). And transdisciplinary research in an international and developing world context recognizes the importance of dealing with institutional cultures (Cundill et al., 2018), institutional ambiguity and informality (Van Breda and Swilling, 2019). What the transdisciplinary literature does not yet offer, is guidance on how to enable a process and platform for reflexivity and joint learning in a context of power differences, conflicting interests and institutional diversity, ambiguity and informality.

Current guidance and experience is shared only through fairly abstract phrases such as the need for “mechanisms to support mutual learning” and taking the necessary time (Raymond et al., 2010). However, in many cases participation requires not just taking the effort and time to invite stakeholder representatives and raise their problem awareness, but also requires empowering and capacitating different types of stakeholders to participate and collaborate effectively (Richards et al., 2004; Krueger et al., 2016: 380).

In a context of power differences and competing interests, transdisciplinarity requires two types of capacity building and empowerment. It is not just the capacity of all actors to participate in the knowledge and learning process on an equal footing, but also the capacity to influence and act more effectively in processes of problem solving for water management. Since

transdisciplinary water research seeks to combine scientific knowledge development with societal problem solving, those two types of empowerment are of equal importance. Truly engaging with this dual empowerment dimension is relatively novel (Massuel et al. 2018; Steelman et al., 2015: 596).

2.2.2. A negotiated approach to empowerment and transdisciplinary problem solving

The need to address power dimensions in stakeholder participation has been recognized by development practitioners (e.g. Bebbington et al., 2006; Sneddon and Fox, 2007; Barnaud et al., 2010). This has led to different approaches, including a negotiation approach, starting from the shortcomings of participation models such as social learning or participatory decision-making to deal with conflict (Leeuwis, 2000). Rather than approaching participation as collective decision-making or knowledge co-development, participation should be approached as negotiation: "If in practice participatory projects emerge as `arenas of struggle', and if stakeholders tend to act strategically, rather than communicatively, then why not base methodological approaches on these assumptions?" (Leeuwis, 2000: 946). Including more explicit attention for strategic behaviour would also provide better outcomes of negotiation and participation process for disadvantaged groups (Edmunds and Wollenberg, 2001). Building on work in relevant field such as consensus building (Susskind et al., 1999), network management (De Bruijn and Ten Heuvelhof, 2008) and negotiation analysis Fisher et al. (2011), different tasks for an integrative negotiation process were thus identified (Leeuwis, 2000).

In parallel to, and interaction with, this academic development, civil society organizations had similar observations and experiences, reaching similar conclusions. Their experiences and the academic reflections transpired into practical guidelines for a so-called negotiated approach over the past years (Koudstaal and Paranjpye, 2011). The earlier participation and co-production activities are still important pillars: Access to knowledge development for local platforms and continuous learning, recognizing community knowledge as well as rigorous and innovative science. However, the negotiated approach uses this as part of a larger aim, which is a transformation of governance, i.e. moving towards self-governance of local communities. For this, it follows the tasks proposed by Leeuwis and Van den Ban (2004) and the notion of 'principled negotiations' as described and popularized by Fisher et al. (2011). In principled negotiations, parties focus on their underlying values and interests, rather than on specific positions regarding preconceived negotiation outcomes. This is somewhat similar to the difference in "creating actions, designed to build a bigger pie, and claiming actions, designed to obtain a larger share of the pie so created" (Raiffa, 2002: 2).

The negotiated approach offers eight tasks as guidance, and, as can be seen from Table 2, these tasks connect well to some of the challenges identified for transdisciplinary research. This is especially visible for the transdisciplinary research challenges related to participation, joint ownership and legitimacy of the process and its outcomes.

[INSERT TABLE 2 AROUND HERE]

3. Methodology and data

An open question is how to combine these empowerment processes with transdisciplinary knowledge co-production. We investigate this question, using the main phases for transdisciplinary research as described in Table 1, combined with the main tasks for a negotiated approach as provided in Table 2. In the subsequent sections, we share our experiences with combining transdisciplinary research with the negotiated approach to address the challenges in groundwater management in peri-urban villages near Khulna, Bangladesh and near Kolkata, India.

Over the period 2014 to 2019, an international team of researchers and civil society organizations executed the Shifting Grounds project in Khulna, Bangladesh, and Kolkata, India. This project was financed by the Dutch Research Council under its Urbanizing Deltas of the World programme and had an explicit focus on transdisciplinarity, combing scientific research with sustainable development. In the project, team members from Bangladesh, India and the Netherlands cooperated to enhance understanding and build capacity with local stakeholders to support sustainable groundwater management in peri-urban Kolkatta and Khulna. Project partners consisted of staff from SaciWATERs and The Researcher in India, IWFM-BUET and JJS in Bangladesh, and Both ENDS and Delft University of Technology (project lead) in the Netherlands.

The description of our experiences in the next sections is based on a large body of documented meetings, workshop reports, project progress and evaluation reports, research publications and a three-day team reflection and writing workshop at the end of the project, in 2018 in Khulna, Bangladesh. Many of the workshop reports and research publications can be accessed via the Shifting Grounds project website (SaciWATERs et al., n.d.). The report of the final team writing workshop is available as Hermans et al. (2019). Furthermore, an overview of activities related to capacity building for institutional analysis in this project is contained in the dissertation of Sharlene Gomes (2019).

In the description of our experiences, we follow the main phases, tasks and activities as identified in Tables 1 and 2 above. In doing so, we pay specific attention to the interactions and interfaces between researchers, local communities, and state/government actors. Although the three main transdisciplinary research phases and the eight negotiated approach tasks help to structure our account, it is important to note that activities often overlap and that the process always features various iterations, going back-and-forth between phases and activities. It is less of a linear and more of an interative and circular process.

