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Supporting community problem solving in the peri-urban Ganges Delta

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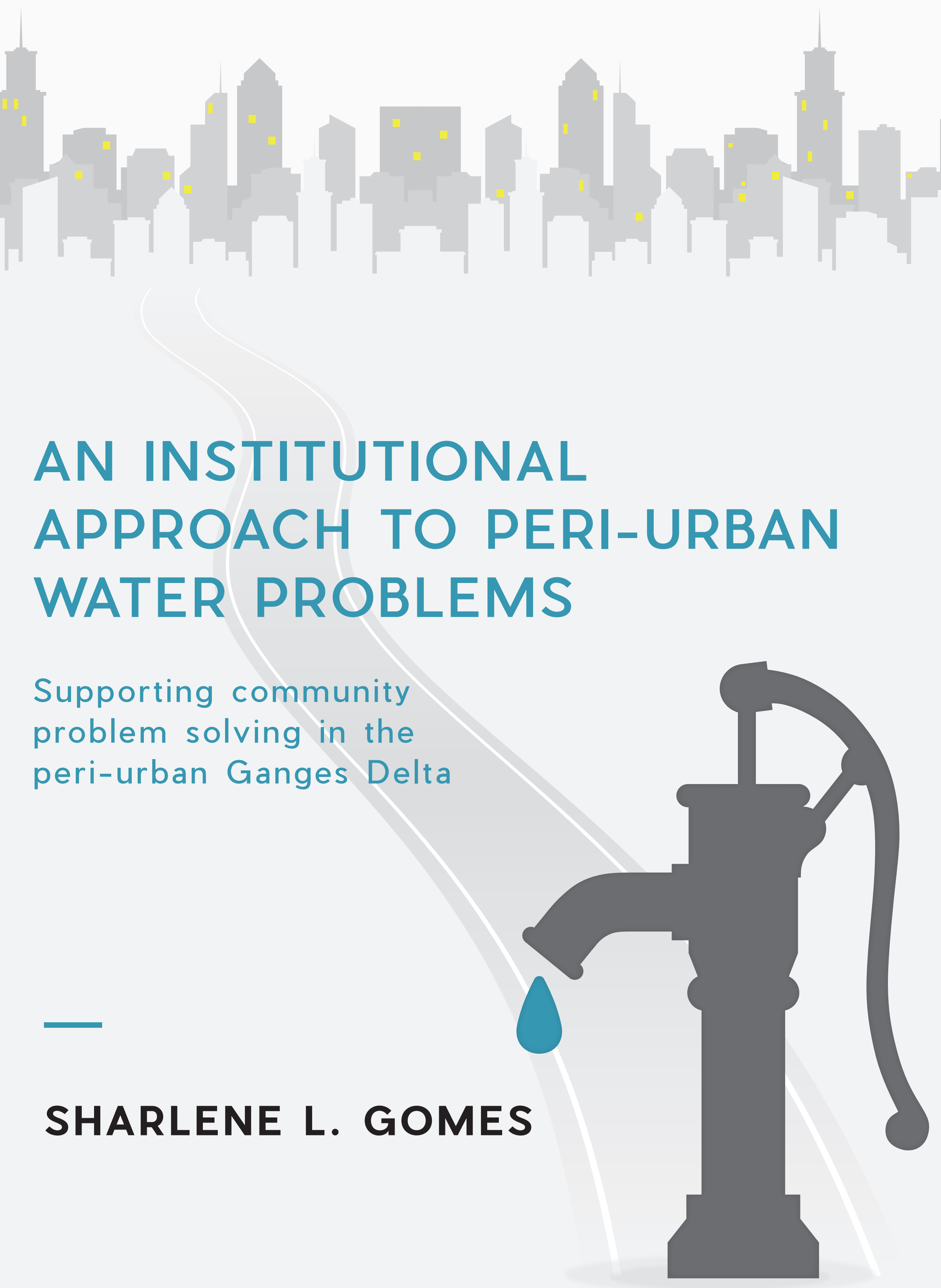

AN INSTITUTIONAL APPROACH TO PERI-URBAN WATER PROBLEMS

Supporting community problem solving in the peri-urban Ganges Delta

SHARLENE L. GOMES

An Institutional Approach to Peri-urban Water Problems

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Dissertation

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by

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Keywords : Peri-urban, institutions, water, community operational research, game theory, gaming-simulation

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Sharlene Gomes

Delft, NL

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Summary

An Institutional Approach to Peri-urban Water Problems:
Suporting community problem solving in the peri-urban Ganges delta

Background

Urbanization in the Global South is an important research area given the scale and pace at which it is expected to continue in the coming decades. One of the challenges relates to the sustainability of natural resource management during urban transitions. The peri-urban context plays a critical role during urbanization. This is where rural to urban transitions are most visible. Peri-urban areas experience significant changes in terms of population and resource needs. They are the cities of the future. Therefore, focused research to better understand peri-urban problems is needed to support a more sustainable urban trajectory.

This research takes place in the Ganges delta in south Asia. This region is currently experiencing significant changes as a result of urban expansion. Peri-urban areas near Khulna city (Bangladesh) and Kolkata city (India) are directly impacted by this. Despite being situated in a hydrologically abundant region, changing land use, economic activities, and population have put significant pressure on local groundwater resources; an important source of water in these peri-urban communities. Groundwater overexploitation and contamination have created competition and conflicts between peri-urban users.

Research focus and objective

The focus of this thesis is on the institutional context of peri-urban problems, whereby institutions refer to rules that structure decision-making and interaction in society. Formal and informal rules play an important role during problem solving when multiple societal actors are involved. Their different perspectives, interests, and resources add complexity to the problem solving process. Peri-urban institutions are often described in literature as being unclear, overlapping, and fragmented. This is because rules arranged along rural-urban administrative boundaries create a void in peri-urban areas. Rural institutions in many peri-urban contexts are not designed for the emerging urban pressures and peri-urban dynamics and are therefore, ill-equipped to manage this. If a sound analysis of the institutional dimension is limited in scope or even completely absent, it results in an incomplete problem understanding or a narrower solution space.

This study supports problem solving by peri-urban communities who are often impacted as a result of inadequate institutional arrangements. These communities are typically isolated from the policy-making process, yet face the direct impacts of policy outcomes. Theory states that actors who are faced with problem situations can either explore alternate strategies that are permitted by the existing institutional setup or alternatively, explore institutional change as a way of effecting the outcomes to their societal problems. Peri-urban communities can similarly use these options to resolve problems. However, knowledge gaps about the institutions or the multi-actor arenas within the problems act as constraints. Therefore, this research supports peri-urban

communities by bridging the gaps in knowledge and building capacity to intervene in policy-arenas.

Research question

The main research question underlying this thesis is as follows:

How can peri-urban communities be supported in addressing institutional aspects of water related problems during urbanisation?

Theory

The starting point for the study is the literature on institutions and institutional change in relation to the peri-urban context. Two characteristic features are found to be pertinent to understanding institutions and problem solving. First, peri-urban areas are dynamic, given their transitional nature. As a result, institutions run the risk of becoming ineffective over time, as the system and actors' needs evolve. Second, a socially heterogeneous composition means that problem solving emerges from negotiations between actors. Their different perspectives, interests, and resources adds complexity to the problem- solving process.

This review of literature leads to a hypothesis of institutional change with three main postulates. It can be expected that system change will lead to institutional change based on (1) actors' evaluations of institutional function and credibility, (2) a process of satisficing, whereby the costs, resources, and benefits of institutional change are considered in selecting an alternative that produces a satisfactory outcome, (3) whereby the nested structure of institutions strongly influences associated costs and resources available to actors to effect institutional change. This theory is used to design an approach that offers peri-urban communities an understanding of local problems through an institutional lens.

APIA: An approach that tackles the institutional aspects of problems

The next step in this research deals with ways to collaborate with peri-urban communities on their problems of interest. Existing approaches are explored, in particular, those associated with participatory research and community operational research. A structured approach was then designed to suit the context, process, and analytical needs of this study. It is referred to as the Approach for Participatory Institutional Analysis or APIA.

The APIA is structured along four main steps: problem identification, institutional system mapping, strategic analysis, and strategy exploration. The main output of problem identification (Step 1) is to help the community identify and define the boundaries of their most pressing problem that can be further analysed through an institutional lens. In step 2, the institutional system of the problem is mapped and analysed using the Institutional Analysis and Development framework. An expected output of step 2 is that peri-urban communities become familiarised with their institutions. The purpose of step 3 is to structure multi-actor interactions occurring within problem arenas as strategic 'games'. This is undertaken with the help of game theory modelling. Finally, in step 4, communities will explore solution strategies through simulation games that are developed from the game theory models in step 3.

An evaluation framework, designed around input, activity, and outputs of APIA applications is used to assess the methods, process, and results of this intervention.

Case-study application of the APIA

This study applies the APIA to the peri-urban case of Hogladanga village, situated near Khulna city within the Ganges delta in Bangladesh. Problem structuring was undertaken in partnership with a local non-government organization based in Khulna, responsible for managing community engagement activities on the ground.

Step 1: Problem Identification

Problem identification revealed that access to safe drinking water supply is a major problem within this community. It was one of three priority concerns highlighted by the community which also included canal water access for livelihood purposes and urban waste management. Defining the problem boundary in Hogladanga was a highly iterative process, which extended beyond step 1. Regular community meetings were needed to build trust with the community and forge a relationship for long-term interaction. Establishing a network of locally active residents early on, made it possible to sustain the APIA activities.

Results from step 1 demonstrate the complex and varied nature of peri-urban problems. Different types of water related concerns were described by residents, many of which are inextricably linked to livelihoods, climatic conditions, urbanization, and moreover, are embedded within a strong socio-political context. This made it challenging to define problem boundaries. Insights from subsequent steps of the APIA activities helped refine the initially scoping of the problem. Initially, residents signalled a gap in drinking water infrastructure, however, further discussions highlighted the need for better water quality as well. For example, the community's negotiation plan revealed that not only did residents need more public tube-wells, but deeper tube-wells in order to access good quality groundwater for drinking. In addition to regular engagements with the community, step 1 benefitted significantly from social mapping exercises conducted by JJS during this time. Creation of a village map helped facilitate the discussions of local problems.

Step 2: Institutional mapping

The next phase mapped the institutional context of the community's drinking water problem. Step 2 was conducted using the Institutional Analysis and Development framework. Community inputs during interviews, focus group discussions, and site visits were supplemented with secondary research and discussions with other peri-urban stakeholders. The institutional analysis provided a systems view of the drinking water problem. It revealed how key institutions (both formal and informal) shape interactions in different multi-actor arenas, and the evolution of the problem over time.

At present, public drinking water infrastructure in Hogladanga is installed by the Department of Public Health Engineering with the approval of a licence from a Water and Sanitation committee at the rural administration. The analysis shows that the rules for allocating tube-well licences by the committee have failed to result in drinking water infrastructure in Hogladanga. As a result, local residents have adapted by using informal rules to share the already existing tube-wells, and invest in private tube-wells. In the future, drinking water supply is expected to change due to urban expansion from Khulna city. Peri-urban areas like Hogladanga will be serviced by the urban service provider, the Khulna Water Supply and Sewerage Authority, once they become part of the urban jurisdiction. However, this too is unlikely to lead to drinking water security due to water supply gaps and increasing tariffs. As a result, similar informal means of accessing drinking water services will need to be used in a future scenario via private tube wells or by purchasing water from bottled water companies. The analytical findings confirmed the hypothesis of how marginalized communities like Hogladanga respond to system changes through their institutions.

Results from step 2 were shared and discussed at a de-briefing workshop by peri-urban actors (that included Hogladanga residents). It helped the community reflect on their own as well as the perspectives of other actors. Moreover, apart from the existing situation, possible future changes to the drinking water problem as a result of urban expansion was discussed. This workshop also served as a platform for Hogladanga to discuss their problems directly with local decision-makers. Separately, details about the specific formal institutions underlying water resource management, especially drinking water services, were developed into short printed briefs and shared with the community. It helped highlight what is stated versus what is actually experienced in practice with regards to their problem. Although the briefs needed explanations from facilitators, many residents felt they gained information previously unknown to them.

Step 3: Strategic analysis

Strategic analysis was the third step in the APIA that was implemented in Hogladanga. Here too, residents (and other peri-urban actors) provided essential inputs for structuring the game theory models. Three models were developed, each focusing on a different aspect of the problem. Two non-cooperative game theory models examined strategic behaviour in the existing (peri-urban) and future (urban) drinking water scenarios respectively. As a result, the actors and their actions differed slightly in each model. Groundwater monitoring was modelled as a cooperative game. This third model analysed cooperative strategies to improve groundwater data, highlighted as one of the major stumbling blocks in ensuring safe drinking water quality.

The three models provided insight into actor strategies to interpret existing outcomes in the problem as well as alternate strategies for Hogladanga to improve drinking water supply and quality. In the existing drinking water supply situation, model 1 highlighted that for Hogladanga to access public tube-wells they needed to incentivise a more equitable allocation of licences from the committee. However, even then, the risk of poor drinking water quality will remain unless the Department of Public Health Engineering can also change the way they select locations for tube-well installations. Without these changes, Hogladanga's best alternative to a negotiated outcome is to invest in more private tube-wells, although this strategy also does not guarantee better drinking water quality as there is limited knowledge of underground aquifer conditions during installation.

Model 2 about the future drinking water supply situation recommended Hogladanga to apply for piped water supply (household connection) from the Khulna

Water Supply and Sewerage Authority. Although presently, it is difficult to predict the outcome of this strategy as it is dependent on the availability of piped supply projects in the future. Without this option, residents will need to continue relying on investing in private tube wells or purchase bottled water (a new option in the future scenario). However, both may not be affordable options for everyone and run the risk of being unreliable in terms of water quality.

The challenges of drinking water supply from both models 1 and 2 clear pointed to a need for safer, more reliable drinking water quality. Therefore, model 3 explored cooperative strategies to improve groundwater monitoring. Cooperation offered better payoffs for both community and government actors alike, given that each of them are individually restricted in their knowledge of local aquifer conditions. The grand coalition offers a highest possible payoff, although the rewards are higher based on how the coalition is formed. Results from step 3 are largely analytical in nature, and were used to design role-playing games to share model findings in step 4, strategy exploration. The experience of developing game theory models revealed the challenges of discussing model inputs with communities, and model limitations despite having direct contact with most of the actors who were modelled.

Step 4: Strategy exploration

Strategic exploration in step 4 was facilitated through role-playing games, as part of a workshop with Hogladanga residents. Game theory models provided the essential inputs needed to design this game. The workshop comprised three separate games wherein participants experience through role-play, the outcomes of different solution strategies. The first game was about the existing peri-urban drinking water supply situation; the second on the future urban situation. The third game explored non-cooperative vs cooperative strategies for groundwater monitoring.

The workshop built on the existing knowledge of the community. Evaluation results showed learning on several fronts. Participants realized how important local aquifer conditions are in determining their access to good quality drinking water. Moreover, game 1 helped them understand the motivations and decision making constraints of formal service providers. In game 2, participants discovered new options to access drinking water in the future with their own set of constraints as a result of different actors in the game. In game 3, participants described the challenges of cooperating with other actors as experienced during the cooperative role-play round. This game also made the community realise their role in problem solving, beyond raising concerns and requesting solutions from the government. More generally, this workshop give participants a conceptual understanding of strategic games wherein different strategies requires interacting with different actors the outcomes of which produced varied levels of satisfaction. Moreover, it gave Hogladanga residents the experience of negotiating with government actors. The role-playing method was valued by participants and facilitators alike, as an interactive medium to compare and evaluate strategies. They expressed an interest in sharing the game with others in the village and potentially using it during negotiations in the future.

The experience with the APIA in Hogladanga shows the value of an institutional approach to problem diagnosis and offers tools, and approaches to do this with communities. Overall, the APIA offers extensive analytical insights into peri-urban problems. More importantly, the APIA provided a structured approach to capacity building over time. Overall, problem understanding was improved with regards to underlying institutions and multi-actor interactions within the problem. However, it proved difficult to distinguish learning outcomes that can be directly attributed to the APIA from other capacity building activities and workshops conducted in parallel as part of a larger project. This pilot application also highlighted the important role of local facilitators in this participatory approach. Regular engagements were necessary to properly define peri-urban problems and thereafter, help the community understand and discuss the results of each step. The study suggested that for peri-urban communities, visual tools to communicate and discuss problems is greatly beneficially, especially for discussing the institutional context. Social mapping in step 1 and role-playing games in step 4 helped engage residents with different educational levels and analytical capabilities to also have discussions within the community as well as with government actors.

Generalizing beyond the case-study

As a single case study, the APIA application in Hogladanga offers a limited basis for more general conclusions about the approach and its associated methods, for capacity building and decision support. Therefore, the APIA is also evaluated from three other peri-urban case studies within the Ganges delta. Although these are less intensive, partial applications, they revealed nonetheless, insights about application nuances in different contexts, with different problem owners, and when used to address different societal problems.

In Badai village (India), problem identification was pursued with local stakeholders. This case study highlighted the variety of peri-urban problems that the APIA may be applied to. The institutional context was found to be significant in Badai's industrial water issues and its multi-actor nature similarly led to issues of marginalization. Further analysis through the APIA, requires adapting the engagement process for different kinds of problems. For example, in Badai it means engaging with local industries and government departments. Here, the sensitivity is important to keep in mind while structuring capacity building workshops.

Another application featured the use of steps 1 and 2 in Thiuria village (India). It revealed important lessons about using the APIA in other contexts. Although Thiuria faces very similar drinking water problems to that of Hogladanga, the APIA analysis was adapted to Thiuria's unique institutional context. Unlike Hogladanga, bottled water companies are much more widespread in Thiuria and moreover, discovered to be quite politically sensitive. Furthermore, the location of the village in an arsenic prone region made the drinking water quality issue much more significant. Testing local drinking water sources was needed by the community but required hydrogeological insights. Therefore, further analysis was not pursued through the APIA. Instead, the Shifting Grounds project took up capacity building by through arsenic testing programs in this and other neighbouring villages.

A third APIA application with different types of problem owners took place in Khulna. There, the strategic exploration workshop (Step 4) that was developed for

Hogladanga residents was played with government stakeholders to examine drinking water management problems. The game-based method was valued by the government participants, yet their capacity building needs and interests differed from that of the Hogladanga community. In other words, APIA analyses also need to be tailored to different kinds of problem owners.

Conclusions

This thesis developed and investigated an approach to help peri-urban communities explore and understand their problems from an institutional perspective, given the important role that institutions play in this context. This, of course, is not limited to areas experiencing urbanization, as institutional gaps, system changes, and multi-actor complexity are common features in many kinds of societal challenges. However, exploring this lies outside the scope of this study. In general, the APIA is beneficial for analysing institutional dimensions of problems in a structured way. Case studies from the Ganges delta offer lessons about this approach to further improve decision-support interventions framed through an institutional lens.

One principle behind the design of the APIA was that it should be participatory in nature. In other words, facilitate the participation of marginalized actors (in this case, peri-urban communities). The application in Hogladanga reveals just how challenging it is to actually collaborate with communities and discuss institutional concepts. As a result, participation scored better for some steps, less so in others where the researchers played a critical role in translating inputs into the APIA methods and later on, sharing results with the community. For example, the game-based strategy exploration workshop succeeded in actively engaging local residents, more so that strategic analysis where that was less collaborative. Future research should explore simple, practical ways for problem owners to directly apply the methods of the APIA with the help of local facilitators. This requires a better understanding of how to tailor the methods and supporting materials to specific contexts.

The monitoring and evaluation of APIA outcomes also demands further research. Given that these interventions are often undertaken as part of a larger project, it is important to identify results attained from the APIA activities but also on-going interactions with local stakeholders throughout the project. Moreover, given the focus on institutions, monitoring the long-term impact of capacity building efforts should also be emphasized. The case studies from the urbanising Ganges delta provide a useful starting point to improve the APIA as a tool to support policy-making. Given the gaps in existing peri-urban policies, especially in the global south, the APIA offers a way to intervene in these types of problems by supporting stakeholders directly affected by its outcomes. Through informed decision-making and developing skills to intervene in complex, multi-actor problems, it creates an opportunity for local actors to create a more sustainable and equitable rural to urban transition.

Samenvatting

Een Institutionele Benadering voor Peri-urbane Waterproblemen: Ondersteuning voor participatieve probleemanalyse in de Ganges delta

Achtergrond

In het licht van de schaal en het tempo waarin verstedelijking of urbanisatie zich de komende decennia zal voortzetten vormt het een belangrijk onderzoeksgebied rond mondiale ontwikkeling.. Een van de uitdagingen heeft betrekking op het duurzaam beheer van natuurlijke hulpbronnen tijdens stedelijke transities. De overgang van platteland naar stad is prominent zichtbaar in de zogenaamde peri-urbane gebieden. Deze peri-urbane gebieden ondergaan grote veranderingen wat betreft bevolking en grondstof-gebruik. Het zijn de dorpen uit het verleden en de steden van de toekomst. Onderzoek dat zich richt op deze peri-urbane gebieden is essentieel voor duurzame verstedelijking.

Het hier beschreven promotie-onderzoek heeft betrekking op de Ganges-delta in Zuid Azië. Deze regio ondervindt op dit moment grote veranderingen door de groei van stedelijke gebieden. Dit heeft ook direct impact op peri-urbane gebieden in de omgeving van de steden Khulna (in Bangladesh) en Calcutta (in India). Ondanks de ligging in relatief waterrijke en natte gebieden, staat het lokale grondwaterbeheer in deze peri-urbane gebieden onder grote druk door veranderingen in landgebruik, economische activiteit en bevolkingsgroei. Grondwater vormt een belangrijke waterbron voor de peri-urbane dorpsgemeenschappen. Het overmatig gebruik en de toenemende vervuiling van grondwater leidt tot spanning en conflicten tussen peri-urbane gebruikers.

Onderzoeksfocus en -doel

De focus van dit onderzoek ligt op de institutionele context van peri-urbane problemen, waarbij instituties verwijzen naar de regels die maatschappelijke besluitvorming en interactie structureren. Formele en informele regels spelen een belangrijke rol bij het oplossen van problemen waarbij verschillende maatschappelijke actoren betrokken zijn. De verschillende perspectieven, belangen en hulpbronnen van deze actoren maken het oplossen van problemen complexer.

Peri-urbane instituties worden in de literatuur doorgaans beschreven als zijnde vaag en onduidelijk, en met zowel fragmentatie als onderlinge overlap. Regels volgen vaak een administratief onderscheid tussen stad en platteland, hetgeen leidt tot een administratief niemandsland voor peri-urbane overgangsgebieden. Doorgaans vallen deze peri-urbane gebieden nog onder de rurale instituties, maar deze rurale instituties zijn niet toegerust voor de nieuwe stedelijke eisen en de peri-urbane dynamiek. Als een goede analyse van de institutionele dimensie ontbreekt, leidt dit tot een incompleet begrip van de problemen en een beperktere oplossingsruimte.

Dit onderzoek ondersteunt probleem-oplossen door de gemeenschap in peri-urbane dorpen die vaak te kampen hebben met inadequate institutionele arrangementen. Deze peri-urbane dorpsgemeenschappen zijn doorgaans

buitengesloten van het beleidsproces, maar ondervinden wel direct de impact van de daar genomen besluiten. De theorie stelt dat actoren die problemen ondervinden ofwel naar oplossingen kunnen zoeken binnen de bestaande institutionele setting, ofwel kunnen proberen instituties te veranderen als manier om invloed uit te oefenen op de uitkomsten: Men kan proberen het spel beter te spelen volgens de bestaande regels, of men kan proberen of andere spelregels tot betere uitkomsten leiden. Dit geldt ook voor de actoren in peri-urbane dorpsgemeenschappen. Echter, de beperkte kennis van de instituties en de besluitvormingsarena's belemmeren dit vermogen. Dit onderzoek ondersteunt peri-urbane gemeenschappen om deze kennis- en capaciteitskloof te overbruggen om daarmee beter te kunnen interveniëren in beleidsarena's.

Onderzoeksvraag

De hoofdvraag van dit onderzoek luidt:

Hoe kunnen peri-urbane gemeenschappen ondersteund worden bij het aanpakken van institutionele aspecten van water-problemen tijdens verstedelijking?

Theorie

Het vertrekpunt voor deze studie wordt gevormd door literatuur over instituties en institutionele verandering, in relatie tot de peri-urbane omgeving. Twee karakteristieken blijken van belang voor een beter begrip van instituties en probleem-oplossen. Ten eerste, peri-urbane gebieden zijn dynamisch, omdat juist het overgangsproces belangrijk is in deze gebieden. Dit betekent dat instituties het gevaar lopen dat ze na een tijd ineffectief worden, wanneer het systeem en de behoeften van de actoren veranderen. Ten tweede, een sociaal heterogene samenstelling van de peri-urbane gemeenschap betekent dat probleem-oplossen het resultaat is van onderhandelingen tussen actoren. Hun verschillende perspectieven, belangen en hulpbronnen maken probleem-oplossen complexer.

De literatuurstudie leidt tot een hypothese voor institutionele verandering met drie veronderstellingen. Een verandering in een bestaand systeem zal leiden tot een institutionele verandering gebaseerd op: (1) de evaluatie/waardering door actoren van institutionele functie en geloofwaardigheid; (2) een proces van 'satisficing', waarbij de kosten en baten van institutionele verandering afgezet worden tegen de beschikbare middelen totdat men een alternatief heeft gevonden dat leidt tot een bevredigende uitkomst; (3) waarbij de gelaagde structuur van instituties een sterke invloed heeft op de kosten en beschikbare middelen voor actoren om institutionele verandering te bewerkstelligen. Deze theoretische inzichten zijn gebruikt om een benadering te ontwerpen die peri-urbane gemeenschappen begrip kan bieden van de institutionele aspecten van lokale problemen

APIA: Een benadering voor de institutionele aspecten van problemen

De volgende stap in dit onderzoek behandelt manieren om samen met peri-urbane gemeenschappen te werken aan hun problemen. Bestaande benaderingen zijn verkend, met name benaderingen met betrekking tot participatief onderzoek en 'community operational research'. Een gestructureerde benadering werd ontworpen om aan te sluiten bij de omgeving, het proces en de analytische vereisten van dit onderzoek. Deze benadering heeft de naam "Benadering voor Participatieve Institutionele Analyse", ofwel APIA ("Approach for Participatory Institutional Analysis") gekregen.

De APIA benadering kent vier stappen: Probleem identificatie, in kaart brengen van institutionele systeem, strategische analyse, en strategie-verkenning. De probleem identificatie (stap 1) helpt de gemeenschap om de meest prangende problemen die zich lenen voor verdere institutionele analyse te identificeren en af te bakenen. In stap 2 wordt het institutionele systeem rond het probleem in kaart gebracht en geanalyseerd met behulp van het "Institutional Analysis and Development framework". Een verwachte uitkomst van stap 2 is dat peri-urbane gemeenschappen beter bekend worden met hun instituties. De bedoeling van stap 3 is om multi-actor interacties in probleemarena's te structureren als strategische "spellen". Dit wordt gedaan met behulp van speltheoretische modellering. Tenslotte, in stap 4, verkennen gemeenschappen oplossingsstrategieën door middel van spel-simulaties die zijn ontwikkeld op basis van de speltheoretische modellen uit stap 3.

Om de methodes, het proces en de resultaten van de interventie te beoordelen is een evaluatie-raamwerk gebruikt, ontworpen rond input, activiteit en output van APIA toepassingen.

Case-study toepassing van de APIA benadering

In dit onderzoek is de APIA benadering toegepast op de casus van Hogladanga, een peri-urbaan dorp in de nabijheid van de stad Khulna, in de Ganges delta in Bangladesh. Probleemstructurering werd uitgevoerd in samenwerking met een lokale niet-gouvernementele organisatie, JJS, die verantwoordelijk was voor de betrokkenheid van de lokale dorpsgemeenschap.

Stap 1: Probleem identificatie

Toegang tot een veilige (schone) drinkwatervoorziening bleek een groot probleem voor deze gemeenschap. Het was een van de drie grootste zorgen die de gemeenschap naar voren bracht, naast een goed functionerend drainage-kanaal en de verwerking van stedelijk afval. Het vaststellen van de probleemafbakening was een zeer iteratief proces, dat ook voortging na Stap 1. Meerdere bijeenkomsten waren nodig om vertrouwen te bouwen en een band met de gemeenschap voor langduriger interactie. Het vroegtijdig opbouwen van een netwerk van actieve lokale bewoners was essentieel om de APIA activiteiten over een langere periode voort te zetten.

De resultaten van stap 1 demonstreren het complexe en gevarieerde karakter van peri-urbane problemen. De bewoners uitten verschillende water-gerelateerde zorgen, waarvan er vele gekoppeld waren aan levensonderhoud, klimatologische omstandigheden, verstedelijking en ingebed in een sterk sociaal-politiek krachtenveld. Dit maakte het een uitdaging om een duidelijke probleemafbakening vast te stellen. Inzichten uit latere stappen hielpen om de initiële probleemafbakening te verfijnen. Aanvankelijk signaleerden de bewoners een tekort aan drinkwater-infrastructuur, maar latere discussies maakten duidelijk dat er ook behoefte was aan betere waterkwaliteit. Bijvoorbeeld, het latere 'onderhandelingsplan' van de gemeenschap liet zien dat de bewoners niet alleen behoefte hadden aan meer van de bestaande drinkwaterputten, maar ook aan diepere drinkwaterputten om drinkwater van een voldoende goede kwaliteit te kunnen leveren. Stap 1 had ook baat bij andere probleemidentificatie-activiteiten door JJS, zoals het gebruik van "social mapping".

Stap 2: In kaart brengen van instituties

De volgende fase bracht de institutionele context in kaart van het drinkwaterprobleem. Input uit de gemeenschap werd verkregen door middel van interviews, focus group discussies, en veldbezoek. Dit werd aangevuld met secundaire bronnen en met gesprekken met andere peri-urbane stakeholders. De institutionele analyse liet zien hoe belangrijke instituties (formeel en informeel) de interacties in verschillende arena's beïnvloedden, en hoe het probleem evolueerde in de tijd.

Op dit moment wordt de publieke drinkwater infrastructuur in Hogladanga geinstalleerd door het Departement of Public Health Engineering ("Volkgezondheid") met een vergunning door het Water and Sanitation comité van het regio-bestuur. De bestaande regels voor het toewijzen van vergunningen voor nieuwe waterputten door het regionale comité hebben niet geleid tot voldoende drinkwaterinfrastructuur voor Hogladanga. Lokale bewoners hebben zich aangepast door gebruik te maken van informele regels om de bestaande waterputten te delen en te investeren in private waterputten. De verwachting is dat in de toekomst de drinkwatervoorziening zal veranderen als gevolg van de stadsuitbreiding van Khulna city. Het is de verwachting dat peri-urbane gebieden als Hogladanga onder het formele stadsbestuur zullen gaan vallen en voor de drinkwatervoorziening dan zullen resorteren onder de stedelijke "Khulna Water Supply en Sewerage Authority". Echter, dit betekent niet automatisch dat daarmee de toegang tot betaalbaar en veilig drinkwater gegarandeerd is in de toekomst. Informele mechanismen zullen ook een rol blijven spelen, via private putten of door flessen-water te kopen van private waterbedrijfjes. De analytische uitkomsten waren in lijn met de verwachtingen uit de eerdere hypothese omtrent wanneer en hoe systeemverandering leidt tot institutionele verandering.

De resultaten van Stap 2 werden gedeeld en besproken tijdens een workshop met peri-urbane actoren (inclusief de inwoners van Hogladanga). Dit hielp de gemeenschap om te reflecteren op hun eigen probleemperspectief en op het perspectief van andere actoren. Naast de huidige situatie werden ook de mogelijke toekomstige veranderingen besproken. Deze workshop gaf de bewoners een platform om hun problemen en zorgen direct met de lokale gezaghebbers te bespreken. Daarnaast werden brochures opgesteld met overzichten van met name de formele drinkwaterinstituties en gedeeld met de gemeenschap. Dit illustreerde het verschil tussen wat er officieel vastgesteld is, en wat er in de praktijk wordt ervaren. Hoewel deze brochures uitleg van JJS facilitatoren nodig hadden, hadden veel bewoners het idee dat ze hierdoor nieuwe informatie kregen.

Stap 3: Strategische analyse

Strategisch analyse was de derde stap in de APIA benadering die werd geïmplementeerd in Hogladanga. Ook hier verschaften de bewoners (en andere peri-urbane actoren) essentiële input voor het structureren van de speltheoretische modellen. Drie modellen werden ontwikkeld, elk voor een ander aspect van het probleem. Twee non-coöperatieve speltheoretische modellen onderzochten strategisch gedrag binnen respectievelijk de bestaande (peri-urbane) en de toekomstige (urbane) drinkwater scenario's. De actoren en hun acties verschilden iets in elk model. Als derde werd grondwater monitoring gemodelleerd als coöperatief spel. Dit model analyseerde strategieën voor samenwerking om de beschikbaarheid van grondwater data te verbeteren, iets dat eerder was geïdentificeerd als struikelblok om een betere waterkwaliteit te kunnen garanderen.

De drie modellen gaven inzicht in de strategieën van actoren om bestaande uitkomsten te interpreteren evenals alternatieve strategieën voor Hogladanga om drinkwatervoorziening en kwaliteit te verbeteren. In de bestaande drinkwater-situatie, gaf model 1 aan dat een eerlijker verdeling van vergunningen door het regionale drinkwatercomité alleen te verwachten was met andere prikkels (incentives) voor de leden van dat comité. En zelfs dan zou het risico op slechte waterkwaliteit blijven bestaan, tenzij ook het Department for Public Health Engineering ook de procedures zou veranderen voor het selecteren van locaties voor drinkwaterinstallaties. Zonder deze veranderingen was de beste overgebleven optie voor Hogladanga (de "Best alternative to a negotiated outcome") om zelf te investeren in private putten, hoewel ook dit geen garantie gaf voor betere drinkwaterkwaliteit gegeven de bestaande beperkte kennis van het lokale grondwatersysteem.

Model 2, over de toekomstige drinkwatersituatie, resulteerde in een aanbeveling voor Hogladanga om een aanvraag in te dienen voor een huisaansluiting bij de stedelijke drinkwateraanbieder, KWASA. Echter, de voorspellende waarde van dit model en deze aanbeveling is relatief klein omdat realisatie afhankelijk is van de onzekere beschikbaarheid en uitbreiding van het stedelijke drinkwaterleidingnet in de toekomst. Zonder deze optie zullen bewoners nog steeds afhankelijk zijn van eigen investeringen in private drinkwaterputten, of, mogelijk, van het kopen van drinkwater in flessen van private aanbieders. Voor beide opties geldt dat niet iedere inwoner ze zich kan veroorloven en dat er nog steeds een risico bestaat op onvoldoende waterkwaliteit.

Stap 4: Strategische verkenning

Strategische verkenning in stap 4 werd ondersteund door een rollenspel (role-playing game), als onderdeel van een workshop met bewoners van Hogladanga. De speltheoretische modellen vormden de essentiële input voor het ontwerp van dit spel. De workshop bestond uit drie verschillende rollenspelen, die de bewoners in staat stelden om de uitkomsten van verschillende strategieën te ervaren. Het eerste spel ging over de bestaande peri-urbane drinkwatersituatie; het tweede over de toekomstige situatie. Het derde spel verkende coöperatieve versus niet-coöperatieve strategieën voor het monitoren van grondwater.

De workshop borduurde voort op de bestaande kennis van de bewoners. De evaluatie van de workshop liet zien dat er op verschillende fronten geleerd werd. Deelnemers realiseerden zich hoe belangrijk (zeer) lokale grondwatercondities waren voor het bepalen van de toegang tot schoon drinkwater. Daarnaast hielp Spel 1 ze om te drijfveren en overwegingen van de formele spelers beter te begrijpen. In spel 2 ontdekten de deelnemers via de betrokkenheid van verschillende actoren in het spel nieuwe opties om in te toekomst toegang te krijgen tot drinkwater van goede kwaliteit, elk met eigen beperkingen,. In spel 3 deden deelnemers ervaringen op met de uitdagingen van samenwerking met andere partijen. Door dit spel gingen de bewoners zich ook realiseren welke rol ze zelf speelden in het oplossen van problemen, naast het onder de aandacht brengen van hun zorgen en het indienen van verzoeken bij de overheid voor een oplossing. Meer in het algemeen gaf de workshop de deelnemers een conceptueel begrip van strategische spellen, waarbij verschillende strategieën andere eisen stellen aan interactie met andere actoren, en leiden tot andere uitkomsten met verschillende waarderingen en maten van tevredenheid. Daarnaast gaf het de inwoners van Hogladanga de ervaring van het onderhandelen met overheidsactoren. De role-playing methode werd gewaardeerd door zowel de deelnemers als de facilitatoren van JJS als een interactieve manier om strategieën te vergelijken en te beoordelen. Ze gaven aan het spel in de toekomst graag te willen delen met andere dorpsbewoners en voor toekomstige onderhandelingssituaties te willen gebruiken.

De ervaring met de APIA benadering in Hogladanga laat de waarde zien van een institutionele benadering voor probleem diagnose en de benadering biedt instrumenten en benaderingen om dit samen met lokale gemeenschappen te doen. Over het geheel genomen, geeft APIA uitgebreid analytisch inzicht in peri-urbane problemen. Bovendien gaf APIA een gestructureerde benadering om lokale capaciteit op te bouwen. Het probleembegrip verbeterde met betrekking tot de onderliggende instituties en de multi-actor interacties. Wel was het moeilijk om leeropbrengsten direct en uitsluitend toe te schrijven aan APIA, omdat het onderzoek plaats vond binnen een groter geheel aan parallelle activiteiten en workshops voor lokale capaciteitsopbouw binnen het grotere project. Deze pilot-toepassing benadrukte ook de belangrijke rol van lokale facilitatoren. Regelmatige betrokkenheid van lokale facilittoren was nodig om peri-urbane problemen te benoemen en af te bakenen en, daarna, om de gemeenschap te ondersteunen bij het begrijpen en bespreken van de uitkomsten van elke stap. Voor peri-urbane dorpsgemeenschappen bleken visuele communicatiemiddelen zeer nuttig als hulpmiddel bij bespreken van problemen en vooral voor het bespreken van de institutionele context. Social mapping in Stap 1 en de rollenspellen in Stap 4 hielpen bij het betrekken van bewoners met verschillende opleidingsniveaus en analytische capaciteiten, voor discussie binnen de gemeenschap maar ook met overheidsactoren.

Generaliseerbaarheid van de resultaten

Een enkele case study als de casus in Hogladanga geeft een beperkte basis voor meer generieke conclusies over de APIA benadering als hulpmiddel voor capaciteitsopbouw en ondersteuning bij besluitvorming. Daarom is de APIA benadering ook toegepast voor drie andere peri-urbane case studies in de Ganges delta. Deze toepassingen waren echter minder intensief en beperkter dan de volledige toepassing in Hogladanga. Desalniettemin leverden ze ook inzichten op voor toepassingen in andere contexten, met andere probleemeigenaren en voor andere maatschappelijke problemen.