4. Case introduction: The Shifting Grounds project and its early project design and problem framing

The Shifting Grounds project was jointly formulated in 2013 through international workshops of researchers in collaboration with government stakeholders and local community representatives. The aim was to combine research, capacity building and development activities to address peri-urban groundwater problems in cities in Bangladesh and India. Khulna and Kolkata were selected as project cities, being both located in the Ganges delta, sharing some key hydrological and geophysical features, but being located in different institutional contexts. The international project team sought a conscious mix between a research-

initiated process and a community-initiated process to enable a balanced effort of co- creation of both scientific knowledge as well as practical solutions.

The project started with the ambition to combine transdisciplinary research and the negotiated approach, given the expected differences in groundwater access, dependence and power within peri-urban communities. The consortium benefited from earlier research cooperation on peri-urban water security between partners in India and Bangladesh, and from extensive experiences of civil society partner, Both ENDS, with the negotiated approach. The initial project design targeted peri-urban villages near each of the two cities. Site selection criteria included scientific suitability as well as willingness and (basic) abilities of village stakeholders to engage with the project. For the latter, we looked at the existence of a nucleus for self-organization, such as the presence of an active community-based organization or local village committee that had also identified groundwater-related problems as an important issue for village development. The latter was used to ensure a workable fit with the initial problem framing around groundwater issues, which had been decided early on by the core project team members as a key research gap for peri-urban water security in the region.

The project was designed around three distinct research activities, along with community empowerment. Two PhD researchers and one postdoc researcher were engaged: the first two, to study physical groundwater systems and local institutions, respectively, and the third, to study socio-economic and livelihoods dynamics. Community empowerment focused on capacity building within the peri-urban communities and on strengthening links of community actors with external government processes and state actors. The community empowerment was led by civil society partners in the project consortium and was referred to as the negotiated approach process; the research process was led by the research organizations. Both functioned together as one team, with joint problem formulation and frequent project team meetings. Key policy-makers and local experts were represented in a Project Advisory Group.

This team constellation was purposefully designed to allow civil society organizations to use their experience and expertise in facilitating (sensitive) processes within the community, while enabling researchers to bring in their research expertise and knowledge. The frequent meetings within the project team helped provide shared understanding on problem framing and process design, as well as a space where different team members could benefit from each others' strengths, expertises and positions within local and national networks. This also brought sometimes tensions, dilemmas and power differerences inside the project team. Through clear arrangements and agreed responsibilities, combined with frequent meetings, we have tried to navigate those.

5. Kolkata experiences

5.1 TDR Phase A: Problem framing and team building

NA Task 1: Preparing the process and Task 2: Reaching agreement on process design

The research-government interface

At the government interface, the project worked with the two distinct systems in place for decision-making processes in the State of West Bengal: an administrative and a political system. The administrative government system was run from the State level, via Districts, to provide important services to the communities. This administrative system had a hierarchical structure, with an important role for the District Magistrate that operated from Kolkata, and the local Block Development Officer at the block level.

In the preparation phase of the project, connections with this administrative system were established via connections with the formal decisionmakers and state-level water agencies. Representatives of some of these agencies were invited as members of the project advisory committee. To gain access to these state representatives, the personal network of one of the Indian researchers proved to be essential. The research components in the Shifting Grounds project were highlighted, whereby especially the groundwater research and hydrogeological modelling had the interest of the government actors. The physical science, a cross-country study in Bangladesh and India on groundwater, turned out to be the main selling point in initiating the contacts with the formal government representatives. At the start of the project implementation, this support from different state government officials also made it possible to get support from the District Magistrate in charge of the district in which the project village was located. Given the relatively hierarchical formal institutional setting and large power distance between District and State-level officials and local level stakeholders, this support was essential to undertake activities with government officials and stakeholders at the local block and village levels.

This created a supportive atmosphere, including state-level experts in the project advisory group, but the ownership at the district and state levels for the Shifting Grounds project remained limited. Although the groundwater problems in the peri-urban areas were acknowledged as important issues, the project itself was too much focused on one specific local area, with relatively limited resources, to spark a more intensive involvement from the higher levels of administration.

The research - community interface

In parallel to the administrative system, there is a political system with elected representatives at various levels. At the community level, these are the panchayat members and the gram panchayat. These are local self-governing bodies, with village councils (panchayats) being the lowest elected official body in rural areas in India, and gram panchayats consisting of a number of village councils.

In the beginning, the project team had visited various peri-urban villages to select a suitable project site. In this selection process, we looked for visible signs of groundwater management problems, for willingness of local stakeholders to work with researchers to address these issues, and for the presence of a certain nucleus of self-organization as sign of a certain level of competence within the village community that our project could build on. The peri-urban village that was eventually selected for this project was located alongside a canal of historic importance, south-east of Kolkata. It is part of the East Kolkata Wetlands, a Ramsar site. Recent developments included a growth in aquaculture, profitable with rising demand for fish in Kolkata and its suburbs, as well as an increased reliance on groundwater for aquaculture and rice paddy fields.

The project team benefited from the existence of a receptive village leadership. Certain members from the local panchayat shared their knowledge and support and actively participated in project activities from early on. Support from informal local community groups was present through a local youth club and various smaller women self-help groups, who were mobilized with the help of a local panchayat member. An initial informal community meeting was facilitated through the involvement of a youth club, which was asked to bring people from different occupational groups to ensure diversity in participation.