In het peri-urbane dorp Badai (India), werd probleemidentificatie verkend met lokale stakeholders. Deze casus onderstreepte de variëteit aan peri-urbane problemen waarvoor APIA kan worden toegepast. De institutionele context bleek een belangrijke rol te spelen bij problemen rond industrieel watergebruik in Badai en de multi-actor karakteristieken leidden ook hier tot marginalisatie van bepaalde groepen. Verdere analyse met APIA vergt aanpassingen aan het proces aangezien het gaat om andere type problemen dan in Hogladanga. Bijvoorbeeld, in Badai zullen ook lokale industrieën en overheidsinstanties betrokken moeten worden. Ook is het bij deze casus van groot belang om zorgvuldig om te gaan met de grote gevoeligheid van het onderwerp bij het structuren van workshops.

Een andere toepassing van Stap 1 en 2 is gedaan voor het peri-urbane dorp Thiuria (India). Dit gaf inzichten in toepassingen in een andere context. Hoewel Thiuria vergelijkbare problemen heeft als Hogladanga met de toegang tot drinkwater, was de APIA analyse aangepast op Thiuria's specifieke institutionele context. In tegenstelling to Hogladanga, zijn in Thiuria de waterbedrijven die flessenwater verkopen een belangrijke speler en, bovendien, ligt hun rol politiek gevoelig. Daarnaast was het kwaliteitsaspect hier ook aanwezig, maar veel prominenter dan in Hogladanga, vanwege de ligging van Thiuria in een gebied waar veel arseen voorkomt. Het testen van waterbronnen was nodig en vergde andere geohydrologische kennis en middelen. Daarom werd APIA hier niet ingezet voor verdere analyse maar lag de focus van het Shifting Grounds project op verdere capaciteits-opbouw voor het uitvoeren van een arsenic testing programma in Thiuria en omliggende dorpen.

Een derde APIA toepassing, met een ander type probleemeigenaar, vond plaats in Khulna. Hier werd het strategische verkenningsspel (stap 4), dat was ontwikkeld voor de bewoners van Hoglandanga, ook gespeeld met overheidspartijen om drinkwater problemen te onderzoeken. De spel-methode werd gewaardeerd door de overheidsdeelnemers, maar ze verschilden in hun behoeften van de bewoners van Hogladanga. APIA analyses moeten dus toegesneden worden op verschillende typen probleemeigenaren.

Conclusies

Deze dissertatie ontwikkelde en onderzocht een benadering om peri-urbane dorpsgemeenschappen te helpen bij het verkennen en begrijpen van hun problemen door een institutioneel perspectief, vanwege de belangrijke rol die instituties spelen in de peri-urbane context. Het belang van instituties is natuurlijk niet beperkt tot gebieden die te maken hebben met verstedelijking, maar de reikwijdte van deze studie is wel beperkt tot de toepassing in peri-urbane gebieden. Hier is de ontwikkelde APIA benadering zinvol voor het analyseren van institutionele dimensies van problemen op een gestructureerde wijze. Casustoepassingen in de Ganges delta leveren lessen op over verdere toepassing van deze benadering.

Een van de ontwerpprincipes van de APIA benadering was dat het een participatieve benadering zou moeten zijn. Het zou de participatie van marginale groepen (in dit geval: peri-urbane dorpsgemeenschappen) moeten ondersteunen. De toepassing in Hogladanga laat zien hoe uitdagend het is om echt samen te werken met een peri-urbane gemeenschap en met hen institutionele concepten te bediscussiëren.

Participatie kwam beter uit de verf voor sommige stappen en minder in andere stappen, waar onderzoekers een grotere rol moesten spelen bij het vertalen van inputs naar APIA methoden en, later, bij het delen van de resultaten met de gemeenschap. Bijvoorbeeld, de game-based workshop voor strategie-verkenning hielp om de lokale bewoners bij de analyse te betrekken, maar de onderliggende strategische analyse was minder interactief. Toekomstig onderzoek zou simpeler en praktischer manieren moeten verkennen waarop probleemeigenaren direct de methoden van APIA zelf zouden kunnen toepassen met behulp van lokale facilitatoren. Dit vergt een beter begrip van hoe de methoden en ondersteunde materialen toegesneden kunnen worden op een specifieke context.

Het monitoren en evalueren van de toepassingen en uitkomsten van de APIA benadering vergt ook verder onderzoek. Omdat dergelijke toepassingen vaak zullen worden ingebed binnen grotere projecten, is het belangrijk om de directe resultaten van APIA activiteiten te identificeren, maar ook de andere lopende interacties met en tussen lokale stakeholders gedurende het project. Bovendien, gegeven de focus op instituties, moet het monitoren van lange-termijn effecten van capaciteitsopbouw benadrukt worden. De case studies in de verstedelijkende Ganges delta geven een bruikbaar startpunt om APIA als besluitvormingsinstrument verder te verbeteren. Vanwege de hiaten in bestaand beleid voor peri-urbane gebieden, zeker in lage- en middeninkomenslanden, geeft APIA een interventie-benadering voor het ondersteunen van stakeholders die direct geraakt worden door de uitkomsten van dat beleid. Door middel van geïnformeerde besluitvorming en het ontwikkelen van vaardigheden voor interventie in complexe multi-actorproblemen, creëert de benadering een mogelijkheid voor lokale actoren voor een duurzamer en eerlijker transitie van ruraal naar urbaan gebied.

Acronyms

ABM	Agent Based Modelling
APIA	Approach for Participatory Institutional Analysis
BADC	Bangladesh Agricultural Development Cooperation
BDT	Bangladeshi Taka
BRAC	Bangladesh Development Agency
BUET	Bangladesh University of Engineering Technology
BWDB	Bangladesh Water Development Board
CEGIS	Center for Environmental and Geographic Information Services
COR	Community Operational Research
COR	Community Operational Research
CSO	Civil Society Organisation
DAE	Department of Agricultural Extension
DIC	District Industrial Centre
DMS	Development of Mohila Society
DOE	Department of Environment
DPHE	Department of Public Health Engineering
ETP	Effluent Treatment Plant
FGD	Focus Group Discussion
IAD	Institutional Analysis and Development Framework
IWM	Institute of Water Modelling
KCC	Khulna City Corporation
KDA	Khulna Development Authority
KWASA	Khulna Water Supply and Sewerage Authority

LGED	Local Government Engineering Department
LGRD&C	Ministry of Local Government, Rural Development, and Cooperatives
MLD	Million Litres per Day
MSME	Micro, Small & Medium Enterprises
NA	Negotiated Approach
NGOs	Non-Governmental Organisations
NWO	Netherlands Organisation for Scientific Research
O&M	Operation & Maintaintence
OR	Operations Research
PCB	Pollution Control Board
PHED	Public Health Engineering Department
PRA	Participatory Rural Appraisal
RRA	Rapid Rural Appraisal
Saci WATERs	South Asia Consortium for Interdisciplinary Water Resources Studies
TU Delft	Delft University of Technology
WARPO	Water Resources Planning Organisation

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Chapter One

Introduction


Photo courtesy: The Researcher (2015)

1.

Introduction

1.1 Peri-urban water management: The case of the urbanising Ganges delta

Urbanisation is a global phenomenon that will continue to occur over the coming decades. The latest 'World Urbanisation Prospects' report by the United Nations, predicts that by 2050, 68% of global population will reside in urban areas (UN, 2018). In the future, substantial growth in urbanisation is expected in the global south. It is projected that by 2030, most of the world's 43 megacities with over 10 million inhabitants will be in developing countries and furthermore, that many of the fastest growing urban agglomerations will be cities of 1 million inhabitants from Asia and Africa (UN, 2018). Therefore, research is needed to better understand the urbanisation processes and issues in these regions, where most of the urban growth is likely to occur.

One of the challenges many countries in the global south face, is managing the transition from rural to urban. This transition occurs in peri-urban areas. Peri-urban areas are situated in close proximity to expanding urban centres, which is why they are sometimes referred to as the urban fringe (Bowyer-Bower, 2006; Iaquinta & Drescher, 2000; Narain, 2010). They embody the physical, social, and economic changes that are associated with the urbanisation process (Allen, 2003). These changes are visible in the utilization of resources, population, and livelihood activities of peri-urban communities. Given that today's peri-urban areas shape the cities of tomorrow, peri-urban governance plays an important role in the direction that urbanisation takes.

The Ganges Delta in South Asia is a region experiencing significant change as a result of urbanisation. Within this delta, rapid and largely uncontrolled urban expansion is occurring in major cities like Kolkata (India) and Khulna (Bangladesh). The effect of this is felt most by surrounding peri-urban areas. In peri-urban Khulna and Kolkata, population is increasing as the urban proximity, emerging job markets, and affordability of peri-urban areas attracts migrant populations. For example, following major cyclones like Sidr in 2007 and Aila in 2009, many coastal residents migrated to Khulna city and its surrounding areas (Kartiki, 2011; Mallick & Vogt, 2014). Meanwhile, peri-urban areas north of Kolkata city have been transformed by the growth in the industrial sector, particularly dyeing factories, given the availability of resources and market connectivity (Gomes, 2018).

The urban expansion process in the Ganges Delta poses several challenges for resource management. This is especially true for groundwater resources. The Ganges Delta is one of the world's largest aquifer systems, so it is no surprise that groundwater plays an important role. Many peri-urban communities rely almost entirely on groundwater for drinking purposes. Major economic sectors also utilize groundwater for certain kinds of agricultural, aquaculture, and industrial activities. Communities that do not have access to community ponds or canals, also pump groundwater from shallow tube-wells for domestic uses. Given this widespread dependency on groundwater, sustainable utilization of this resource is a concern.

Increasing demand for groundwater as a result of urbanisation also has a major impact on the condition of local aquifers. Previous research in this delta shows evidence of deteriorating groundwater conditions, growing competition between users, and in some cases, even conflicts (Kumar, Khan, Rahman, Mondal, & Huq, 2011). In peri-urban Khulna, over-exploitation is causing a decline in the groundwater tables and creating salinity issues; whereas in Kolkata arsenic contamination is reaching critical levels in many peri-urban areas (Thissen et al., 2013). Overall, this groundwater crisis that is developing in the Ganges delta poses a significant threat to peri-urban communities.

1.2 The Institutional dimensions of peri-urban problems

Managing common pool resources like groundwater requires multiple actors to share and coordinate resource use. Here, institutions exist to regulate decision making and provide mechanisms for interaction (North, 1990; Ostrom, 2005). Institutions refer to formal and informal 'rules' in society. Formal rules include laws, acts, and policies while informal rules consist of norms, customs, and beliefs (North, 1990). One of the reasons why peri-urban resource management proves challenging stems from the underlying institutional context.

In peri-urban areas, existing institutions are often ineffective. It is difficult to spatially demarcate peri-urban areas, as a result of their transitional nature. For this reason, many scholars today prefer to define the term 'peri-urban' more as a process or a concept rather than in spatial terms (Allen, 2003; Narain, 2010). This poses an institutional design challenge, as peri-urban governance typically occurs along rural-urban administrative boundaries. It leaves peri-urban areas with unclear, fragmented, and sometimes overlapping institutions. In India and Bangladesh for example, peri-urban areas are officially part of the rural jurisdiction, despite being situated closer to urban areas and featuring more urban than rural features. This creates an institutional 'gap'. Over time, rural institutions are less able to cater to the needs of peri-urban actors (Allen, 2003).

The peri-urban institutional landscape naturally has an impact on governance. Unclear or fragmented rules make it difficult to ascertain actors' roles and responsibilities. In a multi-actor problem such as groundwater management, institutions specify the rules for coordination. However, coordination is difficult to achieve in a fragmented institutional context with poorly defined or poorly implemented rules. Moreover, ineffective rural institutions and the geographic location of peri-urban communities away from rural decision-making centres can marginalize them from essential public services. Therefore, in addressing peri-urban problems, it is important to take this institutional context into consideration.

In the Ganges Delta, peri-urban communities are in need of solutions to their groundwater issues. There is an opportunity here to support the community in their problem solving efforts. Currently problem solving is constrained due to several factors. Many peri-urban communities in India and Bangladesh are isolated from the formal policy process. Decision-making at the most local official level typically occurs at the block or sub-district administrative levels, that is geographically quite far and thus inaccessible to peri-urban communities. This influences problem solving in two ways.

First, isolation from policy processes limits communities' access to information relevant to solving the problems they face, such as for example, the formal institutions. Second, given the multi-actor nature of peri-urban problems, problem solving emerges through interactions and negotiations with other actors. Isolation from decision centres not only limits communities' ability to formally intervene and influence the policy process on these issues, but also gives them limited experience within these arenas. Together, this limits their solution space.

Peri-urban actors also need to explore solutions that suit their context. The dynamic nature of this context suggests that a long term perspective is needed during problem solving. This requires an understanding of potential future scenarios and strategies available within these scenarios. Short-term solutions might be less effective, or worse, have negative effects in the longer term. Moreover, they can further limit the solution space as new solution possibilities become available in the long-term as a by-product of system changes.

1.3 Research objective

The aim of this research is to support peri-urban communities in the Ganges Delta by addressing institutional gaps in their problem solving capabilities. The study provides insight as to how this can be achieved in peri-urban communities from the Ganges Delta where water related issues are a big concern. In this context, community problem solving capacity is constrained by three main issues:

- Information gaps about institutions underlying peri-urban problems
- Solution strategies that fail to consider peri-urban dynamics
- Limited involvement of peri-urban communities in the policy-making processes

It is guided by the following overarching research question:

How can peri-urban communities be supported in addressing institutional aspects of water related problems during urbanisation?

This question will be addressed by answering the following sub-questions, as detailed below:

What is the role of institutions in community problem solving in peri-urban contexts? (RQ1)

Supporting local communities in this way, requires at first, a general understanding of how institutions shape decision-making outcomes. For this, the study explores the existing literature on institutions and institutional change in societal problem solving, contextualized within a peri-urban setting. Identifying potential limitations to problem solving is also relevant, particularly those faced by peri-urban communities. This will provide a basis for understanding the type of support needed by peri-urban communities.

What approach can be used to structure participatory institutional analysis of peri-urban problems? (RQ2)

The insights from literature will be used to design an approach to offer local communities, the necessary decision-support inputs. Specific design criteria will be drawn according to the aims of this research. Next, existing approaches for facilitating problem solving in participation with real-world problem owners (including communities) are explored, and will be used to tailor-make a step-by-step institutional approach to problem solving for peri-urban communities.

How did the APIA help Hogladanga community address their peri-urban problems? (RQ3)

The approach that will be ultimately presented in this study is called the Approach for Participatory Institutional Analysis or APIA. The next step is to assess whether the APIA is beneficial as a decision-support tool to real-world peri-urban communities facing their own unique problems. For this, the APIA is pilot tested in a peri-urban community within the Ganges delta through capacity building interventions. The village of Hogldanga, near Khulna (Bangladesh) serves as the case study in this study. Results are evaluated after each step of the APIA. This will generate insights about the extent that the Hogladanga community benefited from the institutional approach to problem diagnosis.

What is the potential of the APIA beyond Hogladanga when applied to different kinds of problems, in different contexts, and to support different problem owners? (RQ4)

Evaluating the APIA in Hogladanga is useful but as a single case-study has its limitations. It is likely that there may be other case-studies, different from Hogladanga, in terms of context, types of problems, and problem owners that could also benefit from the APIA and the problem structuring insights it is designed to offer. Therefore, this study evaluates its potential in three additional case-studies, all situated in peri-urban areas of Khulna and Kolkata. Although a full-scale intervention with the APIA in multiple case-studies was not achievable within the timelines of this project, these supplementary case-studies will nevertheless offer a means to evaluate participatory efforts and specific problem structuring activities implemented through the APIA.

A schematic of the different research questions as they relate to the thesis structure is provided later in section 1.5 which further elaborates the different chapters within this thesis (Fig. 1.3).

1.4 Integrating institutional research within the Shifting Grounds project

The work described in this thesis is undertaken as part of a larger Shifting Grounds project. An overview of this project is elaborated below, demonstrating how the institutional approach developed in this study contributes to the research and capacity building objectives of the larger project.

This study is conducted as part of an NWO funded Urbanizing Deltas of the World project titled 'Shifting Grounds: Institutional transformation, enhancing knowledge and capacity to manage groundwater security in peri-urban Ganges delta system'. The project works in peri-urban areas of Kolkata city (India) and Khulna city (Bangladesh), both situated within the Ganges Delta. The city of Kolkata is in the state of West Bengal, while Khulna is located in Khulna district.

Research and capacity building are two aspects in which the Shifting Grounds project makes a contribution. The research sheds light on key groundwater issues occurring within peri-urban communities within the Delta. For this, trans-disciplinary research on the institutional, socio-economic and hydrological systems is conducted by researchers at TU Delft[1] (the Netherlands), BUET[2] (Bangladesh) and Saci Waters[3] (India) respectively. In this way, research provides three complementary perspectives to peri-urban problems.

This thesis will focus on the institutional system of peri-urban areas. Participatory research targets the examination of formal and informal rules, actor networks, and organizations at the local peri-urban level while also considering the interaction with the state and national level institutional developments (Thissen et al., 2013). Moreover, institutional research is also integrated within the biophysical and socio-economic systems and their dynamics.

Alongside, local project partners in Kolkata and Khulna undertake capacity building of peri-urban communities. These activities follow the suggested structure of the Negotiated Approach (NA) (Both ENDS & Gomukh Envronmental Trust for Sustainable Development, 2011). The NA offers a way to organize negotiation activities by balancing traditional top-down decision-making with bottom-up initiatives and decisions from local communities (Thissen et al., 2013). The approach is community focused and is based on ten key principles (Both ENDS & Gomukh Envronmental Trust for Sustainable Development, 2011). It has been applied in South American and Asian countries with positive experiences in the area of river basin management (Galli, n.d.).

Fig. 1.1 gives an overview of research and capacity building activities within the Shifting Grounds project. It represents a theory of change based on the expected outputs of both research and capacity building efforts. Capacity building activities serve as a platform to integrate research with practice. Through the NA, local partners engage with local peri-urban communities on specific problems facing them. In this way, research focuses on the most pressing problems experienced at the local level. This encourages local communities to actively participate and share knowledge about the institutions, groundwater, and socio-economic conditions during the research. And furthermore, the NA process facilitates research uptake directly into problem solving efforts.

Capacity building is intended to support institutional transformation for sustainable, equitable and pro-poor groundwater management. Capacity building is needed to negotiate institutional arrangements that are better equipped for existing and future groundwater challenges. Through the project, peri-urban communities are also provided with a platform to interact with decision-makers on important local

[1] Delft University of Technology
[2] Bangladesh University of Engineering and Technology
[3] South Asia Consortium for Interdisciplinary Water Resources Studies

issues. Here, capacity building helps communicate local needs and engage with actors more effectively. Therefore, the project provides a basis for bottom up problem solving, initiated by peri-urban communities directly affected by the outcomes of existing institutions.

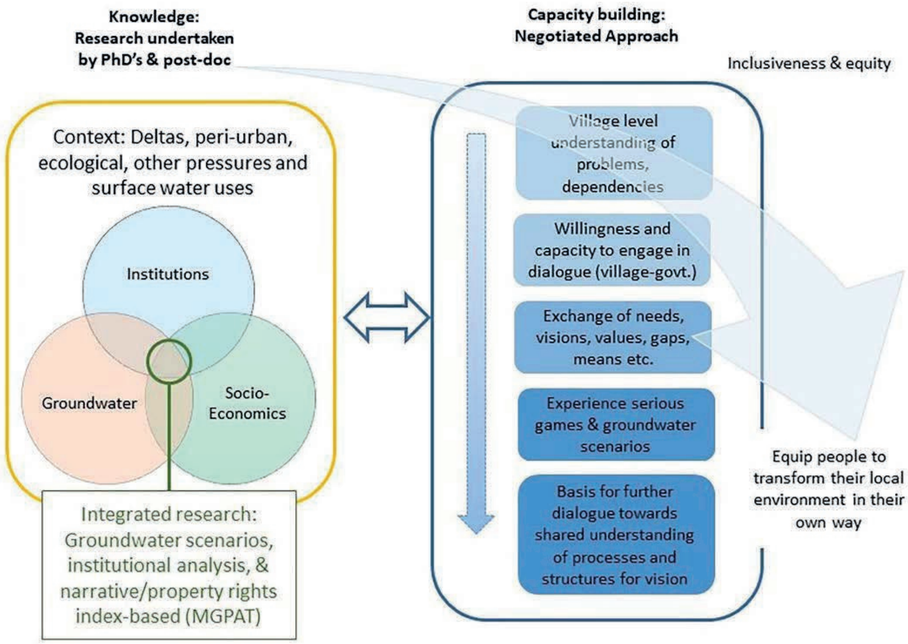


Figure 1.1 Overview of the Shifting Grounds project (adapted from Hermans, 2018; Thissen et al., 2013)

The Shifting Grounds project focuses on four villages from different peri-urban blocks (or *upazillas*[4]), at the sub-district level as shown below in Fig. 1.2. The block names are Sonarpur and Barrackpur II near Kolkata and Bhotiagata and Phultala near Khulna (Thissen et al., 2013). These blocks were initially selected during the preparatory phase of the project and later verified in terms of suitability during the first year after the project commenced (2014-2015). During this time, the blocks were evaluated against a set of seven criteria which included: peri-urban nature, importance of groundwater, tensions over groundwater, willingness of key players to engage in the project, ability of key players to engage, practical feasibility, and diversity between the sites (Banerjee, 2016). In Kolkata, this was done using K-mean cluster analysis, focus group discussions, and key informant interviews by local partner, *The Researcher*. Whereas in Khulna, the evaluation was based on observations, focus group discussions, and experience of the local project partner *Jagrata Juba Shangha (JJS)* (P. Banerjee, 2016).

[4] The administrative structure below the district level varies between the two countries. In Bangladesh, the local term for a sub-district is *upazilla.*

The same seven criteria were also used to select peri-urban villages. These villages would serve as case studies for research and capacity building activities. In Kolkata, key informant interviews with block level officers and *panchayat*[5] members led to a shortlisting of 6-7 villages within the blocks. In Khulna, similar key informant interviews with *union*[6] officers and focus group discussions with communities identified 8 potential villages. Thereafter, one village from each block was selected using a Rapid Rural Appraisal method (Banerjee, 2016). The four villages are Hogladanga and Matumdanga in peri-urban Khulna, Badai and Thiuria in peri-urban Kolkata. The administrative units for each village are shown below in Table 1. Research activities have been conducted in all four villages, however, capacity building activities have focused on just two villages.

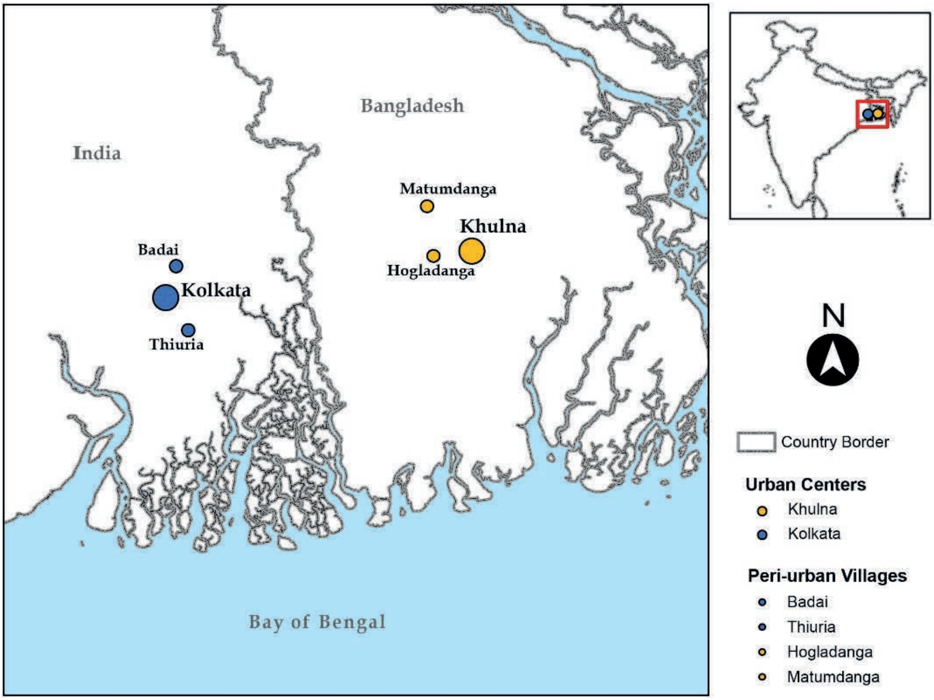


Figure 1.2 Geographic locations of peri-urban blocks in Kolkata (India) and Khulna (Bangladesh) from the Shifting Grounds project (adapted from Banerjee & Jatav, 2017)

[5] In India, they follow the *Gram Panchayat* system, with a number of villages falling under a single panchayat.

[6] In Bangladesh, the lowest administrative level is the union (subdivided into smaller *mouzas* that consist of a number of villages).

Country	District	Sub-district/ Block [7]	Union / Gram Panchayat	Village
India	North 24 parganas	Barrackpur II	Bilkanda I	Badai
	South 24 parganas	Sonarpur	Thiuria	Thiuria
Bangladesh	Khulna	Phultala	Atra-Gilatola	Matumdanga
	Khulna	Bhotiagata	Jalma	Hogladanga

Table 1.1 Shifting Grounds case study villages and their administrative units in peri-urban Khulna and Kolkata

In this thesis, an institutional approach to peri-urban problems is developed for and applied to Hogladanga village (Khulna). A participatory approach to institutional analysis is undertaken by integrating institutional research with the design of capacity building interventions facilitated by the local partner in Khulna, JJS.

1.5 Thesis Overview

This thesis is structured as presented below in Fig. 1.3. The research starts by exploring existing literature on institutions and institutional change in peri-urban contexts. Chapter 2 conceptualizes how actors intervene in problem situations through strategic and institutional responses. It then highlights specific institutional features of peri-urban areas pertinent to consider for this research. Thus, the aim of Chapter 2 is to formulate a theoretical hypothesis of how peri-urban communities can address institutional design problems in the Ganges Delta (RQ 1).

Chapter 3 deals with the design challenge of how to explore these institutional design problems with peri-urban communities. It uses existing participatory approaches to problem solving to develop a structured four-step approach that is appropriate for this context. This chapter relates to RQ 2 of the study (refer section 1.3).

The next four chapters (Chapters 4, 5, 6 and 7) describe how this approach was implemented in the peri-urban case study of Hogladanga village, Khulna. Each step of the approach is presented in a separate chapter. They each describe the methods, results, and inferences drawn from each step of this case study application. Together, chapters 4,5,6, and 7 answer RQ 3 (section 1.3).

Chapter 4 is about problem identification (Step 1). It describes the methods used to facilitate this with the local community. Thereafter, the chapter describes the most pressing peri-urban issue to be addressed by the peri-urban village. In this case, it is access to safe drinking water supply.

The mapping of the institutional system or step 2 is described in chapter 5. The institutional context of this drinking water problem was analyzed using the Institutional

[7] The administrative structure below the district level varies between the two countries as reflected in the nomenclature used in Table 1.1.

Analysis and Development (IAD) framework. Results describe how the institutional context has affected drinking water access in Hogladanga village over time.

In chapter 6, the focus is on the interactions and strategic behaviour of actors involved in the drinking water problem. It refers to step 3 of the approach. Strategic analysis of this problem using game theory modelling is first described in the methods. Thereafter, results from three game theory models are presented and discussed. They address the question of what strategies Hogladanga residents can adopt to address their drinking water problem under the existing and alternate institutional settings.

The fourth and final step (strategy exploration) is presented in chapter 7 which explains how gaming-simulation methods are used to facilitate strategy exploration with Hogladanga residents using role-play. Results of capacity building activities in this step are described to evaluate how strategy exploration improved the community's problem understanding of potential solutions and their feasibility.

Generalization beyond the Hogladanga case study is done in chapter 8. Here, three additional case-studies from the Shifting Grounds project, which have made use of different steps of this approach, are evaluated. They are used to answer RQ 4 in section 1.3. Strategy exploration (Step 4) with government stakeholders in Khulna offers insights about game-based strategy exploration with other types of problem owners. In Thiuria, implementation of steps 1 and 2 offers lessons on participatory problem solving with communities in different institutional contexts. Finally, the potential of the approach to a variety of peri-urban problems is explored via an institutional analysis (Step 2) of industrial development in Badai village.

Discussion and final conclusions follow in chapter 9. The discussion evaluates the case-study application in Hogladanga, and reflects on the results from peri-urban case studies elsewhere. The chapter provides a synthesis of the research's main contributions, limitations, and areas for further work. Final conclusions from this study are discussed in reference to the main research question.

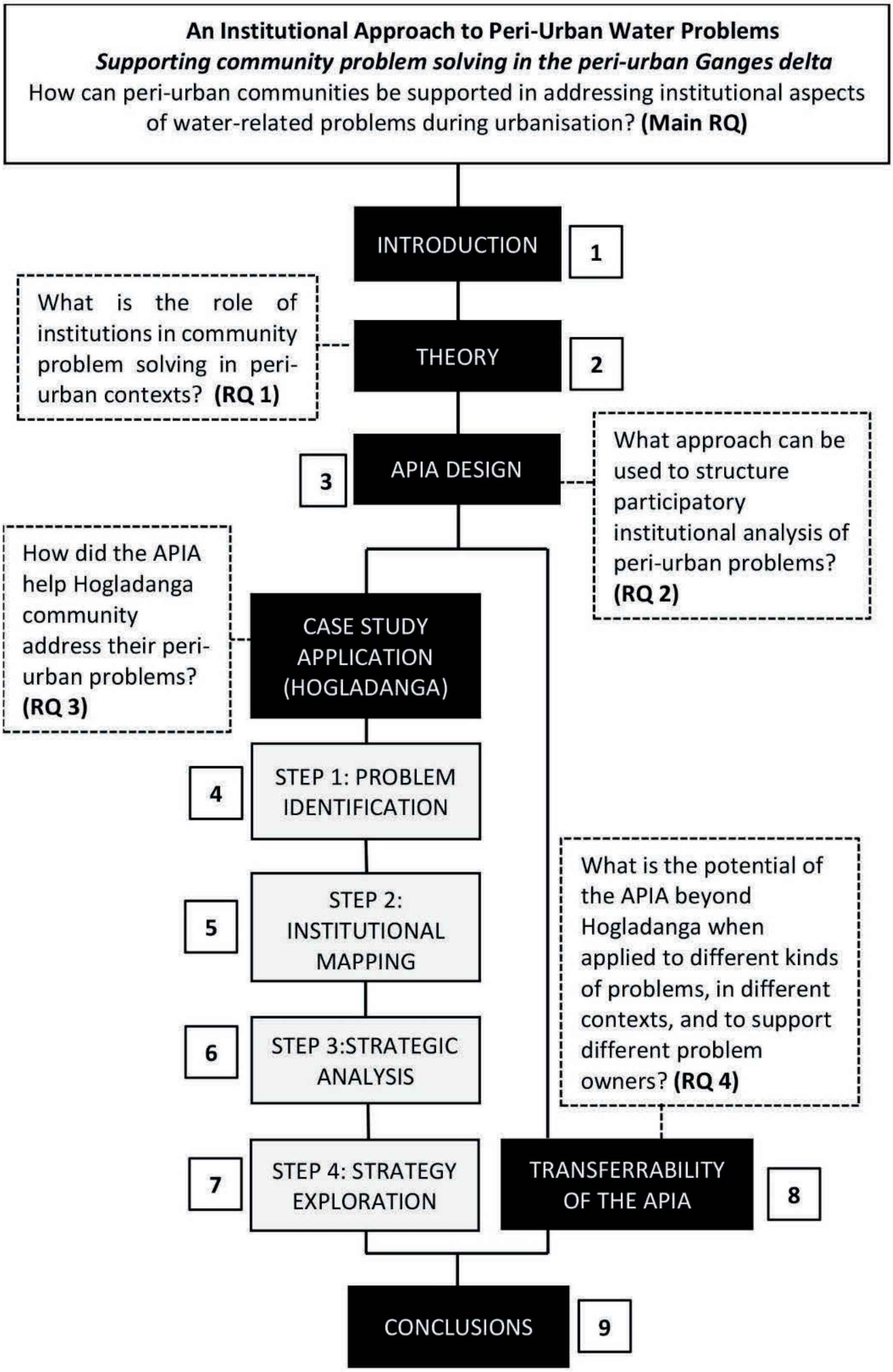


Figure 1.3 Visual outline of this thesis


Photo courtesy: Author (2019)

Chapter Two

Theoretical perspectives on peri-urban institutions

2.

THEORETICAL PERSPECTIVES ON PERI-URBAN INSTITUTIONS

This chapter builds on theory sections from previously published papers by Gomes & Hermans (2016a) and (Gomes & Hermans, 2018)*. Further literature on the topics discussed in this chapter is available in an earlier concept note by Gomes (2015b).*

Chapter 1 introduced a need to support problem solving in the peri-urban Ganges delta, given the emerging groundwater crisis and resulting challenges faced by marginalized peri-urban communities in this unique context. Examining problems through an institutional lens was highlighted as one way to help communities during the problem solving process. An institutional approach is expected to deliver much needed insights to communities who otherwise have a limited understanding of their problems' institutional context.

Designing an approach to facilitate problem examination through an institutional lens starts from the literature on institutions and institutional change. Therefore, Chapter 2 encompasses an inter-disciplinary discussion of institutional theory within the context of peri-urban groundwater management. The objective of this chapter is to understand the role of institutions in community problem solving within the peri-urban context. This provides a basis for tailoring the approach to the unique needs of peri-urban communities in the Ganges delta.

Chapter 2 is structured as follows. Section 2.1 defines institutions and their role in societal problem solving. Thereafter, the topic of institutional change is discussed in section 2.2. It addresses the drivers, mechanism, constraints, and typologies of institutional change (sub-sections 2.2.1 - 2.2.4 respectively). Constraints to institutional change can be found in section 2.3. Section 2.4 and 2.5 relate institutional theories to characteristics of peri-urban contexts and groundwater management respectively. This chapter concludes with a conceptualization of how peri-urban communities use institutional change to address their problems and potential problem solving gaps can may be addressed using this approach.

2.1 Institutions as societal 'rules'

Institutions are defined in the literature in several ways. This thesis adopts the definition by Douglass North. North (1990,1991) states that institutions provide the enabling and constraining *rules* that structure social, political, and economic interactions and behaviour in society. This concept of institutions as rules also features in work by Ostrom (2005) and Scharpf (1997). Others like March & Olsen (1989), offer a normative description suggesting a tendency for rule conformity based on action obligations of specific roles defined by institutional context rather individual motivation or a logic of consequence. This leaves out other regulative, and cognitive functions of institutions. Therefore a broader definition of rules is needed.

The definition of institutions as societal 'rules' suggest an important role in decision making. Literature explains that institutions provide structure to interpret and navigate social dilemmas. With this structure, institutions create stable expectations of behaviour (Greif, 2006; Hodgson, 2006). In this way, institutions play a key role in society. Ostrom, (2005) offers a typology to describe and examine institutions in action. The focus here is on the *action arena* in which individuals and groups interact to resolve societal problems referred to as *action situations*. These arenas serves as the focal point in conceptualizing the relationship between institutions and societal outcomes. To understand the dynamics within action arenas, the types of rules are important to consider.

2.1.1 Classification of rules

Societies have different kinds of institutions and there are several ways of classifying institutions. A simple classification as formal and informal rules is proposed by North (1991). North explains the differences between the two kinds of rules. Formal rules include consciously designed regulations such as constitutions, laws, property rights whereas informal rules spontaneously emerge and are socially transmitted sanctions, taboos, customs, traditions, and codes of conduct that together makes up a society's culture. Thus, actors can make use of both formal and informal rules for making decisions within these action arenas.

Further institutional classifications are also discussed in the literature by Ostrom, (2005) and Pahl-Wostl (2009) (which discusses classifications by Scott 2001 and Black 1962). The structural classification offered by Ostrom (2005) is useful for understanding how institutions influence the interactions within action arenas and their outcomes. Ostrom refers to position rules, boundary rules, choice rules, aggregation rules, information rules, payoff rules, and scope rules. Together, these rules define the participants within an action situation, their positions, actions, control, information, potential outcomes and their costs and benefits (Ostrom, 2005). In this way, institutions shape societal behaviour.

Given that all societal interactions are shaped by different kinds of rules, the next step is to understand how they are operationalized during the decision making process.

2.1.2 The role of institutions in decision-making

Institutions are operationalized or applied by societal actors. Here, *actors* refer to the participants in an action situation (Ostrom, 2005). They can be defined as social entities; an individual or organization with an ability to directly or indirectly influence the system in which it has an interest (Enserink et al., 2010). Sometimes, actors can also be organizations, referring to groups of individuals bound by a common goal who collectively act to achieve this objective (North, 1990).

Literature highlights that institutions play a key role in societal problem solving. They feature in day-to-day decision making, whenever actors navigate new situations or face a new problem. In such situations, institutions provide structure to interpret and navigate social dilemmas. With this structure, institutions create stable expectations of behaviour (Greif, 2006; Hodgson, 2006). Thus the role of institutions consists of the following: sense-making of problem situations, guidance on how to respond, and prediction of other actors involved in that situation.

This works well if the institutions are pertinent to the kinds of problems faced by actors. But what about when the existing rules are not applicable to the problem situation? How can actors address these problems? To understand this, the next section explores the topic of institutional change.

2.2 Institutional change

Institutional change is a prominent, yet sometimes contested topic of discussion in the literature. Several scholars like North (1990), Ostrom (2005), Williamson (1998) recognize that that institutions are not fixed but evolve. Theses theories shed light on the drivers and mechanisms of institutional change, as discussed below.

2.2.1 Drivers of institutional change

Institutions in society, evolve over time through the processes of learning in human beings (North, 1996). Building on this, Ostrom's (2005) theory explains that institutional change is a by-product of actors evaluating system feedback. Here, the 'system' refers to more than just the institutional context. Ostrom's (2005) IAD framework highlight the presence of other contextual variables such as biophysical conditions, social and economic attributes. These contextual variables together with the actor interactors form part of a larger system. Institutional change is driven by not only feedback from the outcomes of past decisions but also emergent system conditions, and sudden exogenous changes. She further adds, that feedback is evaluated against certain criteria which determines how well the outcome fulfils the actors' goals and values.

This characterization highlights that actors are key to effecting institutional change. However, it is important to understand how actors decide between a change in strategy within existing institutional settings versus a change in institutions, the mechanisms of institutional change, and types of changes that are possible. Other theories help elaborate these details. One of them, referred to as the *Credibility Thesis* conceptualizes institutional change by focusing on institutional function (Ho, 2013, 2014). Ho (2014) explains that a consensus regarding the underlying institutions promotes a shared perception of their credibility. In other words, there is some assurance that actors will behave according to jointly agreed upon rules. This behavioural guarantee (expectation) offered by institutions is a symbol of their purpose in society. This relates back to the structural and predictive properties of institutions described earlier (Greif, 2006; Hodgson, 2006; Ostrom, 2005). Using the credibility argument, institutional change is triggered by a perceived gap in function (Ho, 2014).

2.2.2 Mental models and the institutional change process

The learning process occurs with the help of mental models. Actors form perceptions of situations they wish to address. These perceptions are saved as mental models. A mental model is a cognitive representation which help actors structure and interpret their environment (North, 1996). Mental models evolve through feedback received from the physical environment, social context, and from interacting with other actors (North, 1996; Ostrom, 2005). Over time, these mental models are adapted via lessons learned and new insights gained about the system. The process of processing feedback and updating mental models is referred to as learning (Keen, Brown, & Dyball, 2005; McGinnis & Ostrom, 2012; Pahl-Wostl, 2009).