Access to safe drinking water was a critical issue, identified at the first stages of engagement with the village community in 2015. The existence of a private water-bottling plant inside the village was a controversial issue. The bottling plant was set up on purchased village land and had a bore well installed as the source of bottled water supply. Given these investments and operations, the owner of the bottling plant was a locally powerful figure. In the first project community meetings we discovered two distinct interest groups, divided in a pro- and anti-bottling plant lobby. One group supported the activities at the bottling plant, sometimes because they would benefit from those, as water vendors or workers, while another group considered it an illegitimate appropriation of local groundwater resources in the village.

The local water bottling plant proved to be a very sensitive issue, as it was closely linked to the village power structures and politics. Even before any choices on problem framing were made, the ability to continue within the community was threatened by the sensitivities over the bottling plant. Therefore, as more information on village problems emerged, the project continued with a more specific focus on what was *not* the most contentious, but the most crucial issue, shared by groups across the village: access to safe drinking water, free from arsenic risks. This choice was informed by village concerns, later on combined with and confirmed by groundwater research information. In later stages, providing visible contributions to help villagers cope with the arsenic problems, helped us to build confidence with the villagers and their social and political leaders.

Gradually, the project team realized that the village was very much divided on political lines, a common feature of rural society in the state of West Bengal. The water bottling plant was one issue of contention, but not the only one. This put us in a difficult position. Already from the start, we realized the importance of remaining neutral as a project team, avoiding reliance on current political leaders who might represent one political faction only. At the same time, the village leadership and the officially elected local bodies could not be by-passed, in order not to compromise the participation process and the safety of its participants. As a result, politics and associated legitimacy questions affected the further stages of the project.

Experiences within the Shifting Grounds project team

The researchers of SaciWATERs (Hyderabad) and TU Delft (the Netherlands) had easier access to the State and District level government officials than the local project organization, The Researcher, in Kolkata. SaciWATERs and TU Delft were recognized as research institutes of national and international importance, which enabled them to access to the stakeholders at these levels. The local partner in Kolkata, The Researcher, cultivated a good rapport with the local community representatives. At the same time, across the project team, there was a steep early learning curve on the mechanisms and particularities of the negotiated approach. Even if guidelines were available, these were fairly generic, and their application in this specific setting in West Bengal, brought its own challenges and questions. During the first two larger project workshops in Kolkata, the

presence of professor Paranjpye, one of the original developers of the negotiated approach for water management in India, proved essential to support the team in the early phases of process design for stakeholder empowerment.

5.2 TDR Phase B: Co-creation of solution-oriented knowledge

NA Task 3: Joint fact-finding and situation analysis

Groundwater research and access to official data

The groundwater modelling, another key research component, struggled with the acquisition of regional-level data for the Kolkata site, despite early efforts to establish good contacts and obtain the support from key government officials for our project. A very limited set of regional level data, combined with some local measurements during a local field visit, constrained the groundwater researcher in modelling and in-depth site-specific knowledge on the local groundwater specifics. Nevertheless, the groundwater knowledge that was available suggested that simply demanding more tube wells might not be advisable, as it would lower the water table of that particular village.

The presence of arsenic is a known issue in the Gangetic delta regions in India and Bangladesh since the 1980s and 1990s. For India, estimates were that about 6.5 million people were affected by severe health risks, using groundwater from affected aquifers for human consumption (Hasan, 2016). A review of groundwater data that were available, supported the focus on arsenic mapping and awareness, as likely risks also for this particular village. The water quality data that were obtained for the groundwater research indicated the presence of arsenic, which was validated by the Block Development Officer, Gram Panchayat, and Public Health Department Engineer.

Institutional research on formal institutions and water rights

Formal institutions provide a key leverage point for sustaining future interventions and improvement in water management. For these national and state level policies, acts, and ordinances, an institutions brief was prepared by the institutions researcher to support the negotiated approach process. The brief was presented to the community in their own language, Bengali, printed as a brochure with many pictures and illustrations that made it attractive and helpful to understand, also for the illiterate community members. This was useful in respect of imparting knowledge to the community about people's rights to water and the official government acts and departments regulating water in the state. The community had never heard of such rights to water or water governing acts. Not all of this knowledge could be translated immediately into action, but the knowledge remained an element of awareness and empowerment on community water rights. Being aware of your rights, and the official legal acts and ordinances that are recognized by government bureaucrats and administrators, helps communities become more accepted as partner for dialogue.

Socio-economic research: Synchronizing longer-term research with short-term community needs

The initial idea was that an integrated groundwater security index, based on household survey results, could be shared with the community and would help to prioritize issues to be tackled in the negotiated approach. It would also have been useful to conduct an early survey, to get a better picture of socio-economic heterogeneity and structures. However, a survey could not be started without initial community engagement and support. As this was initiated, the first community meetings already helped to prioritize local issues and suggested that a lot of the issues represented in the scientific groundwater security index might not be relevant locally. Based on this, more questions towards water quality and water distribution could be included and wastewater irrigation was added – something that was not there in the standard set-up for the index survey. Also, conducting the household survey gave the project team a better overview of the problems in the village, especially the differential access to water.

Peri-urban spaces are zones of transition and great socio-economic heterogeneity (Allen 2003; Singh and Narain 2020), where the socioeconomic dynamics change very rapidly with regard to status and income. In more remote rural areas it is easier to understand the status of the people as it is more stable. Here, the socioeconomic status became clear only during the survey, when we visited the households more intensely for several months. The survey also gave us the idea that there is a sizable section of population using groundwater for irrigation. This was not raised in the first community meetings, where the village community had predominantly raised its drinking water problems.

The household survey results eventually were only available well into the third year of the project. At this time, the negotiated approach team had already started working on the particular issue of drinking water and arsenic. Still, the socio-economic research did reinforce earlier choices in the process. We came to know that there were over 900 families in that village and there were only ten available water sources. This reinforced the focus on drinking water.

Discontinuous participation due to village politics and power shifts

In the spring of 2016, State Assembly elections were held, resulting in political schisms reaching new hights between rival groups. The deep political divides meant that some community members who had earlier been in leadership positions and had been very supportive to our activities in the initial project stages, could no longer play a role in support of the negotiated approach process. These political dynamics meant that the project team had to make continued efforts by bringing the various lose threads together, roping in new persons, and assuaging the conflicting interests to the extent possible. After two of the three initial village ‘champions’ left the stage due to the rising political tensions, we built rapport with the new leadership of the youth club. One re-elected panchayat member who had previously shown support provided a stable factor and enabled us to connect with the community in the subsequent phases of the process and to maintain contacts with the women’s self-help groups. We attended several meetings of these self-help groups, urging the participating women to attend also our informal project community meetings. These efforts ensured a good participation of women in the subsequent meetings.

5.3 TDR Phase C: Re-integrating and applying produced knowledge in science and social practice

NA Task 4: Solutions analysis and Task 5: Forging agreement

In a project mid-term review meeting in September 2016, community representatives signalled impatience and dissatisfaction with project progress. Their feeling was that, until then, little direct benefits to the community were visible, endangering their willingness to continue the engagement. They requested the project team to do something concrete in the short-term, to gain confidence of the community and continue the process further. From a pure scientific research perspective, this was difficult to respond to. The research activities were nowhere near finalization and actionable results. Also, the three project researchers by then had differentiated between project sites to focus on in their research, based on access to data, progress in the research and capacity building, and power dynamics. Two researchers were focusing relatively more on Khulna and one researcher was focusing relatively more on Kolkata.

As part of a reciprocal transdisciplinary process, the international project team promised to make an effort to mobilize additional resources to address the pressing issue of arsenic contamination of water sources. This was started in the months after the mid-term meeting and brought in new experts, doctors and equipment to enable visible actions focused on the arsenic contamination of local domestic water sources. An arsenic awareness and mapping campaign was started, with arsenic testing of various local water sources and a village health camp. For this, national and local experts were engaged, including a local medical college and water laboratory. This helped to get more detailed information on the local prevalence of arsenic in various water sources, and through the local health camps and workshops, villagers could be checked for symptoms and received medical advice, as well as education about locally developed arsenic removal filters.

NA Task 6: Communication with constituencies and Task 7: Monitoring and continued involvement

Tackling the arsenic drinking water quality issue in the village was only possible with the consent of the panchayat officials. After the earlier friction, the panchayat officials eventually recognized the importance of our activities, as they invited us to the local Book Fair organized by three Gram Panchayats in early-2017, to make an audio-visual presentation on the water security issue before a larger audience of several hundred people.

As drinking water had been the most crucial issue across the political divide, people belonging to both political sides were involved in the arsenic testing and education process in a more indirect and informal way. During the testing of water samples and the door to door campaign on water quality, political allegiance played no role, and people from the opposition camp were also involved. But in the formal process, i.e. in village meetings and workshops, these people from the political opposition camp were not always involved. Even when present in less formal community meetings, they were not so vocal due to fear of being identified. In the second part of the process, we organized an arsenic health camp and an arsenic awareness workshop involving local health workers where arsenic-affected tube wells were marked in maps of all the villages under the panchayat, as part of an effort to address the specific concerns regarding arsenic contamination of domestic water supply. In addition to

the direct practical health benefits, these maps and the knowledge gained through these health camps and workshops, enabled the villagers to better discuss their needs and concerns to government representatives and panchayat bodies.

Monitoring the effects of project interventions and proposed solutions after the project timespan was not possible due to the lack of resources for the project team members to visit the village after the finalization of the project. Although unsatisfactory, it was anticipated in the project design, whereby we have tried to be clear to all stakeholders, and careful ourselves, about our exit from the village after project closure. Part of this exit strategy, for instance, was to steer away from the most controversial issues around the local drinking water bottling plant, in order not to stir up more conflict than we were capable of handling within the time and resources of the project.

NA Task 8: Strengthening capacity to become and remain equal partners in negotiations

A key dimension in the equal partnerships emphasised in the negotiated approach, is gender equality. In the informal meetings and the larger more formal community workshops, women were no less vocal than men. One of the key persons to mobilize the community for us was a local female panchayat member. That she was a woman probably helped the other women in the community to join our programme in good numbers as well as to speak out. However, if this lady in our project village had not been re-elected again in the panchayat elections that were held later in the project period in May 2018, our effort to involve the women might have been thwarted. This shows that this effect, although visible, also is fragile.

The Government of India is giving much importance on the panchayat and allocates several hundred crores of rupees for water supply. Among the formal institutions supposed to be in place at this level, is the Village Water and Sanitation Committee (VWSC), looking after the water and sanitation problems of the gram panchayat area and formally chaired by the panchayat pradhan. However, in this panchayat, the committee mostly remained on paper. So our aim was to make it function as the sustainability of the negotiated approach process was dependent on the functioning of this VWSC that works for the whole GP, consisting of seven villages. The panchayat pradhan (chairman) gave us permission and during the final project workshop, members of the committee participated and pledged to use the written project reports with the arsenic testing results forward, to improve the situation. It remains to be seen whether this committee will become and remain truly active.

6. Khulna experiences

6.1 TDR Phase A: Problem framing and team building

NA Task 1: Preparing the process

The village was selected for project work based on pre-assessment and pre-scoping visits in the first project phase, reviewing different potential villages as project-sites, similar to the process done for Kolkata. The project activities were then initiated with a community workshop in October 2015. Following this workshop, several smaller group meetings were held in the

village to further establish dialogue. Through a series of village level meetings and workshops, people learned about the project and its negotiated approach, while the project team learned more about the village, its stakeholder groups and social dynamics.