Mental models help actors determine how they should respond to situations over time. Positive feedback justifies continuing with the same strategy whereas, negative feedback prompts them to look for other, more appropriate strategies. In the latter situation, actors may select alternate strategies within the existing set of rules or invest in institutional change which will help them achieve their desired outcome (North, 1996; Ostrom, 2005). Therefore, institutions shape decision-making outcomes, and in the process of evaluating these outcomes, actors form opinions about the performance of the system, including the underlying institutions.

2.2.3 Institutional change and the nested structure

The mechanism and feasibility of institutional change strategies to problem solving can be understood from the way institutions are organized in society. Institutions typically exist in what Ostrom (2005) describes as a nested structure where rules at one level are determined by higher level rules. There are four main levels to this nested structure: operational, collective choice, constitutional and meta-constitutional levels, each having their own set of rules. For example, operational rules can be found at the level of individual actors as these rules structure day to day activities. The nested structure is also referenced in North's (1990) work on the hierarchy of formal rules and in Williamson's (2000) economics of institutions.

The nested structure plays an important role in the institutional change process. Rules at one level (e.g. operational rules) are based on the set of rules at a higher level (e.g. collective choice rules) and institutional change requires actors at one level to refer to a higher order rule changing arena (Ostrom 2005). The feasibility of institutional change is, moreover, dependent on the level at which they exist. Institutions become increasingly more embedded in society as we move higher up this nested structure (Ostrom, 2005; Williamson, 2000). As a result the cost of institutional change also increases. It is reflected in the timescales along which institutions at different levels typically change (Williamson, 2000).

Effecting institutional change in this way therefore requires resources. These resources need to be mobilized in the appropriate rule-changing arenas to influence outcomes. This is not only used if actors are attempting to bring about changes in the rules, but may also be required if actors wish to try a different strategy permitted by the existing institutional context. If actors are successful, the literature also describes different typologies of institutional change. Given the existence of both formal and informal rules, institutional change can be achieved in either formal or informal arenas. The feasibility of formal versus informal changes also relates to the nested structure. Ostrom (2005) explains that actors unable to activate higher-level institutions to change rules, may look for solutions in parallel institutional arenas or create informal rules as a way to circumvent costly formal channels. Therefore, actors need to consider both formal and informal opportunities for institutional change during problem solving.

The feasibility of institutional change also reflects in other institutional change typologies. For example, the credibility thesis is based on the theory that institutions which lack function will be ignored, changed or fade over time (Ho, 2014). The differences between these options will likely depend on several factors, one of which is the cost of rule change. Similarly, others highlight the emergence of empty institutions over time if actors simply ignore them (Ho, 2013; Klijn & Koppenjan, 2006; North, 1990); implicit reinterpretation of rules (Klijn and Koppenjan, 2006); and institutional bricolage that is a combination of exploratory and exploitative approaches to institutional change (Cleaver, 2002; Lanzara, 1998). When exploring institutional change in the real-world it may be useful to use one or more of these typologies to explain how actors are using their institutional context during problem solving.

The above discussion clearly describes how institutions and institutional change is meant to support problem solving in society. The existence of the institutional context for this purpose then begs the question of why societies are sometimes unable to resolve problems. In the following section, this is explored in further detail. Literature reveals that decision making is far more complex and is affected by several constraints. These constraints together shape the reality of problem solving.

2.3 Limitations of institutions in societal problem solving

The challenges of societal problem solving arise due to constraints at the institutional levels, actor decision-making level, and at the level of actor interactions.

2.3.1 Institutional constraints to problem solving

There are several reasons why institutions fail to help in problem solving. Ostrom (2005) highlights that rules can be misinterpreted due to a lack of clarity. The effectiveness of institutions also depends on if and how well they are enforced and monitored. Enforced rules prevent opportunistic behaviour and free riding, which can be a problem in multi-actor situations where trust is limited (Mantzavinos, North, & Shariq, 2004). Failure to abide by existing institutions increases when the risk of rule breaking is small due to lack of monitoring (Ostrom, 2005; Scharpf, 1997). Thus, in situations where external enforcing mechanisms are key, institutions that lack these run the risk of being ineffective.

Institutions are also more effective if they are context-appropriate. In other words, the environmental and cultural context must be considered as limited understanding of how rules or rule combinations impact a particular context can result in unintended or even disastrous outcomes (Ostrom, 2005). This suggests that efficient institutions from one context does not guarantee similar results unless adapted for the local conditions and given the same enforcing capabilities.

Furthermore, and related to the above point, institutions need to work in relation to other existing institutions. Often, situations involve multiple or overlapping rules, which requires actors to decide on which rules apply. This is also referred to as legal pluralism (Greif, 2006). In the governance literature, this is similarly discussed through the notion of polycentricism. Polycentricism involves multiple decision making centres at different levels with overlapping roles, to suit the realities of biophysical boundaries (Aligica & Tarko, 2012; Huitema et al., 2009; Pahl-Wostl, 2009). The relationship between institutions in this network determines if they complement, reinforce, or conflict one another (Greif, 2006). March & Olsen (1989) explain that actors select which rules to apply in a plural institutional context through legal reasoning; by ranking the rules based on various criteria. For example, familiarity with certain rules that are recently used or developed increases their likelihood of being evoked.

2.3.2 Problem solving constraints at actor's decision-making level

Apart from institutional constraints, actors own limitations also influence the problem solving process. Here, arguments against the rational choice model of behaviour are relevant and receive support. There are at least two reasons why human behaviour is not always rational. For one, behaviour is based on mental models generated through system feedback. However, information is costly and thus limited as is the actor's cognitive ability to process information, particularly if the situation is complex (Simon, 1972). This can result in incomplete, subjective or mis-represented mental models (North, 1996; Ostrom, 2005).

Decision making is also limited by the rationality of actors. The term 'bounded rationality' is a more useful characterization of actor behaviour (Simon, 1972). Early neo-classical theories like the rational choice theory describe a *homo economicus*, whose behaviour is driven solely by economic benefits. However, North (1990) explains that in reality behaviour is also shaped by values such as trust, altruism, self-interest and fairness among others. Although, Weber's notion of value-rational social action highlights the role that values, morals, and ethics have in decision-making (Kalberg, 1980), it too, assumes that actors can rationally make trade-offs between values. Furthermore, values can evolve over time to create unstable decision patterns. As a result, decision-making is not always optimal, given the trade-offs that need to be made between utility and value judgements on top of actor's information gaps and cognitive limitations (North, 1990; Ostrom, 2005).

It is assumed that actors adopt a 'satisficing' approach in reality- selecting one of the available solutions, instead of searching for the "best" or most "optimal" solution to their problem (Simon, 1972). In other words, they opt for a haphazard weighing of readily available options instead of performing a complete analysis of options with its pros and cons. This notion of satisficing can be found elsewhere, albeit in somewhat different terms.

Bounded rationality impacts the solutions considered during problem solving. For example, actors' cognitive limitations can deter institutional change. Imperfect mental models of the system limits the solution space, preventing actors from considering certain strategies or even, institutional change possibilities. Alternatively, if such options are considered, actors might fail to consider the transaction costs in producing their desired outcome or the arenas in which resources are to be mobilized. This too, can have unintended consequences during problem solving.

2.3.3 Constraints of multi-actor interactions

Problem solving constraints also stem from the action arena in which decision are made. These arenas typically comprise multiple actors with varying objectives. This first of all, makes it more challenging to predict how other actors will behave despite the existence of rules and mental models. Secondly, it becomes difficult to reach a consensus, take collective action, or cooperate.

As a result, problem solving in a multi-actor context often requires a convergence of different objectives, a level of trust among participants, and the desire to pursue strategies towards a common interest (Ostrom, 2005). Williamson (1993) refers to trust as a risk borne by participants in assuming similar behaviour of others, which can be strengthened through repeated interactions. Lack of trust triggers opportunistic behaviour as described in transaction cost economics (Williamson, 1998a, 1998b) or as previously stated, increases the likelihood of rule-breaking.

The feasibility of institutional change, given the nested structure was also previously highlighted. Therefore, the ability to solve problems through institutional change requires resources to be mobilized in the appropriate arenas. However, resources are unevenly distributed in society (Ostrom, 2005). Meizen-Dick & Bruns (2000) explains that differences in economic, social, political status creates power imbalances. Therefore, all actors do not have equal opportunity to intervene in social dilemmas through institutions.

As a result, institutional change emerges through negotiations and interactions in various (institutional) arenas (Klijn & Koppenjan, 2006). During these negotiations, resources and power dynamics can either support or constrain institutional change. In fact, institutions are not socially efficient meaning that outcomes typically favour those with the most bargaining power (North, 1990, 1996). Therefore, it is important to understand whether the perception of credible institutions is shared by all actors. Institutional function and thus credibility is subjective (Ho, 2014). While some actors might seek institutional change, others that derive function from existing rules, can use their resources to maintain the status quo and protect their vested interests. It also highlights that actor interactions and negotiations are continuously occurring, which makes the process of institutional change a dynamic disequilibrium in which a steady state is never reached but the rate of change can vary (Ho, 2016).

These insights reveal that more than just the institutional settings play a role in problem solving. This includes the wider socio-cultural settings also. Hammond and Butler (2003) stress the importance of considering this for a robust understanding of social problems (cited in Ostrom, 2005). In other words, even an institutional approach to problems calls for a broader scoping of the system. It entails exploring other contextual features (e.g. social, economic, biophysical conditions) that impact problem solving.

2.4 Characteristics of the peri-urban context affecting problem solving

This section explores important contextual features that are relevant for the peri-urban Ganges delta. The focus is on characteristics of peri-urban areas and groundwater resources that affect the effectiveness of institutions in problem solving and the feasibility of institutional change. By connecting earlier mentioned institutional theories, this section highlights those aspects of the institutional system most relevant for the aims and objectives of this research.

Urban transitions are most visible at the peri-urban interface. Several definitions exist regarding the term peri-urban. Some define it as a process of change in land use, resource exchange, and social heterogeneity (Allen, 2003; Narain, 2010). Narain (2010) explains peri-urban as the transition zone in close proximity to the expanding city with a two way flow of goods, services and population. This definition overcomes the geographical constraints of defining it in spatial terms as the urban fringe (Bowyer-Bower, 2006; Mattingly, 1999). It also gives peri-urban areas a dynamic characteristic which is important to the context of institutional change. Conceptual definitions as the blend of rural and urban activities, in contrast, offers a static account of peri-urban features (Allen, 2003; Narain & Nischal, 2007).

The process and conceptual definitions are both considered in this thesis, given that each of them offers something useful in describing peri-urban areas. Allen (2003) and Narain (2010) suggest that peri-urban areas have a dynamic and have a unique symbiotic relationship with the nearby city. Meanwhile, the conceptual definition highlights the heterogeneous, multi-actor nature of peri-urban areas given the mix of rural and urban activities. Both of these characteristics influence the institutional context.

2.4.1 Institutions in dynamic peri-urban areas

Institutional arrangements are often developed along a urban-rural dichotomy. This is the case in South Asia. Governance in both India and Bangladesh is along rural and urban administrative boundaries. Given that peri-urban areas are dynamic, it is difficult to define them geographically. This creates institutional problems for peri-urban areas. For example, during the rural to urban transition, there may be situations where both urban and rural institutions coexist, making it unclear which rules to apply or what the roles and responsibilities are during problem solving. Legal pluralism can also increase the cost of institutional change if institutions share similar elements that are self-enforcing (Greif, 2006).

This type of institutional design can also lead to a mismatch between the rules and the kinds of problems faced by peri-urban actors. Within the Ganges delta, many peri-urban areas are formally considered part of the rural administration, and are therefore governed by rural institutions. These rural institutions may not be appropriate for changing peri-urban needs. Theory explains that formal institutions in peri-urban contexts run the risk of becoming ineffective over time due to size constraints and their traditional orientation toward either urban or rural administration (Allen, 2003). It relates to the importance of context-specific rules.

Traditional planning approaches thus have limited uses in the peri-urban context. The institutional setup described above calls into question the sustainability of urban development. Peri-urban planning and management is often piecemeal involving multiple, often overlapping administrative, community, and private sector actors. This affects decision making. Peri-urban areas bear features commonly found in polycentric governance. Ostrom (2010) highlights that polycentric systems with multiple, autonomous decision centres at different scales has benefits in terms of rule-making, learning (with the help of local knowledge), innovation, cooperation etc. Yet, early studies on polycentricism in metropolitan regions also discovered that without an overarching coordinating body, decisions tend to be focused on self-interest (Aligica & Tarko, 2012). It thus, remains to be seen how peri-urban institutional arrangements have affected governance and problem solving in the Ganges delta.

2.4.2 Social heterogeneity and its effect on problem solving

Peri urban areas have a changing and mixed social composition that typically includes among others, farmers, industrial entrepreneurs, informal settlers, and the urban middle class (Allen, 2003). These actors differ in their lifestyle, economic and educational backgrounds contributing to varying objectives and responses to local problems. Problem solving is affected by this.

First, Ostrom (2005) explains that in situations with changing or heterogeneous participants and irregular interactions, the chances of trust building and thus cooperative outcomes is further reduced. In situations where cooperation and collective action is needed, failure to achieve trust, limits the solution space. Peri-urban areas can similarly be limited in their solution space if peri-urban actors are unable to pursue cooperative strategies to address local problems.

Second, the different social backgrounds of peri-urban actors highlight also their different abilities to influence outcomes via institutional change. As mentioned earlier, resources and power differences define which actors have the ability to change the rules underlying a given problem (Ho, 2014; Klijn & Koppenjan, 2006; North, 1990). Therefore, it is possible that formal institutional change may only be an option for some, leaving others to utilize other kinds of solution strategies. Informal institutional change is also cited by Ostrom (2005) as a way of circumventing the high costs of formal interventions. In peri-urban areas, it is important to consider the role that informal institutions play during problem solving.

Third, due to social heterogeneity, peri-urban actors differ in their lifestyle, economic and educational background which then contributes to different objectives. This has implications for how actors respond to problems. These multi-actor interests further add to the challenging environment in terms of cooperation. It can lead to inequitable outcomes, particularly if some peri-urban actors are left out of the decision making process.

This points to a need for social considerations during the decision-making processes, a key component often left out of the policy-making cycle in the global south. Narain (2009) highlights how historically top-down policies have failed to adequately address peri-urban issues in India with key stakeholders being mere recipients but having no role in the actual policy process. Several researchers highlight the need for peri-urban planning and management to evolve into a strategic, participatory and flexible process with due importance given to non-technical forms of knowledge (Allen, 2003; Mattingly, 1999; Narain, 2009). This aspect of knowledge also ties back to information access, which enables informed decision making and the creation of robust mental models.

2.5 Institutional challenges of groundwater management

Over 2 billion people globally depend on groundwater as a source of freshwater (Kemper, 2004). In the Ganges delta, groundwater is the primary source of freshwater in peri-urban communities. It plays an important role in the agricultural economies of both India and Bangladesh. Nearly 60% of irrigated areas in India are cultivated using groundwater (Shah, Roy, Qureshi, & Wang, 2003). As a result, groundwater makes an important contribution to rural livelihoods and economic growth.

In the global south, groundwater abstraction began in the 1970's and has increased significantly due to its high economic benefits per unit volume, 'on-demand' availability, drought resistance, low infrastructure, treatment and transport costs (Burke & Moench 2000 cited in Foster & Chilton, 2003; Kemper, 2004; Shah et al., 2003; Taylor et al., 2013). Uncontrolled abstraction of groundwater causes scarcity and degrades resource quality through the mobilization of contaminants. Overexploitation relates to Hardin's (1968) 'Tragedy of the Commons' theory, signalling a potential for widespread degradation of common property resources.

Part of the problem relates to the resource's unique characteristics. Managing a common pool resource like groundwater is affected by excludability and subtractability issues (Feeny, Berkes, McCay, & Acheson, 1990). Ostrom, Gardner, & Walker (2006) define subtractability as resource abstraction by one user reduces the units available to another user and excludability as the cost of limiting resource use. Sustainable groundwater management requires regulating groundwater use within permissible resource limits. However, in the Ganges delta this has been difficult to achieve.

Groundwater plays a very important role in the agricultural economy of South Asia and its food security. It has contributed to rural and economic growth while also improving local livelihoods. However, the emerging scarcity disproportionately affects low-income households that are unable to invest in deeper wells or find alternate sources (Kemper, 2004). On the other hand, a successful groundwater economy has spontaneously emerged in South Asia due to the market setup of groundwater distribution among private tube well owners due to agricultural demand and low investment costs (Shah et al., 2003).

The challenges concerning groundwater governance relate to politics. Groundwater problems often stem from the lack of public investments in groundwater management compared to other kinds of water resources. Foster & Chilton (2003) highlight that long-term deterioration ultimately impedes development; yet governments choose to invest little in managing this resource. This could be a due to the invisible nature of groundwater compared to surface water projects that help generate public support and thus, feature higher on political agendas. Shah et al. (2003) offer evidence of such supply driven reactions to groundwater scarcity in Asian case studies.

Groundwater management issues are also related to the institutions, their enforcement and monitoring. Research from South Asia shows that even where demand side interventions through pricing or regulations have been attempted, they fail to bear positive results if implementation capacity is weak (Shah et al., 2003). Determining permissible abstraction limits also requires an understanding of the biophysical conditions. However, information uncertainty makes it difficult to define rules for regulating groundwater use. Foster & Chilton (2003) explain that groundwater governance globally suffers from insufficient data about quality, quantity, geomorphological and other hydrological data or unreliable data due to inadequate sampling and analytical protocols. Evidence of over-exploitation and deteriorating groundwater quality in the Ganges delta raises concerns of similar institutional gaps (Thissen et al., 2013).

This shows that within peri-urban areas, institutions for groundwater management are problematic. Many groundwater dependent regions in the global south show evidence that the existing institutions have failed to achieve sustainable and equitable resource use. Groundwater scarcity disproportionately affects low-income households unable to invest in deeper wells or find alternate sources (Kemper, 2004). Thus, ineffective institutions for groundwater management ultimately translate into issues of inequity and unsustainability.

2.6 Conceptualizing problem solving and institutional change by peri-urban communities

Chapter 2 set out describe the role of institutions in community problem solving in peri-urban contexts. In general, institutions serve as guidelines during problem solving. Theories explain that when favourable solutions cannot be obtained from the existing rules, actors may invest in institutional change to obtain a more favourable outcome. This mechanism for problem solving similarly exists in peri-urban areas to address a variety of problems including for example, groundwater related problems. However, literature highlights several reasons why problem solving by peri-urban communities can prove difficult.

The challenges of problem solving in the peri-urban parts of the Ganges delta can be explained by the unique features of this context. Two in particular are found to play an important role. First, the dynamic nature of peri-urban areas limits the effectiveness of underlying institutions as problem solving guidelines. This is because institutions arranged along rural-urban boundaries, leave peri-urban areas with an unclear, fragmented, and even overlapping set of rules. It can therefore be confusing for peri-urban communities to know which rules apply and who is responsible for addressing local concerns. Moreover, rural institutions are likely to become ineffective over time, as new problems emerge or resource needs evolve in peri-urban areas as urbanization continues.

Emerging institutional voids create a need for either formal or informal institutional change, as a way of dealing with peri-urban problems. However, incomplete mental models of complex peri-urban problems can either prevent such strategies from being considered, or worse, have unintended consequences. This includes knowledge of underlying formal and informal rules, and the nested structure in which they exist. This is needed for peri-urban communities to attempt institutional change as a solution to their problem.