Land use change is a common feature of peri-urban environments. This is accompanied by a rise in the price of land and efforts at occupational diversification (Narain 2009; Narain and Nischal 2007). This dynamic was also visible in the project village. Traditional fish farming and agriculture were on the decline. Some people were selling their agricultural land to land developers and others to migrants.

During the first visits, it was observed that the village road acted as a rough division between the groups of migrants and permanent residents. The permanent residents were located mostly on the right side of the road, and appeared to be more homogenous, with less rivalling groups within them. The part of the village on the left side of the road had more migrants, who were not as well organized. This made it easier to start the community engagement process mainly at the right side of the road. This, of course, had implications for village representation in the remainder of the project. Although this was known to be far from ideal, the project timeline and resources did not allow for complete community mobilization and organization, given that activation and organization of the migrant households would have taken significant additional efforts and resources. Realizing these limitations, at later meetings residents, including migrants, from both sides of the village were included, such as in the gaming workshops (see below section 6.3).

NA Task 2: Reaching agreement on process design

In the course of the first year of engagement, farmers and fishermen groups were formed to represent the community in the project's negotiated approach process. The traditional livelihoods of these groups in the community were under pressure, among others as a result of increased selling of land to land developers and migrants.

These village negotiation groups would be supported in a participatory problem analysis, for which the main steps had been outlined in a local Bengali guide for the negotiated approach. This guide had been developed by the local project partner JJS, after the support received from international negotiated approach experts from the Netherlands and India (see Kolkata experiences). This local project partner also facilitated the implementation of these steps with the community, to prepare them for a purposeful dialogue with other stakeholders, including government actors.

Contact with government officials had been initiated from early on in the project. Although government resources seemed constrained, the rapport with government officials based in Khulna City, including the Khulna Development Authority and district agencies, was good and no real problems were foreseen for later stages. The good relations with these government officials in Khulna benefited from the existing relations of local NGO partner JJS, which was based in Khulna, and the nation-wide reputation of the research partner BUET in Dhaka.

6.2 TDR Phase B: Co-creation of solution oriented knowledge

NA Task 3: Joint fact-finding and situation analysis and Task 4: Solution analysis

Community level activities

The village negotiation group conducted a problem analysis that benefits from the survey results conducted in the village for the project and that included a social map with water sources and water uses in the villages, a stakeholder mapping, and an identification of several water-related problems. Three priority problems were identified:

i. accessible safe drinking water,
ii. canal encroachment and water logging,
iii. waste dumping by the city corporation.

These priority problems followed community needs and priorities, and thus were not all directly related to groundwater. Nevertheless, all three issues were incorporated in the project, even if the research interface for some of these problems was weak or even absent. This was part of the implicit process agreement between project team and local community stakeholders. For these three priority issues, some researchers contributed their expertise, and the local team helped the villagers to develop a small-scale management plan to address them.

Although migrants were not represented in the smaller village negotiation group, they were part of the research activities and were invited at some of the workshops. This suggested that the drinking water problem was also acutely felt by this section of the community. The group of migrants included both relatively wealthy and relatively poor households. Most migrants in the vulnerable category used one of the three shared tube wells in the village and they (as well as other poor persons) needed over one hour to collect water. This was especially a problem for the women, who were responsible for water collection.

Research contributions to situation and solution analysis

The groundwater researcher made several field visits to the village for primary data collection. During these field visits, awareness on groundwater issues was raised through discussions with village community members. When first results were available, information on groundwater quality and groundwater over-pumping fed into the village negotiated approach process, among others via a lecture by the researcher on groundwater scenarios to the village water group. Further, researchers assisted with a Bengali translation of key groundwater terminology.

Community-based groundwater monitoring was considered during the project mid-term deliberations, as way to combine village capacity building with groundwater research data collection. Eventually, this was not initiated, mostly due to project research priorities – in which a PhD study was a key element, for which data collection results would come too late – and time and resource constraints.

Research findings from the developed groundwater models indicated that local groundwater abstractions might not have a very large effect on local groundwater availability, which seemed more influenced by regional level forces tied to the river (Hasan

et al., 2019). This provided a confirmation of the participatory management plans, reducing the need to focus on local water-demand management issues for the short-term.

The development of a community-based participatory approach for institutional analysis was a core objective for the institutional research component. This approach was developed with the Kolkata and Khulna sites in mind. The steps in the approach were mostly explored and applied with the Khulna village community for the prioritized drinking water issue. During the earlier stages in the project, an institutions brief on water supply and groundwater management was prepared, translated and discussed with participants in the village. The brief outlined the different organizations, rights and responsibilities for water resource management in Bangladesh. It also contained an infographic about the process for tube-well applications in peri- urban areas. This was accompanied by a de-briefing workshop with the village negotiation group, other community members and some government officials, where they reflected on these institutional structures. This supported the village group in its awareness of the situation, and the stakeholder mapping for the solutions planning. At the same time, the institutional research used local reports of the negotiated approach meetings as a source of data on the community's problem perceptions.

Combined, these groundwater and institutional research efforts helped to deepen the knowledge of villagers about the groundwater management situation, in such a way that they were able to talk about this to the authorities. Their increased knowledge and their ability to use officially recognized terminology, empowered villagers in their communication with the government officials.

6.3 TDR Phase C: Re-integrating and applying produced knowledge in science and social practice

NA Task 5: Forging agreement and Task 6: Communication with constituencies

For the direct engagement with the government officials, a specific six-member community negotiation group was formed by the villagers for negotiation and advocacy with authorities for their water related problems. They were trained by the local NGO (JJS) and at a local university in Khulna on advocacy and strategy development.

The community negotiation group shared their water related problems with the identified authorities and agencies during a workshop meeting. This workshop enabled the community negotiation group to continue discussions with the individual water related authorities after the meeting. During these individual follow-up meetings, there was more time and opportunity to discuss the specific problems and the authorities shared their plans and initiatives for overcoming those problems. Through these follow-up meetings, all three priority problems were taken up by various government authorities. The public health agency in charge of rural water supply committed to test drillings to establishing a functioning deep tube well for drinking water in the village, in recognition of the declining water tables and the need for sufficient safe public drinking water supply points. The Khulna City Corporation cleaned the waste dump near the village and selected two new sites for landfilling. The local level government administration (called upazilla) took the initiative to remove canal barriers. Linkages with the

Bangladesh Water Development Board and an ongoing internationally funded water management project resulted in an effort to further clean up the drainage canal.

The issue of canal encroachment and water logging was caused by clogged drainage canal structures but was exacerbated by local fish farming practices. Although fish farming was decreasing, a few powerful local elites did engage in fish cultivation. Branches of the drainage canal were captured to put temporary bamboo structures to keep fish. However, these bamboo fences and temporary dykes for fish cultivation reduced the water flow and exacerbated problems with drainage during heavy rains and water logging. The fish cultivators earned a lot of money and shared the benefits with local powerful individuals. This made it difficult for the local open-water fishermen and smaller farmers to deal with them. The village negotiation group first tried to involve these powerful canal encroachers in the project meetings, but they were not interested as they thought they would lose their livelihood. After these initial efforts, the focus was put on capacity strengthening of the more marginalized groups, to help them to negotiate and improve their knowledge. Illegal activities, especially canal encroachment, were condemned by the government officials at the meeting and in later press coverage.

Applying produced knowledge on drinking water management and institutions

The institutional research followed a sequenced design for a participatory analysis process, aligned with the negotiated approach in the Khulna village (Gomes, Hermans and Thissen, 2018). In the final stage, this resulted in two gaming- simulation workshops, where the analytical results were shared and discussed with participants in a structured role-playing format. An important reason to opt for this format, rather than a formal report or presentation, was the low level of literacy in the peri-urban village community. In addition, gaming simulations are known to be effective means of communication, if well designed and facilitated. One workshop was with the village community, a second workshop was with government representatives from different agencies involved in drinking water and/or groundwater management at the local level in Khulna. The purpose of these workshops was for participants to explore strategies to address drinking water related problems experienced in peri-urban Khulna. The workshops provided a platform for research uptake where the results of the institutional analysis were shared with local stakeholders in the form of a role-play game. The workshops were valued by the community participants with suggestions for future uses to engage more groups (Gomes, Hermans, Islam et al., 2018; Gomes, 2019).

NA Task 7: Monitoring agreed actions and sustaining societal impacts

At the end of the project period, peri-urban water issues were being discussed at different levels of government, at universities and in the local media. A gaming-simulation seminar and workshop were organized at the local university, as well as more conventional workshops and meetings. A linkage between community and government stakeholders was developed. A peri-urban water forum was established with representatives of several communities (beyond the project village community only), related government authorities and civil society. This forum connected the Shifting Grounds project with similar projects and activities in other peri-urban villages around Khulna City. In this way, the peri-urban water forum could become sustainable.

A small spin-off project after the ending of Shifting Grounds continued work with the approach for participatory institutional analysis, whereby local professionals were trained to develop gaming workshops for other water-related issues, with external support from Delft-based researchers. Although this enabled a bit more monitoring after the project end, the longer-term monitoring in Khulna suffered from similar limitations as that in Kolkata (see above).

NA Task 8: Strengthening capacity of participants to become equal partners in negotiations

Community empowerment for water management in Bangladesh carries a specific gender-challenge. As women were most affected by drinking water problems they were interested in participating. During initial field visits it was observed that, though women got a voice in village matters, the last word was always with the men. In the community negotiation group that spoke with the government officials, three of the six members were women. In the first workshop, only the men spoke and when we asked women to speak, the men did not allow them. Towards the end of the project, the women had no problem to speak during workshops and meetings. They actively participated in the negotiation role-playing game and during the final project workshop, the women eventually were discussing directly with male senior government officials.

The success on empowerment, fairness and legitimacy was mixed in the project. Although efforts were made, both powerful and powerless groups were eventually excluded from some of the most intensive part of stakeholder participation activities in the village. For the group of migrants, with its large heterogeneity, this was mostly dictated by limited timelines and resources. For some of the powerful local elites engaged in fish cultivation, their exclusion seemed a willing choice, possibly seeing the process as a potential threat to their business activities. Within the group that was represented, the role of women seemed to grow over time.

7. Discussion of the Shifting Grounds project experiences with transdisciplinarity and empowerment

The project experiences described for the research and negotiated approach activities in peri-urban villages near Kolkata and Khulna, partly confirm the challenges known for transdisciplinary research trajectories. Project designs had to be continuously adapted and changed, and, in some ways, had been over-ambitious. Project activities had to be tweaked to the site-specific conditions and constraints, and as a result, the activities across countries were not uniform, neither for the stakeholder empowerment, nor for the research components. The resulting process was very intensive and time-consuming, for all parties involved, much more than projects aimed at either primarily research, or practical local water management interventions. Nevertheless, there also seem to have been synergies and added values, and, minimally, the societal process with community and government stakeholders has shaped research activities and results, and in turn these research activities and results have influenced the societal dialogue within communities and between communities and government officials.