Managing groundwater resources can be particularly challenging in peri-urban contexts. Regulating groundwater use in a dynamic, multi-actor context such as this requires on-going monitoring of aquifer conditions, strong enforcement of rules, and political motivation to regulate groundwater demand. Yet, both appear to be limited in the Ganges delta. Sustainable groundwater management in a fragmented institutional context can prove difficult if actors have different interests. This is the second reason affecting problem solving.

The social composition of peri-urban areas means that problem solving arenas consists of actors with varying objectives. Moreover, as peri-urban areas are dynamic, the composition of the arenas also evolves over time. This decreases the likelihood of trust, cooperation and makes it difficult to predict behaviour. Peri-urban communities need to understand these changing multi-actor conditions, in order to be able to negotiate solutions or explore cooperative outcomes.

Furthermore, resources are unequally distributed among peri-urban actors, given their varied socio-economic backgrounds. For some, lack of resources reduces the feasibility of institutional change as a potential problem solving strategy. As a result, peri-urban areas can face issues of inequity and marginalization. Overcoming these problem solving barriers, requires knowledge of alternate options, such as for example, informal institutional mechanisms.

A synthesis between the various perspectives described in this chapter leads to a conceptualisation of three interrelated mechanisms of institutional change adopted by peri-urban communities during problem solving efforts:

i. Institutional function and credibility: Actors respond to system changes via institutional change to get a certain function that is currently not provided by the existing institutional context. This can be a new function, as the changing system produces new needs and requirements, or it can be an existing function for which the 'old' institutions are no longer suitable.
ii. Satisficing: The process of responding to system changes occurs through a satisficing process, whereby actors engage in a limited scanning and trial of alternative courses of actions, until they reach a new situation that produces outcomes that are sufficiently satisfactory. This satisficing process is the result of cognitive and resource limitations of actors.

iii. Nested structure: Actor's satisficing process is influenced by the nested structure in which institutions exist. This nested structure influences the resources required and available to actors for satisfactory institutional change.

Supporting peri-urban communities in the context of this research, using an institutional approach, is expected to address these problem solving gaps. To achieve this, the approach needs to offer insight into both formal and informal institutions underlying local problems. Institutions may be examined in terms of how actors apply them during decision-making. Therefore, the focus of problem structuring efforts should be around the action arenas. This will offer insight into their composition, decision-making, and distribution of resources. Framing problems through an institutional lens should not only take into consideration the community's existing problem situations but also, how they evolve over time.

There is also a need to expand the solution space for peri-urban communities through this approach. This requires insight into both formal and informal strategies for addressing local problems. Exploring institutional change will help broaden the solutions considered by peri-urban actors. However, communities need to be aware of potential resource constraints. This could lead to thinking beyond these limiting factors for alternatives solutions that best achieve their needs.

This synthesis of theories in chapter 2 helps define the research and capacity building focus in the proposed institutional approach to problem structuring. In chapter 3, a design is outlined to facilitate this in the real-world.

Chapter Three

Designing an Approach for Participatory Institutional Analysis

Photo courtesy: Jagrata Juba Shangha (2016)

3.

DESIGNING AN APPROACH FOR PARTICIPATORY INSTITUTIONAL ANALYSIS

This chapter is based on the sections 1,2.1 and 3 from the journal paper by Gomes, Hermans, & Thissen (2018). The article outlines a participatory approach designed to help communities analyse institutional design problems.

Chapter 2 described the role that the institutional context has in societal problem solving. Societal problem solving is guided by underlying rules and through institutional change, alternate solutions can become available to actors affected by peri-urban problems. It highlighted the essential inputs that could support problem solving or help facilitate institutional change by peri-urban communities. The next step in the research is to apply these theories to intervene in on-going problem solving efforts with real-world problems. This chapter seeks to identify a suitable approach to structure participatory institutional analysis of peri-urban problems. Ultimately, the goal is to design an approach that facilitates institutional analysis of existing problems in participation with local peri-urban communities.

Chapter 3 is divided into four main sections. Section 3.1 outlines design objectives which must be satisfied while designing the approach. Next, existing techniques are discussed in section 3.2 such as community-based operational research and participatory research for design and application inputs. Using these inputs, section 3.3 presents a participatory approach to facilitate an institutional analysis of peri-urban dilemmas with local communities. It is referred to as the 'Approach for Participatory Institutional Analysis' (APIA). It consists of four main steps: problem identification, institutional system mapping, strategic analysis, and strategy exploration. The objectives, methods for implementation, and the expected outputs are described for each step. Finally, section 3.4 describes a framework to evaluate the APIA from its applications in real-world case studies.

3.1 Design objectives for the approach

The goal for this chapter is to outline a suitable approach that can facilitate the institutional analysis of problems with peri-urban communities. The starting point for developing such an approach is the identification of specific criteria that need to be satisfied. These design requirements define the scope and offer direction in the selection of methods. The criteria broadly relate to the context, analytical needs, and process related needs.

Contextually, this approach is designed for local communities. In chapter 1, it was demonstrated that peri-urban communities in the Ganges delta are often marginalized as a result of institutional arrangements. This signals that the existing institutions are likely not considered 'credible' by local communities. According to the literature, the effectiveness of institutions in societal problem solving is shaped by actors who use them, and in this way, either self-enforce the rules and shape their credibility or result in institutional change (Greif, 2006; Ho, 2013, 2014; Ostrom, 2005). In the same way, the approach should help actors evaluate the effectiveness of their existing rules as a first step towards considering solutions to fix problems.

A community centred approach requires communities to be actively engaged in the steps of this approach. Meaningfully supporting communities in their problem solving efforts requires taking up their most pressing problems. The types of problems faced by communities can vary depending on the context, stage of urbanization, and local priorities. It requires a generic approach to suit a variety of problems. For example, in the Ganges delta, not all peri-urban areas may experience groundwater insecurity in the same way, or as severely. Therefore, the analysis and insights generated using this approach should be tailored to the specific gaps in knowledge and skills of the community.

The approach must suit specific problem features associated with a unique peri-urban context. The first relates to problems with a seemingly unclear or ineffective institutional context. The second relates to problems of a multi-actor nature. Third, the dynamic nature of the peri-urban context means that local problems should not be examined as static situations, but as those that are continuously evolving in space and time.

These contextual features define the analytical needs of this approach. Analysis of underlying formal and informal rules can be done by examining the arenas in which actors apply and change institutions. This also offers insight into how different actors implement the rules, and negotiate solutions in these settings. A suitable level for the analysis is the operational level, which is where peri-urban communities experience problems and their outcomes first hand. However, theories also highlight the importance of higher level rules in interpreting operational level outcomes as well as in effecting institutional change (Ostrom, 2005). This too must be considered in the analysis. Further, chapter 2 highlights that besides institutions, peri-urban problems are also shaped by broader social, economic, and biophysical system changes. Thus, a systems perspective is also beneficial during problem diagnosis. The spatial-temporal characteristics of peri-urban areas are also important. Therefore, considering how for example, past and future problem situations and the evolving geographic boundaries of peri-urban areas falls within the scope of this approach.

Regarding the process, the approach needs to align with project timelines. In the timeframe of the Shifting Grounds project (four years), it is unrealistic to expect solutions to be reached or institutional change as outputs of this approach. Literature highlights the extended timescales over which institutional change occurs, that typically extend beyond most research projects (Williamson, 2000). Therefore, improved problem understanding is a more realistic target for using the approach in this context, although, in the long-run it is possible that these insights lay the groundwork for community-led institutional interventions.

Project resources also impact process related choices. The goal is for problem examination to be a shared effort between researcher and community. However, funding, language barriers, time, analytical skills of the community and data limitations can impact this process. Therefore, the approach should be able to accommodate necessary adjustments in the implementation. For example, in Shifting Grounds, local partners can lead participatory activities on the ground, serving as a platform for two-way knowledge exchange between researcher and community. This also influences the choice of methods to facilitate knowledge exchange through a local partner.

3.2 Scanning existing approaches for participatory problem diagnosis

The criteria described in section 3.1 are used to design the approach for this study. It begins by exploring participatory research techniques commonly used with communities in the global south to tackle societal problems. This serves as the starting point in the design process. In particular, this section draws from the growing sub-discipline of Community Operational Research (COR) and those associated with the broad umbrella of participatory research.

3.2.1 Community operational research

Community operational research (COR), also referred to as community-based operations research, emerged as a sub discipline of operations research to address localized social policy issues, such as the provision of public goods and services (Johnson, 2012). COR applications are often driven by inequity and injustice, particularly in the allocation of public goods and services (Johnson, 2012). It has been applied in fields such as healthcare (e.g. Boyd et al., 2007; Sheppard et al., 2010), housing development (e.g. Johnson, 2005; Keisler, Turcotte, Drew, & Johnson, 2014), and resource management (e.g. Foote et al., 2007; Mills, 2009). The type of issues COR addresses are often characterized as messy (Ackoff, 1979), given their ill-defined, multi-actor nature, and complex cause-effect relations (Mingers, 2009; Rosenhead & Mingers, 2001a); or wicked when explanations for the observed phenomena vary significantly (Rittel & Webber, 1973). Scholars acknowledge inclusion problems in developing countries to be an important area for further COR research (Johnson, Midgley, & Chichirau, 2017, 2018; Midgley & Ochoa-Arias, 2004). The COR approach offers potential to help address peri-urban problems of a similar messy and wicked nature.

The value of COR lies in its approach. First, most COR interventions are aimed at supporting systemic change in disadvantaged communities, given the inequity and social fragmentation they face (Johnson, 2012). The type of support provided depends on the context, yet the common thread in all COR applications is active stakeholder participation (Johnson et al., 2018; Johnson & Smilowitz, 2012; Mingers, 2009). Participation is believed to be critical to the success of COR, with strong emphasis placed on accountability to the communities in which it is applied (Johnson & Smilowitz, 2012). Further, COR stresses that problems should be addressed within the social context in which they exist, as opposed to isolated from it (Johnson, 2012). In this way, COR is well-suited for assisting marginalized or disadvantaged peri-urban communities.

Second, the systems perspective often adopted in COR is needed to handle the complexity of social problems (Jackson, 1988). In many applications, COR offers communities support in structuring and navigating this complexity in a meaningful way. Here, system boundaries may be tailored to suit the context and stage of the intervention process (Midgley, 2000). A typical COR approach can be broken down into three stages: problem formulation, problem solving, and evaluation (Johnson, 2012; Midgley, 2000; Mingers, 2009). The development of systemic interventions in this way, as Midgley (2000) highlights, involves design choices that broadly include: boundary critique to define the analytic scope; the selection of models and theories that suit the analysis and the context; and implementation of these selected methods. Given their relations, these design elements are developed in parallel, specific to the stage of the COR process, type of intervention sought, and skills of the community (Foote et al., 2007; Midgley, 2000). Given the strong emphasis on accountability (Johnson & Smilowitz, 2012), active participation needs to be considered throughout the design process. This structured approach can similarly be applied to examine problematic institutional arrangements in peri-urban systems.

Lastly, COR offers a variety of OR methods and techniques for practitioners to choose from. In addition to hard OR tools, soft OR was developed to analyse critical social aspects ill-suited for mathematical modelling and 'hard' OR analyses (Johnson, 2012; Mingers, 2009). Soft OR also goes under the heading of 'problem structuring methods' (Ackermann, 2012; Mingers & Rosenhead, 2004; Rosenhead & Mingers, 2001b), and includes methods geared towards a better understanding of social decision processes (Cunningham, Hermans, & Slinger, 2014). In fact, the type of decision support required for community empowerment differs from traditional OR. Here, improved problem understanding is often a more valuable first step than prescribing solutions, and appropriate qualitative or mixed-method designs, as opposed to traditional quantitative methods, are usually needed (Jackson, 1988; Johnson, 2012). Moreover, another common task for the OR practitioner is facilitating a transfer of skills to the community (Boyd et al., 2007; Parry & Mingers, 2004). This also bears some influence on the methods and tools selected for the intervention. In this way, methods from the soft OR toolkit may be utilized in the design of this research, to suit the needs of the community and the context in which they are applied.

3.2.2 Participatory research

All participatory research attempts to re-define engagement between outsider (researcher) and locals (problem owners) recognizing the latter as agents of change who have valuable knowledge and capacity to address problems affecting them (Chambers, 1994; Cornwall & Jewkes, 1995). Participatory research is a broad field that includes action research and rural appraisal (PRA) techniques among others.

Within action research, there are a number of variations described in the literature like for example, participatory research, Participatory Action Research (PRA) and critical participatory action research (Kemmis, McTaggart, & Nixon, 2014). Meanwhile, Participatory Rural Appraisal (PRA) emerged from rapid rural appraisal as a way for local actors to utilize visual, tangible methods of enquiry and analysis of local realities for taking action (Bradbury, 2015). In this way, each of these techniques differs in their purpose.

Yet the common thread running through these participatory techniques is the recognition that stakeholders have capacity to participate in research that is ultimately used to benefit them. In doing this, they promote ownership in the research process and contributing to their empowerment (Kemmis et al., 2014). Moreover, there are benefits in terms of exploring local knowledge and perceptions by enabling active contribution from real-world stakeholders (Cornwall & Jewkes, 1995). Literature highlights a wide variety of methods in participatory research techniques which includes interviews, mapping, modelling, timelines, trend analysis, story-telling, causal link and Venn diagrams among others (Bradbury, 2015; Chambers, 1994).

Literature also highlights some of the practical challenges of facilitating a community-led problem analysis. With action research, for example, the self-reflecting stages of planning, acting and observing, and reflecting as elaborated in the spiral of action research is often fluid and overlapping (Kemmis et al., 2014). Participatory techniques also require building local rapport, which although valuable to the scientific process is intensive, and time-consuming requiring regular local presence (Chambers, 1994). Training local facilitators to include techniques like PRA for example is one way to overcome this, although this too has its challenges (Leurs, 1997). Outside assistance for participants during the research process is also highlighted by Kemmis et al. (2014) in reference to participatory research. In terms of evaluating results, critiques of the validity and reliability of claims concerning local impact can also be found (Chambers, 1994; Leurs, 1997).

3.2.3 Utilizing COR and participatory research to support peri-urban communities

In summary, COR is well suited to the design requirements of this approach. For one, it was created to help marginalized actors address issues of inequity and exclusion. This makes it relevant for the peri-urban context, where similar issues of marginalization exist as a result of the way institutions are typically arranged during urban transitions. COR defines these problems as messy and ill-defined where an improved problem understanding is often needed much more than problem solving support. In this way, COR may be used to address community's gaps in knowledge and problem solving skills with regards to peri-urban problems. Skills transfer is another area that features the use of COR.

Where COR is perhaps most useful is in its design elements. It outlines a process from problem formulation, problem solving, and finally evaluation, while clarifying that the needs of the context determines which steps in the process requires greater focus. Thereafter, the design of each step involves defining boundaries, selecting and applying specific appropriate methods suited to the skills of the community. For the latter, a varied toolkit of hard and soft OR methods are available to choose from. Participatory research techniques also features simple and visual tools that can also be used for problem structuring with communities.

Furthermore, participatory research offers practical lessons for structuring engagements with local communities. It defines the role of a facilitator in sustaining the engagement process. The approach designed to support peri-urban problems can adopt similar measures to sustain the participation of the local community throughout. This is needed to assure that the scope of problem structuring activities is defined by the interests and needs of the community. The following section builds on these existing techniques to design a suitable approach for examining peri-urban problems through an institutional lens with communities.

3.3 An approach for participatory institutional analysis

The approach developed in this research is referred to as the 'Approach for Participatory Institutional Analysis' (APIA) and draws from existing techniques discussed previously in section 3.2. There are four main steps in the APIA: problem identification, institutional system mapping, strategic analysis, and strategy exploration (Fig. 3.1). The boundary, methods, and expected outputs in each of the four steps are outlined in further detail below.

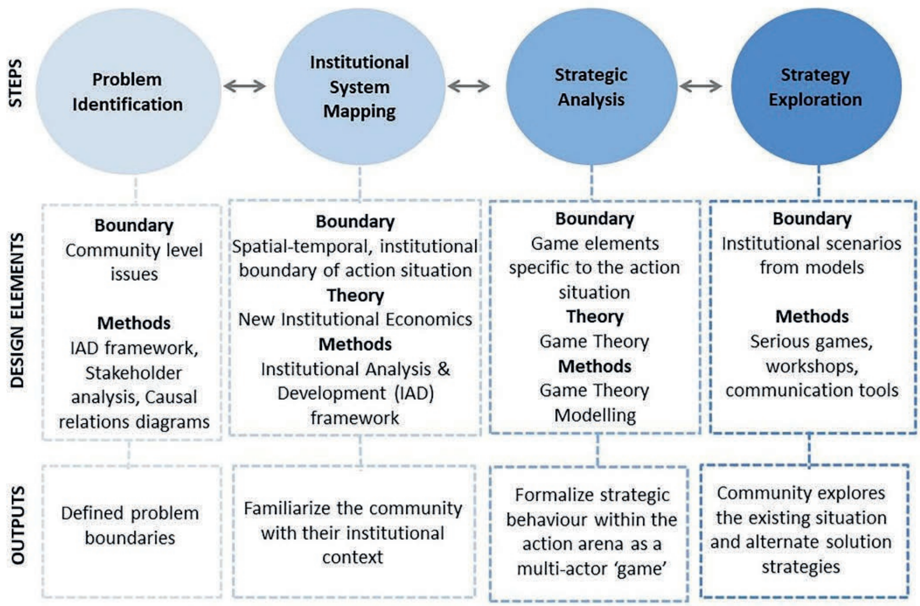


Figure 3.1 Overview of the Approach for Participatory Institutional Analysis (Gomes et al., 2018b)

3.3.1 Step 1: Problem Identification

The first step is to identify the most pressing issues that require a better problem formulation. It is similar to other COR and participatory problem structuring approaches (e.g. Cunningham et al., 2014; Johnson, 2012). It entails working with communities to define problem boundaries for further analysis. In this way, support through this approach is directed towards specific local needs.

Interviews, focus group meetings, and participatory workshops may be used to facilitate this initial engagement with the community. Stakeholder analysis and other

PRA methods may be used to create an initial inventory of actors for each issue mentioned to establish lines of inquiry into actors objectives, perceptions, and relations between them (Enserink et al., 2010; Hermans & Thissen, 2009). The steps in a stakeholder analysis are similar to other participatory tools for power mapping (IIED, 2005) and perspective identification (Cuppen, 2012), with the added advantage of being a quick and easy first step.

In peri-urban contexts, local issues are often linked, making the process of setting boundaries an iterative one. Here, causal diagrams (to represent relevant factors and causal relations within the system) and other visual representation techniques (eg. social mapping) can also help capture the geographic attributes of local problems (Frantzeskaki & Walker, 2013). Research by Buckley & Waring (2013) shows that the use of visual diagramming tools, even drawings, are useful in contexts where confidence in literacy and language skills is low. And moreover, it stimulates interactive discussions in focus group situations.

In step 1, the expected output is defining the boundaries of the most pressing peri-urban problems the community would like to address through this approach. This will offer more clarity on the need for institutional analysis as part of the on-going problem solving efforts – as this need cannot be assumed from the onset, prior to step 1.

3.3.2 Step 2: Mapping the institutional system

Given that the focus is on institutions, step 2 uses appropriate methods to examine the problem using an institutions lens. Obviously, this only becomes relevant if the initial problems identified in step 1 indicate the presence of a significant underlying institutional dimension. This is the case, for instance, if power dynamics, marginalization, collective action, appear to influence the social dilemma.

In step 2, system components are mapped in preparation for a more detailed problem diagnosis, specifically focused on the institutional dimensions. Like most societal issues, addressing problems in peri-urban contexts requires a systems perspective, one that emphasizes the institutional features of the problem. As COR supports systemic intervention through the actions of actors within it (Midgley, 2000), it is used as a template for structuring the institutional analysis of peri-urban problems.