In addition to the confirmation of these prior experiences, the Shifting Grounds experiences also surfaced new challenges and responses, not previously emphasized in reviews for transdisciplinary research. These are summarized in Table 3. These challenges and responses are specific to transdisciplinary research in situations where power and empowerment shape the

process of co-creation of knowledge and solutions and building capacity to implement these. These responses are often context specific, they do not provide cure-alls and often they come with their own dilemmas and limitations. Some of the responses in fact are about accepting limitations or looking for satisfactory rather than optimal solutions. For instance, even if our stakeholder mapping captured the presence of a significant number of migrant households in one of the peri-urban villages early on, their heterogeneity and low level of organization, combined with our limited project resources, did not enable us to enable their effective representation in our project activities. Challenges and responses similar to ours will be familiar to experts working on community or stakeholder empowerment projects, but so far, remained either invisible or fairly abstract for transdisciplinary research. Table 3 is a step in filling this lacuna, based on our experiences in this project.

INSERT TABLE 3 AROUND HERE

In our project, we have adopted a negotiated approach to deal explicitly with power in transdisciplinary research, with some practical lessons captured in Table 3. As we have explicitly engaged with the power-dimension, we have seen power structures and inequalities play out and affect our work. For instance: the contentious issue on the water bottling plant and the local level panchayat politics that proved more important than the State level government administration in Kolkata, the role of fish farming by local elites and the low-level of organization of migrants in Khulna, and the role of women in both locations. The responses in Table 3 illustrate that these power issues could not necessarily be solved, even if they could be observed. A full negotiated approach process will take more than 4 or 5 years and may at times be more intensive than what we could help organize in our transdisciplinary research project. Therefore, it is more accurate to talk about power and politics in transdisciplinary research in terms of empowerment, instead of in terms of solving power inequalities. Empowerment is a dynamic process that may never fully end. We do have indications that we have been able to make a fruitful contribution to this empowerment process in our project villages, through our explicit engagement with power. These indications include an increased visibility of the heterogeneity within the peri-urban communities, the recognition of different groups such as women, youth and migrants, and their increased participation in, and knowledge of, local groundwater management processes.

8. Conclusion

We have applied explicitly a negotiated approach in our transdisciplinary process, recognizing the importance of power dimensions and empowerment, in addition to more neutral co-learning experiences in transdisciplinary research. Overall, our experiences confirm that, at least when working with relatively vulnerable and underrepresented local communities, employing a negotiated approach is useful, if not critical. It forces researchers to pay much more attention to the social and political

realities, and to community leadership and representation, early on in the process. Our experiences further confirm those earlier reports on transdisciplinarity that stress the importance of early and ongoing joint problem formulation, the importance of flexibility, and the struggle to match longer-term ambitions with short-term needs of both researchers and societal stakeholders. In addition to these insights, we also added a specific list of challenges and responses for transdisciplinary research that seeks to address power and empowerment as part of its efforts. This list, which resulted from our project reflections, will help to build a better articulated set of principles and guidelines for future transdisciplinary water research.

An uneasy conversation that we further will need to engage with, is to discuss the limits of transdisciplinarity and the various dilemmas it raises. Whereas many overviews may give the impression of an ever-expanding list of principles, tools and approaches for an ideal-type transdisciplinary process, the reality will be served better by a perspective on transdisciplinarity as yet another craft and "art of the feasible" in which tradeoffs between multiple and sometimes conflicting objectives and perspectives need to be made. An overarching message for transdisciplinary water researchers from this paper, is to engage with power and politics more explicitly, as part of this process. This is critical from the (pre-)inception phase of activities, as a key input for problem structuring and research agenda-setting. Engaging with power and politics is difficult but fundamental to societal change. Even if some researchers will feel uneasy with this dimension, it cannot be ignored in transdisciplinary research. Ignoring it is just another way of dealing with it –allowing existing structures and forces of power and politics to co-shape transdisciplinary results in an unobserved manner.

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Table 1 Challenges and strategies in transdisciplinary water research (source: Lang et al., 2012; Steelman et al., 2015)

Phases and challenges	**Exemplary strategies (Lang et al., 2012)**	**Coping strategies (Steelman et al., 2015)**
Phase A: Problem framing and team building		
Lack of problem awareness or insufficient problem framing	Primary study to build problem awareness	Iterative refinement of problem based on on-going discussions
Unbalanced problem ownership	Joint leadership	Hiring community-based monitors and research design with inputs of community members
Insufficient legitimacy of the team or actors involved	Stakeholder mapping, creating structures that enable participation	Continuous effort to broaden stakeholder representation as problem aspects are re-framed
Phase B: Co- creation of solution- oriented transferable knowledge		
Conflicting methodological standards	Systematic comparison of methods, demonstration projects	Use of creative scientific publishing opportunities, more on process than on results
Lack of integration	Structured and formative knowledge integration methods	Identify publishable units that document smaller aspects of broader research effort, responsive to use to partners
Discontinuous participation	Design low thresholds for, and appropriate levels of, participation	Create reflexive experience and regular contact with local leaders
Vagueness and ambiguity of results	Specification and explicit conflict reconciliation	Collect more data to create greater confidence and delay conveying findings to broader community until realistic solutions can be recommended
Fear to fail	Initialize actions first to stimulate learning-by-doing	N/A (Did not apply)
Phase C: Re- integrating and applying the produced knowledge in both scientific and societal practice		
Limited, case-specific solution options	Comparative studies for generalizable results	Continue to collect, scientific credibility data set will grow with time.