Multiple approaches exist to examine institutions, some of which have demonstrated their value for policy analysis in the developing world (Chaudhury et al., 2016; Schiffer & Waale, 2008; Sova, Thornton, Zougmore, Helfgott, & Chaudhury, 2016). For an explicit consideration of rules, Step 2 uses conceptual frameworks designed specifically for institutional analysis. These allow specific relations of interest to be selected for a more detailed analysis utilizing some of the tools described earlier. The framework selected is called the Institutional Analysis and Development (IAD) framework (Ostrom, 2005). Its elements are similar to other frameworks to analyse institutions that come from the tradition of new institutional economics (Ostrom, 2009; Williamson, 1998a) and the organization and political science disciplines (Chaudhury et al., 2016; Scharpf, 1997). It is grounded in well-developed theories and offers the ability to unpack the framework as needed for a deeper examination of specific components, as per the analytical needs.

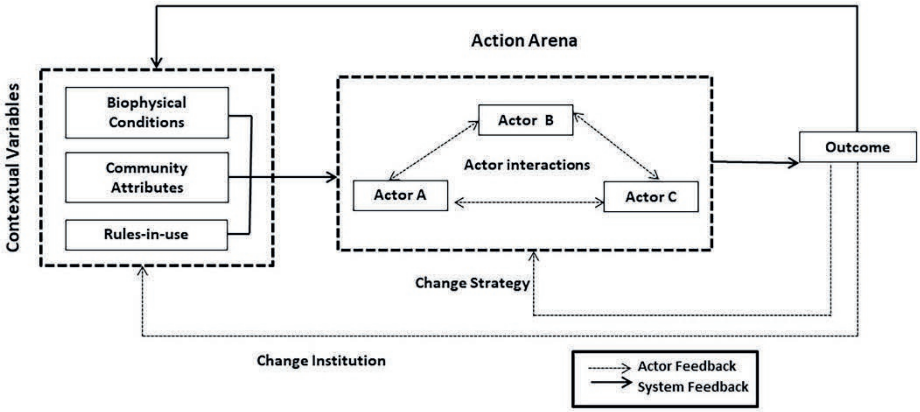


Figure 3.2 Institutional Analysis and Development (IAD) framework (adapted from Ostrom, 2005)

The IAD framework is built around three main components, as shown above in Fig. 3.2. It is made up of exogenous variables that include the rules-in-use, community attributes, and biophysical conditions that may be unpacked to reveal a nested structure. In this way, it is possible to differentiate the institutions at different levels. This provides a deeper understanding of the structure of the institutional context and the relationship between these levels as it relates to a specific problem.

The exogenous variables together structure interactions in the action arena. The action arena is the focal point of the framework. It comprises action situations and interacting participants (or actors) within it. Again, zooming into the arena shows that it is composed of participants, positions, actions, information, control, potential outcomes, net costs and benefits, all of which are given by the underlying rules (Ostrom, 2005). Focusing the analysis around the action arena offers a way to examine how institutions are operationalized by actors involved in the problem.

Decisions taken by the participants in this arena produce outcomes. Decision outcomes are particularly important for understanding institutional change. The framework specifies that actors use evaluative criteria to decide whether to stick with their existing strategies, change their strategies, or change the institutions over time (Ostrom, 2005). The IAD's representation of institutions in this way enables a temporal analysis of issues, and therefore the need for institutional changes.

In this way, the IAD is suited to the needs and objectives of step 2. It can be used to structure and analyse the institutional system related to the problem of interest. A blueprint of the system using the IAD framework can be developed through community level discussions of the operational level rules, situations, and outcomes. Next, higher level institutions and actor dynamics are included to complete the mapping exercise.

The IAD framework can be applied to more than just the existing problem situation. Step 2 also creates blueprints for key turning points or milestones that have occurred in the past and potentially will occur in the future. In this way, the institutional mapping process creates snapshots of the system over time. This allows for discussions to not be restricted to the existing action situation only, but enables problems to be examined in a dynamic way as they evolve. Within the problem formulation process, this type of institutional analysis is needed to highlight the evolution of interactions and institutions over time. Such an approach to problem framing is particularly pertinent to the peri-urban context as it also defines how communities could look for solutions to these kinds of problems.

The use of the IAD framework in step two also guides the planning of capacity building efforts through research uptake. For example, helping peri-urban communities become familiar with the exogenous variables in a given problem is needed prior to the examination of actor level dynamics within this institutional context. Therefore, sharing and discussing the rules with the community is the key output from this step. Institutional insights can be discussed with the help of short institutional briefs that summarize their function with respect to the local level. This also serves as an opportunity for communities to debate which formal rules are applied in practice and which have been replaced by alternate rules or informal practices. This is in addition to the analytical outputs that are expected from applying the IAD framework in Step two.

3.3.3 Step 3: Analysis of strategic behaviour

From this understanding of the institutional context, the next step requires zooming into strategic behaviour within the action arena. step 3, therefore moves away from the system perspective to an actor level analysis of decisions and interactions. Although the IAD framework offers the necessary variables important to consider in this regard, understanding the causal relations between actor interactions and system outcomes requires other analytical tools.

Examining actor interactions and system outcomes requires other analytical tools. From the available methods, some focus on actor-level attributes like perceptions (Bots, Van Twist, & Van Duin, 2000), power and influence (Sova et al., 2015), resources (Fang, Hipel, & Kilgour, 1993) or network level dynamics (Scott, 2000). They are similar to other OR methods in their problem and client-oriented application, but vary in the degree of specificity and analytical quality (Hermans & Thissen, 2009). What can be useful to communities in terms of problem solving, is the strategic behavior of different actors within their arenas. This offers insight into the motivations of other actors, an understanding that can help during negotiations processes.

Game theory and agent-based models are among the tools that offer a systematic exploration of strategic behaviour within action arenas (Ostrom, 2005, 2010). With game theory models, strategic behaviour and outcomes are formalized as a game consisting of players, actions, outcomes, and payoffs (Rasmusen, 2007). Game theory applies mathematical reasoning to quantitatively analyse strategic behaviours and their outcomes, offering rigor and a logical structure for analysing decisions (Hermans, Cunningham, & Slinger, 2014; Osborne & Rubinstein, 1994; Schelling, 2010). For this, software can be used to evaluate game outcomes in equilibrium and optimal terms, like Gambit (McKelvey, McLennan, & Turocy, 2016) or game theory explorer (Savani & von Stengel, 2015).

Agent based modelling (ABM) simulates social agents in evolving systems of autonomous interacting agents (Janssen & Ostrom, 2006). This kind of modelling can analyse emergent, system- level patterns that arise from local agent behaviours and interactions. The use of ABM allows for greater specification of micro-level decision rules among a larger number of agents, providing a realistic picture of emergent patterns (Windrum, Fagiolo, & Moneta, 2007). Today, ABM is used to simulate the influence of rules and values on behaviour, using a grammar of institutions to analyse institutional statements (also referred to as the ADICO syntax) and to program institutions into the model itself (Crawford & Ostrom, 2005; Ghorbani, Bots, Dignum, & Dijkema, 2013).

Literature suggests that choices concerning model selection typically involves trade-offs between simple versus sophisticated models that are perhaps more descriptive in some aspects (Janssen & Ostrom, 2006; Windrum et al., 2007). On the one hand, detail and richness is valued; on the other hand, a well-known modelling principle is to keep models as simple as possible to meet stakeholder purposes rather than try to be all-inclusive (Lee, 1973). Therefore, in step 3, a simple representation of strategic interactions within action arenas with the help of game theory models can be attempted with communities.

In this step, the objective is to understand why actors select their particular decision choices and to see how this permits certain outcomes, while preventing others. Analysing outcomes in terms of payoffs using game theory models can help in this regard. Over time, the approach may call for other kinds of models, including ABM simulations. However, as a first step, formalizing strategic behaviour using game theory concepts should be feasible even with limited data and limited technical abilities of the users of modelling results, which in this research, refers to peri-urban communities in India and Bangladesh.

There are two ways of specifying rule conditions in game theory. Non-cooperative game theory is used to structure conflicts within a fixed set of rules, where actors adopt a self-optimizing attitude to meet their own objectives (Madani, 2010; Slinger, Cunningham, Hermans, Linnane, & Palmer, 2014). In cooperative game theory, the game assumes a willingness to communicate, coordinate actions and pool resources by the actors in this game (Hermans & Cunningham, 2018; Slinger et al., 2014). In step 3, both cooperative and non-cooperative approaches can be used to structure and explore strategic behaviour.

The community's role in the design of game theory models needs to be considered in step 3. Participatory modelling, and similar approaches, such as companion modelling (Barreteau et al., 2003), suggest an iterative design of models, which is a process that offers multiple opportunities to refute model assumptions while facilitating joint learning about systems. This fits in with the OR practitioner's role shifting from expert towards co-participant in COR projects (White & Taket, 1994).

Facilitating this in the field requires sessions with each category of actor whose behaviour is being modelled; particularly marginalized groups whom the intervention is designed to support. During this time, discussions should focus on identifying each actors evaluative criteria, as described in section 3.3.2 in the IAD framework. These criteria are used in the selection of strategies as a reflection of their values and objectives in the problem situation. From the criteria, payoff functions in the game theory models can be calculated. Keeney (1992) offers a value-centred approach to help facilitate discussions regarding values with different actors.

3.3.4 Step 4: Strategy exploration

This stage in the approach links closely with step 3 in terms of a feedback between model design and evaluation by local stakeholders. Here, the goal is for communities to explore the solution space of strategic options under the existing and alternate institutional settings. This step is expected to lead to discussions by the community as to how they can change the outcome in their problem by adapting their strategies, incentives, rule changes, or players.

Although game theory models are visually appealing and empirically useful, game theory requires some understanding of the theory behind it, key concepts, and calculations to interpret model results. Therefore, additional interactive methods are needed to discuss and build upon the insights from game theory models with communities. Participatory workshops with storytelling, visualizations, and other techniques may be used to support these discussions. Gaming-simulation also offers a medium to explore and reflect on model results.

Serious games have appeared in the policy analyst toolkit since the 1960s in response to the need for human-centred approaches that incorporate the socio-political complexity of public policy issues (Mayer, 2009). Since then, different kinds of games have emerged in fields related to this area of application: resource management (Lankford, Sokile, Yawson, & Lévite, 2004; Meinzen-Dick et al., 2016; Onencan, Van de Walle, Enserink, Chelang'a, & Kulei, 2016; Zhou, Mayer, Bekebrede, Warmerdam, & Knepflé, 2010), urban planning (Mayer, Carton, de Jong, Leijten, & Dammers, 2004), and peri-urban conflicts (Ducrot, 2009). Therefore, it is appropriate to consider how these methods can similarly be used in this study.

Gaming-simulation methods simulate the real-world as a game, where real-world phenomena are mimicked in the roles, rules, and incentives of the game (Meijer and Hofstede (2003) cited in Meijer (2009). Game design handbooks by Duke (1980) and Greenblat (1988) argue that design should be based on the game's purpose. In this case, our purpose is to offer strategic support to peri-urban communities. Bots & van Daalen (2007) highlight how strategic support games can serve as 'virtual practice rings' for experimenting with different strategies before formally entering the policy arena. The type of game depends on its purpose. For example role-playing games provides a medium for experiencing how other actors behave. This offers communities insight into the multi-actor complexity of the problem. In this way, a role-play game is appropriate for use in this context. It represents a medium for players to experience how actors behave (within a set of institutions) and what motivates their strategies.

Specifications for game design require abstracting relevant details about the problem. In this study, earlier steps of this approach offer insights which help define the scope and design elements for strategy exploration. For example, insights on actor interactions and overarching formal and informal rules emerge from the analysis in Step three.

Therefore, gaming-simulations methods are to facilitate strategic exploration with communities in steps 4. The logic and analytical rigor of game theory is useful for interpreting real-world decision making phenomena in multi-actor situations (Hermans, Cunningham, & Slinger, 2014b; Osborne & Rubinstein, 1994). In step 3, models formalized strategic behaviour in the form of a 'game' consisting of players, actions, payoffs on resulting outcomes (Rasmusen, 2007). They illustrate how outcomes result from strategic interactions between actors based on their preferences (Madani, 2010). The design schema used for game theory analysis is valuable for game design as the focus in game theory on decisions and outcomes are also the building blocks of meaningful play (Salen & Zimmerman, 2003).

Inputs from game theory models can be directly used by game designers to map the formal structure of a game (Salen & Zimmerman, 2003). Meanwhile, the institutions help design the game mechanics as they specify the order of play, information, and resources available to players in the game. Furthermore, cooperative or non-cooperative modelling approaches offer inputs into the scenario (starting conditions) and pulses (events introduced during the game) during the gaming-simulation activity (Duke, 1980). Together, these inputs help incorporate situational awareness elements into game design. Participants playing the game can start by exploring strategies in the existing problem situation and thereafter, in situations featuring different rules or under changing problem conditions. In this way, game theory models from step three serve as the starting point for game design.

3.4 Evaluation of the APIA in real-world applications

This research also requires suitable methods to evaluate the impact of the APIA from its applications to problems in peri-urban contexts. This section describes an evaluation framework to facilitates this.

The conceptual framework developed by Thissen & Twaalfhoven (2001) is well-suited for evaluating policy analytic activities conducted as part of a larger policy process. Recently, this framework was used to evaluate the use of participatory planning tools in urban adaptation policy processes (McEvoy, van de Ven, Blind, & Slinger, 2018). The components of this framework are useful to similarly design an evaluation framework for the APIA. The evaluation is designed around the inputs, content, process, results, use, and effect.

The approach in this thesis is evaluated from a single case study application. Midgley et al. (2013) highlight the benefits of single case studies, arguing that examining the success of the method within its 'context' is important. They too, offer a conceptual framework that is relevant for this case-study application of the APIA. This framework emphasizes the context, outcomes, purposes, and methods as inter-connected criteria. Another useful contribution of Midgley et al.'s (2013) framework is the differentiation between researcher and participant criteria. The application of the APIA in this study is also likely to produce insights at two levels – empirical and methodological results that are of relevance to the research team and capacity building impacts for the beneficiaries, in this case, the peri-urban communities that utilize the results from this approach in their problem solving efforts.

The evaluation protocol followed in this study is based on inputs from both Thissen & Twaalfhoven (2001) and Midgley et al. (2013) tailored to the context and purpose of this study. The evaluation centres around the input, activities, and outputs of the APIA. There are different criteria against which the evaluation of inputs, activity, and outputs are performed based on the criteria elaborated Midgley et al. (2013). These criteria elaborate specific evaluation protocols for each stage of the intervention, guided by a set of questions.

One common criteria across all stages is the context. The context where this approach is used is an important overarching factor in the APIA application. Therefore, it has to be considered throughout the intervention and features in the evaluation questions posed at each stage of the intervention. The following are the evaluation protocols used in this study.

Input: Evaluating the purpose of applying the APIA in the case study

The evaluation of the APIA during the input stage is based on its purpose. Here, the evaluation focuses on the extent to which the APIA is suitably structured to facilitate capacity building and support problem solving in peri-urban areas. The purpose criteria relates to how well the approach is adapted to the problem solving needs of the community, the research objectives, and the context. The evaluation questions for the input stage are as follows:

- Does the approach fit the research and community objectives?
- Does the approach suit the context in which it is applied?

The reasoning behind these evaluation criteria and protocols are as follows. Initially, it is important to see if there is in fact a need for institutional analysis of problems. This can be determined from initial discussions with the community, based on the nature of their problem solving challenges. Once this need is established, applying the APIA starts by identifying its specific purpose for the project beneficiaries (i.e. community). This is based on what the community expects to gain by participating in the intervention. This also helps define the researcher and/or facilitator's objectives for the APIA in terms of knowledge, skills building, or even problem solving support. The purpose is also defined by other contextual features such as for example, language spoken, local network to conduct the study or resources to facilitate the approach in a participatory way. This is also considered during the input stages in the design of the intervention.

Activity: Evaluating problem understanding, methods, and process in each APIA Step

Evaluation of activities takes place during each of the four steps in the APIA- problem identification, institutional mapping, strategic analysis, and strategy exploration. In this stage, each step is evaluated separately, using the same set of criteria. The criteria include the insights gained about the problem, methods and process used. Problem understanding is evaluated in two ways. First, the improved community's understanding of their peri-urban problem and second, the broader analytical insights it resulted in. The methods and implementation process are evaluated in terms of how well they suit the context in which they are applied. They are also evaluated in terms of how well they fulfil the capacity building needs and analytical goals in each step.

The four steps are also connected, as one is shaped by the results of the step before. This means that the objective of each step is fed by the results of the preceding step. For example, the mapping of institutions depends on the type of problem identified in step 1 and the boundaries defined for that problem. The evaluation questions during the activity stage are as following:

- How did each step of the APIA improve the community's understanding of their peri-urban problem?
- What analytical insights were gained from each step of the APIA?
- To what extent did the methods and process meet the capacity building and analytical objectives in each step?

During the activity stage, evaluating how each step of the APIA benefitted the community is based on the objectives of each step in terms of problem structuring. For example, it is possible to evaluate what kinds of problems were identified by the community following step 1. Step 2 evaluates what the community learned about the institutions underlying their selected problem. And similarly, their impression of the methods and facilitation during institutional mapping. Community insights about strategic behaviour within the problem, game theory methods, and the process used to structure and analyse these models in a participatory way is the focus of the evaluation after step 3. Finally, the community's understanding of different strategies to address the problem are evaluated after step 4, together with how the gaming-simulation methods and their facilitation fared in this context. It is possible that broader insights, beyond those relevant to the community's problem solving needs will also be gained from the analysis at each step. These analytical insights are also evaluated. Evaluating the methods and facilitation process meanwhile, provides an opportunity to reflect on what worked and did not work during each step when used in a particular context.

Output: Evaluating the results from the APIA based intervention

An overall evaluation of the APIA is made during the output stage following all four steps. Impact of the APIA is the main evaluation criterion used at this stage. Here, the focus is on the impact of the approach as a whole on the community's problem understanding and problem solving capacity. Here, the reflection is at two levels – the community and research insights. Research insights refers to participatory methods used in the APIA approach as well as peri-urban problems particularly in reference to its institutional context.. The following questions are asked during this evaluation:

- How did the community's problem understanding improve overall through the APIA?
- What research related insights were gained through the APIA?
- How do these insights influence problem solving in this context?

Chapter 3 set out to design an approach that could be used to address community problems through an institutional lens. The developed approach, referred to here as the APIA, consists of four main steps, each fulfilling a particular objective in terms of facilitating problem structuring and analysis with marginalized communities. The design also recommends appropriate methods to facilitate each step and the expected outputs with regards to capacity building. In the following chapters (4,5,6 and 7), results, and evaluation of a case study appliaion of the APIA in peri-urban Khulna are presented. Chapter 4 presents the results of step 1 (problem identification).

Photo courtesy: Jagrata Juba Shangha (2016)

Chapter Four

Applying the APIA in Peri-urban Khulna (Bangladesh)

4.

APPLYING THE APIA IN PERI-URBAN KHULNA (BANGLADESH)

This chapter builds on sections 3.1 and 5.1 from the journal paper by Gomes, Hermans, & Thissen (2018) that describe step 1 of the APIA application in Hogladanga.

Chapter 4 marks the next phase of this research, with the application of the APIA approach developed in chapter 3 in peri-urban Khulna. This provides a basis to investigate the strengths and weaknesses of the approach in terms of addressing peri-urban problems with local communities in the real-world.

Chapter 4 begins with a short introduction to the case study in section 4.1. A general overview of the broader study context of Khulna city in terms of its geography, population, economic characteristics is presented first, followed by a discussion of how urbanisation is affecting peri-urban areas near Khulna city. The case study of Hogladanga village is introduced in section 4.2, highlighting the dependency of Hogladanga residents on groundwater and discussing some of the key actors involved in groundwater management.