Lack of legitimacy of transdisciplinary outcomes	Take into account existing socio-political context into design	Continue to build research-informed constituencies. Maintain long-term, on-the-ground presence
Capitalization on distorted research results	Establish ongoing collaborative and reflexive discourse	N/A (too early in process)
Tracking scientific and societal impacts	Employ advanced evaluation methodologies	N/A (too early in process)

Table 2. Activities for the negotiated approach (NA) and how they could help address some known challenges in transdisciplinary research (TDR) (Source for NA: Koudstaal and Paranjpye, 2011)

NA Tasks	Explanation of NA tasks	TDR challenges addressed by NA task
Task 1: Preparing the process	Understanding the past initiatives and existing social arrangements Selecting committed participants that represent a 'balance of power' Identifying the broad areas and boundaries of the intervention	Lack of problem awareness Unbalanced problem ownership
Task 2: Reaching agreement on the process design	Understanding of the institutional context, its possibilities and limitations by all participants Specifying the agenda and procedures while allowing flexibility	Insufficient legitimacy of the team or actors involved
Task 3: Joint fact-finding and situation analysis (problem analysis)	Ensuring that the participants understand each other: Clarity on the backgrounds, aspirations and interests of various stakeholders Collecting and understanding of objective information on the natural system Joint fact-finding might be needed	Lack of problem awareness Unbalanced problem ownership Insufficient legitimacy of the team or actors involved Discontinued participation
Task 4: Solutions analysis	Establishing a prior agreement on the criteria, separate from the weight given to them by different stakeholders Considering and discussing all the solutions that are identified by the stakeholders	Discontinued participation Limited solution options Lack of legitimacy of TDR outcomes
Task 5: Forging agreement	Focusing on commonalities and using an iterative process of identifying, analysing and selecting solutions Positional bargaining by one or more parties might require active mediation by an independent outside facilitator	Lack of legitimacy of TDR outcomes
Task 6: Communication with constituencies	Allowing the stakeholder representatives ample time and documented information to maintain the communication with their constituencies	Lack of legitimacy of TDR outcomes

Task 7: Monitoring agreed actions	Making long-term commitment by the stakeholders for monitoring the implementation of agreed actions and the impacts of those actions	Tracking scientific and societal impacts
Task 8: Strengthening the capacity of participants	Extensive training of local communities to build the knowledge and skills they need to become equal partners in negotiations – among themselves and with the other key stakeholders and government officials	Unbalanced problem ownership Lack of legimacy

Table 3. Challenges and responses for the negotiated approach (NA) tasks in transdisciplinary water research (TDR) in peri-urban cases

Phases and tasks	Observed challenged in relation to power and empowerment issues	Strategies used in response
TDR Phase A: Problem framing and team-building		
NA Task 1: Preparing the process	The existing balance of power and socio-political dynamics could not be observed by the project team at the start of the process (there were neither time nor resources to conduct a thorough study prior to initiating the engagement in Kolkata)	Assure that the selected community is the "best available" project site, through careful selection process with selection criteria that include the community stakeholders' competence and willingness to engage
		Pay continuous attention to socio-political dynamics and modify process designs when needed, throughout the duration of the project
	Differences in existing community organization structures caused uneven representation of groups in the negotiation process (Khulna and Kolkata)	Observe and accept an uneven representation in the negotiation process as a limitation of the project
		Include the groups that are under-represented in research data collection and analysis to make interests and roles visible
	Large power distance existed between government decision making and communities (Kolkata)	Use the research process and the participation of an international science team as leverage to engage with government decision makers
NA Task 2: Reaching agreement on process design	The project team members were learning about (NA) process design and steps themselves	Ask help from an internationally recognized local NA expert for the external facilitation of the first workshops
TDR Phase B: Co- creation of solution- oriented transferable knowledge		
NA Task 3: Joint fact- finding and situation analysis (problem analysis)	The competence to articulate and share problem views was different among the stakeholders and project team members alike	Use visual methods for problem appraisal (e.g. "social village maps")
		Develop a joint language through the establishment of a shared vocabulary and a list of terminology

		Use of role-play games to share the analysis insights
		Use of low-cost community testing kits
NA Task 4: Solutions analysis	Urgent problems demanded short-term visible results for the community stakeholders (Khulna and Kolkata) – threatening their longer-term engagement in the TDR process	Free up project resources and mobilize additional resources to work on the emergent issues of immediate need in the villages, also if they were a less good fit for the research agenda of the project
TDR Phase C: Re- integrating and applying the produced knowledge in both scientific and societal practice		
NA Task 5: Forging agreement	The deeper lying conflicts and issues could not be addressed within the project's limits	Focus on other significant issues for the community and in the research
	Some powerful actors did not engage (fully), making an agreement with them difficult	Ensure the participation of other actors with influence (local government actors mainly)
		Mobilize media (Khulna)
NA Task 6: Communication with constituencies	Language barriers existed between (some of the) team members and communities; Illiteracy levels were high among the local community members	Prepare specific stakeholder communication materials using translations and visual images
	Heterogeneity was large in the peri-urban community groups	Organize small-scale community meetings with different sub-groups (frequently)
NA Task 7: Monitoring agreed actions	The limited project timespan, with first agreements reached only after the initial years, made longer-term monitoring by project team members difficult	Monitor within the project time frame through continued periodic visits and workshops with community and government representatives
		Establish a platform linked to other projects and initiatives with continued monitoring by local project partners (Peri-urban water forum Khulna)
NA Task 8: Strengthening capacity of participants to become and remain equal partners in negotiations	Sustained capacity was threatened by short project timespans (& capacity strengthening challenges discussed with some of above tasks)	Link up to the existing structures for collective action and planning (Village Water Council Kolkata village)