The second half of Chapter 4 deals with the application of step 1 in Hogladanga village (4.3). This includes the methods for data collection and analysis (4.3.1), results of problem identification (4.3.2) and discussion of key insights from step 1 (4.3.4). The underlying research objective for chapter 4 is to evaluate step 1 of the APIA (problem identification) in terms of how it helps Hogladanga to identify pressing issues to be addressed further through the APIA.

4.1 Introduction to Khulna, Bangladesh

4.1.1 General overview of Khulna city

The administrative set-up in Bangladesh is shown below in Fig. 4.1. Directly below the central government, the country is organized into divisions. This research takes place in the peri-urban areas of Khulna city, that is situated in Khulna division. Khulna division is located in the south-western region of Bangladesh. Administratively, it is sub-divided into districts (Fig. 4.1). Khulna district (or *zila)*, has a population of approximately 2.3 million people, as per the last government census in 2011 (Bangladesh Bureau of Statistics, 2013). The district is made up of nine sub-districts (or *upazillas)* and five metropolitan *thanas*. The five metropolitan *thanas* together form the Khulna city area (Bangladesh Bureau of Statistics, 2013). Administratively, sub-districts are further organized into unions, *mauzas*[8], and villages (Fig. 4.1).

[8] In Bangladesh, a *mauza* is the lowest administrative and revenue unit having one or more villages within it (Bangladesh Bureau of Statistics, 2013). Nowadays, a *thana* is often referred to as an *upazilla.*

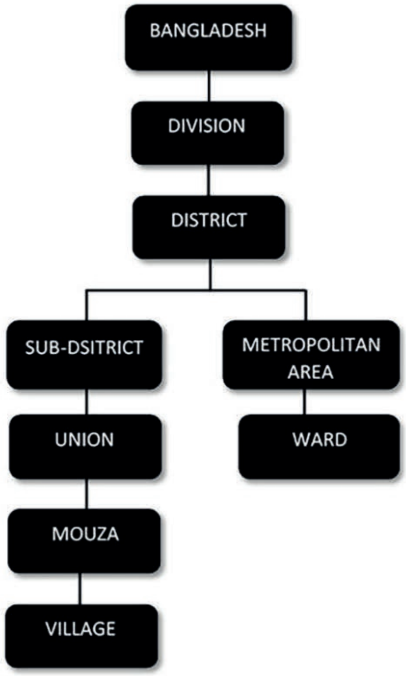


Figure 4.1 General overview of the administrative set-up in Bangladesh

Figure 4.2 Location of Khulna city and Khulna division in south-western Bangladesh (Map courtesy Shawna Gomes, 2017 adapted from Aranjuezmedina 2017)

This study takes place in peri-urban areas near Khulna city, in the nearby sub-district of Batiaghata. Fig. 4.2 shows the location of Khulna division and Khulna city in Bangladesh. Khulna city covers an area of 45.65 sq. km and includes 31 city wards and 184 mahallas (Islamic parishes) (Bangladesh Bureau of Statistics, 2013; Hasan, Hossain, Chowdhury, & Salehin, 2017). It is the third largest city in Bangladesh with a population of over 1.5 million (Khulna City Corporation, n.d.). It is also the headquarters of both Khulna district and Khulna division and thus, is an important administrative seat (Hasan et al., 2017). Khulna city is located on the banks of the Rupsha and Bhairab rivers (Fig. 4.3). Administration within Khulna city falls under the jurisdiction of Khulna City Corporation (KCC). Previously, water supply was managed by KCC from 1990 - 2008, until the Khulna Water Supply and Sewerage Authority (KWASA) was established. Since then, KWASA is responsible for supplying potable water to the residents of Khulna city (Khulna WASA, n.d.).

Figure 4.3 Map indicating Khulna city corporation area (Green) in relation to major rivers and Batiaghata sub-district (Map adapted from Sultan, 2018)

Over time, Khulna city's population has changed significantly. The highest growth rate was experienced at the time of industrialization in the 1950's and 60's that brought in a lot of migrant workers (Hasan et al., 2017; S. Roy et al., 2018). The report by Roy et al. (2018) shows that Khulna's growth rate has fluctuated significantly as a result of changes in political regimes and economic conditions with a negative growth rate reported by the year 2011. At the time this research was conducted, Khulna was experiencing significant urban expansion in the southern part of the city. Several factors are believed to have contributed to this urban expansion including for example, construction of Padma bridge, the Rampal thermal power plant, and a new Khan Jahan Ali airport that is under construction in nearby Bagherhat, construction of which is expected to be completed by 2020 (Hasan et al., 2017; UNB, 2018).

Migration to Khulna city is also experienced due to rural to urban migration for education, employment opportunities, and proximity to one of Bangladesh's major ports: Mongla Port at Bagerhat (Kumar et al., 2011). Frequent natural disasters due to climate change in coastal areas of Khulna region, like the cyclones in 2007 and 2009, has also led to an influx of displaced coastal inhabitants to Khulna city and nearby peri-urban areas (Hasan et al., 2017; Roy et al., 2018). Khulna is also home to two reputable universities - Khulna University and Khulna University of Engineering and Technology (KUET), that attracts a lot of students from all over the country. Khulna's shrimp cultivation and processing has also become an important economic sector in this region. Shrimp farming is the country's second largest export most of which is cultivated in the Khulna area (Ahmed, Demaine, & Muir, 2008; Paul & Vogl, 2011). Nearby peri-urban areas are an attractive industrial base with good links to the city. Khulna city's location near the Sundarbans makes it a potential tourism hotspot as well (Vavier, 2014).

4.1.2 The effects of urbanization on peri-urban Khulna

Urban expansion from Khulna city is changing the landscape in surrounding peri-urban areas. Peri-urban areas are a key source of food supply and other resources for nearby Khulna city. However, future dependency on peri-urban agricultural production is threatened by the conversion of agricultural land for shrimp farming and urban development. Traditionally, rice farming was predominant in rural areas, and a main source of livelihood. Different varieties like Aus, Amon, and Boro are cultivated. Boro is comparatively higher yielding, boro rice production has increased in the last 20 years in peri-urban areas near Khulna city (Banerjee, 2016). Moreover, the profitability of the shrimp farming industry explains why more agricultural land has been converted over the last several decades (Hasan et al., 2017, 2017; Paul & Vogl, 2011).

The Sanchibunia *mauza* area, situated at the southern fringe of Khulna city is where the case study of Hogladanga is located. A study by Hasan et al., (2017) explored the changes in land use and water resources over time in Sanchibunia. This area has witnessed rapid growth in real-estate development and industrialization. Some of this can be attributed to the presence of road infrastructure. For example, Bhotiagata road runs through this area. It serves as an important transportation link to Khulna city. Several prominent industries including a power grid station, rice mill, cable and fish processing industries are now active in Sanchibunia.

Fig. 4.4 below shows the changes in land use in Sanchibunia and surrounding areas for different classes of land cover between 1996 and 2016. Due to rising land value and decreasing profits from rice cultivation, agricultural land declined and was sold for other purposes such as built up areas and rural settlements, that grew by 44% and 35% respectively during this time. This has also contributed to an increase in fallow land. Similarly, land encroachment is also found in this area which has led to the discussion of local water bodies especially canals from nearby Moyur river (Hasan et al., 2017).

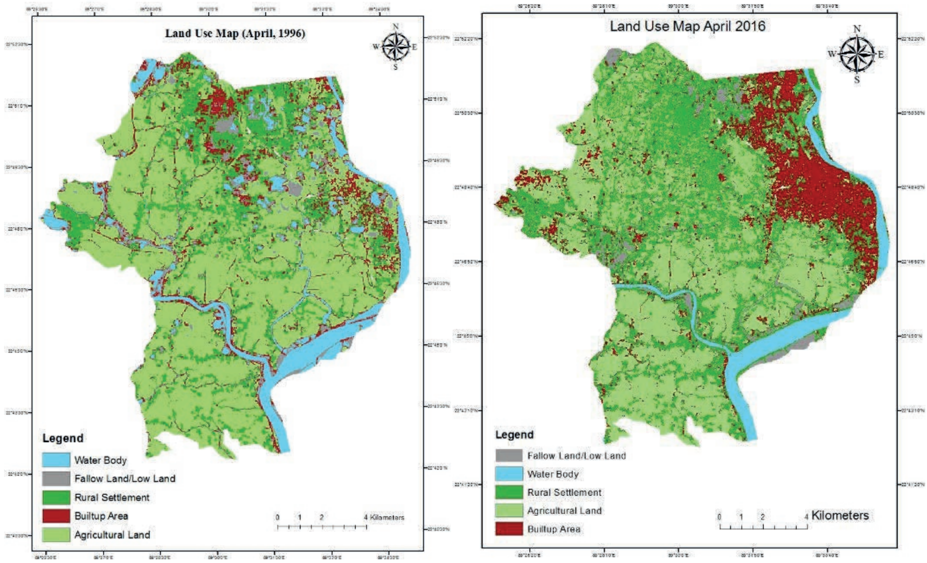


Figure 4.4 Changes in land use cover between 1996 (left) and 2016 (right) in Sanchibunia: Water Body (Blue); Fallow land/low land (Grey); Rural settlement (Dark green); Builtup area (Red); Agricultural land (Light green) (Hasan et al., 2017).

Urban expansion has also affected local groundwater resources. The same study examined groundwater levels between 1996 and 2015 in three unions of peri-urban Khulna. Groundwater levels have declined steadily between 2001-2015 in comparison to 1986-2000 levels where fluctuation was below one meter. Proximity to the city also influences groundwater. From the three unions studied, groundwater levels in the last 15 years declined by 5 meters in Jalma union, situated closest to Khulna city (Hasan et al., 2017).

Hasan et al. (2017) further describe social changes that have occurred in this region. Between 2001 and 2011, their study shows an absolute increase in total number of households, population and household size in all villages within Sanchibunia. For example, an additional 230 households and 1110 residents were found to reside here in 2011 compared to 2001 (Hasan et al., 2017). Literacy in the Sanchibunia areas have also changed significantly, particular with regards to women. Changes in female literacy is regarded as an important indicator of peri-urbanization, although the study is unable to track female employment rates. Hasan et al.'s (2017) study shows the gender gap in literacy decreased in all villages between 2001 and 2011, with one village (Nijkhamar) having even more literate females than males as of 2011.

4.2 Case-study introduction: Hogladanga village

Hogladanga village is located in Jalma union (Batiagata upazilla) near Khulna city. The lowest administrative unit is Sanchibunia *mouza,* that consists of 5 villages including Hogladanga (Hasan, 2017; Hasan et al., 2017). Like all areas outside the Khulna Metropolitan area, Hogladanga is officially considered part of the rural jurisdiction. Therefore, public services such as drinking water supply is provided by the Department of Public Health Engineering (DPHE) in collaboration with the sub-district and union governments. According to a 2016 survey, there are 282 households in Hogladanga and it has seen an increase in migrant populations since 2005 from places like Koyra, Shyamnagar, Dumuria, Terokhada etc. (Banerjee & Jatav, 2017).

This village is still predominantly agrarian. 65% of surveyed households practiced crop cultivation. Other livelihood sectors included allied agriculture (9%) eg. animal husbandry, mixed cropping, forestry, trade (6%), manufacturing and repairing (5%) among others. In the survey, 70% of households had a single source of income, and those who did, predominantly practiced freshwater aquaculture (40%) and construction (16%). Secondary livelihoods were also predominant in households that were primarily practising agriculture. Here, crop cultivation was supplemented with income from aquaculture, allied agriculture[9], construction etc. (Banerjee & Jatav, 2017).

Like other peri-urban communities, Hogladanga has also witnessed changes in agricultural practices. This is due to land grabbing, encroaching of agricultural land and nearby *kahls*[10] (canals) by industries and real-estate developers, decreasing land productivity due to waste dumping and pollution of local *khals* (Banerjee & Jatav, 2017). This has led to competition between local farmers, fisherman, urban elites over local land and water resources. Similarly, agriculture has become increasingly groundwater based.

The case-study selection report by Banerjee, (2016) developed during the Shifting Grounds project mapped the socio-economic conditions in Hogladanga. Housing structures in the village are mixed with predominantly traditional *kuccha*[6] (constructed using less durable and/or traditional materials such as mud), semi-*pucca*[11] (semi-durable materials), and to a smaller extent *pucca* (brick or concrete structures) that have started to emerge more recently (Fig. 4.5). Although sanitation facilities are available in most households, other basic housing facilities such as electricity fared poorly by comparison. Despite proximity to Khulna city, only 39% of surveyed households had an electricity connection (Banerjee, 2016).

[9] Other allied agriculture includes animal husbandry, mixed cropping, forestry, logging and related services (Banerjee & Jatav, 2017).

[10] In Bangladesh, a *Khal* is used to describe a tidal river channel.

[11] In South Asia, *pucca* is used to describe houses built with conventional high-quality materials, as opposed to makeshift or crudely built *kutcha* houses.

Figure 4.5 Examples of *kuccha* structures (Top) and *pucca* multi-level structures under construction (Bottom) in Hogladanga (Photo courtesy Gomes, 2017)

As of 2011, literacy extended to approximately 62% of male and 55% of female population. While the literacy rate has generally increased (for both males and females) since 2001, female literacy has grown significantly, although in comparison to other peri-urban villages Hogladanga has the largest gender gap in terms of literacy levels (Banerjee, 2016).

Groundwater plays a significant role in the daily drinking, domestic, and livelihood water needs of Hogladanga as evident in the study conducted by Banerjee (2016). Nearly all households in Hogladanga rely on deep tube-wells for drinking water purposes while *khals* and shallow tube-wells are also used for domestic purposes such as cleaning, bathing, washing clothes etc. (Fig. 4.6). For irrigation, both surface and groundwater sources are used. *Boro* cultivation using shallow tube-wells from 300-300ft is practiced extensively. These shallow tube wells are privately owned, although some collectively owned tube wells are also found. A groundwater market also exists in this village. Local tube-well or land owners sell groundwater per hour (at a rate of €

1.04[12]), per *bigha*[13] of land irrigated, or in exchange for crops to local irrigators. The *gher* system is also practiced in Hogladanga, where channels are dug around agricultural plots for collecting water in the rainy season for cultivating freshwater prawns (Banerjee, 2016).

Figure 4.6 Examples of a deep tube-well used for drinking purposes (Top) and ponds used for domestic purposes (Bottom) (Photo courtesy Gomes, 2017)

[12] Based on the conversion rate on May 19th, 2019 of €1 = 92.1866 BDT.

[13] In Bangladesh, a *bigha* is measure of land area that equals 0.13 hectares (Ministry of Land, 2016).

4.3 Step 1: Problem identification in Hogladanga

This section describes the application of the APIA in Hogladanga village, to help local residents address their problems.

4.3.1 Methods used to facilitate problem identification in Hogladanga

Problem identification in Hogladanga was achieved through regular discussions with representatives from the local community between 2015 and 2017. The purpose of these meetings was to create an inventory of local concerns and then prioritize them based on importance to the community. Two kinds of community discussions conducted in parallel served as data sources during step 1: field visits conducted by the author and NA activities conducted by JJS in Khulna. Fig. 4.7 shows the timeline of activities and the types of discussions that were conducted over time (during field visits and NA related activities).

A series of meetings were organized by the local partner, JJS, with the community as part of the capacity building activities organized around the Negotiated Approach (NA). These included a one-day workshop in Khulna city in October 2015, followed by several, more regular '*mango tree*'[14] meetings in the village since December 2015. Fig. 4.7 lists the dates and topics discussed in each of the meetings that contributed to step 1. The meetings were held with two self-organized farmer and fish farmer negotiation groups from the village. They were created at the start of the project following selection of case study sites in 2015. These negotiation groups comprised local residents committed to and interested in protecting local water rights. Discussions between October 2015 and June 2016 focused on preparing an inventory of issues in Hogladanga.

[14] In the Shifting Grounds project, a mango-tree meeting was the term used to describe informal meetings held with residents in the village. They differ from larger, more formal workshops held at venues in Khulna city. With the 'mango-tree' meetings, the goal was to hold discussions where residents felt comfortable discussing their problems and was convenient for them to attend on a more regular basis.

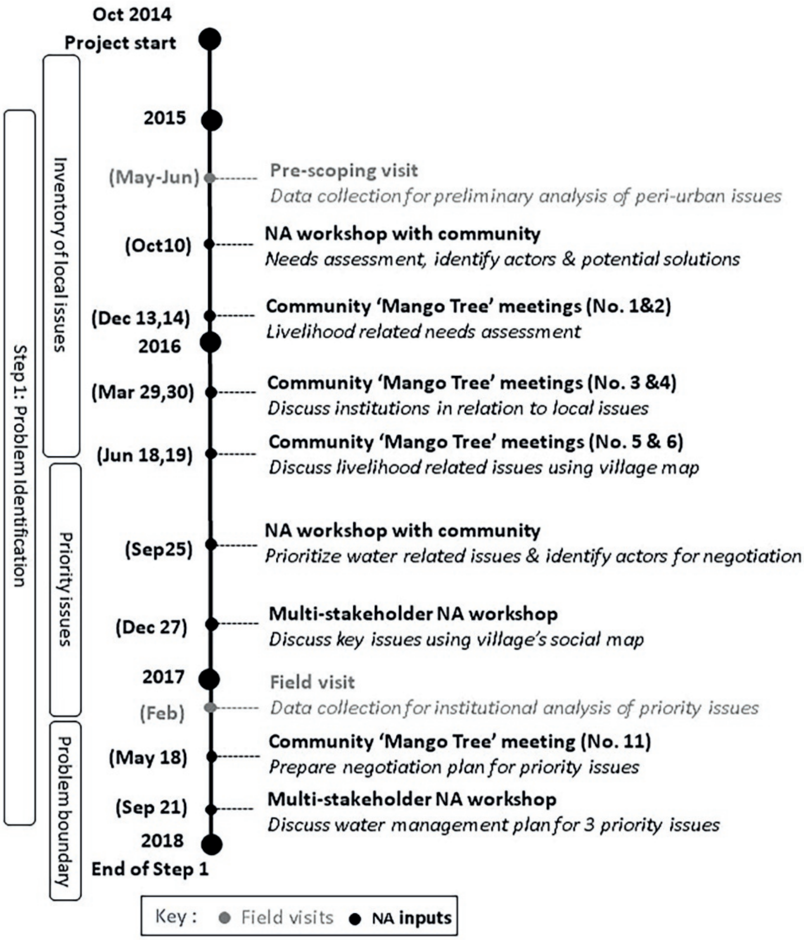


Figure 4.7 Timeline of inputs that were used for step1 : problem identification

In addition to the NA activities, a pre-scoping visit was undertaken by the author to better understand some of the peri-urban issues mentioned on this list. It was conducted between May 24 and June 8, 2015 and served multiple purposes. One of them included analysing the challenges in peri-urban Khulna with respect to urban expansion, water quality, water supply, resource competition from urban areas and peri-urban livelihoods. Results from a preliminary stakeholder analysis using secondary data and inputs from project partners served as the starting point in planning of field activities. Results of this stakeholder analysis can be found in Appendix 1.

During this time, interviews were held with 15 key informants from civil society groups, academic institutions, and government departments at various levels. Three Focus Group Discussions (FGDs) were also conducted with residents from three peri-urban communities near Khulna – Phultala, Matumdanga, and Hogladanga (Fig. 4.8). In Hogladanga, the focus group consisted of 27 local residents representing main water user categories: rice farmers, shrimp farmers, and domestic users. Attempts were made to balance group discussions in both gender and age to get insight into the historical evolution of the village and gender specific impacts of water management outcomes.

Figure 4.8 A focus group discussion from the 2015 pre-scoping visit (Photo courtesy Jagrata Juba Shangha, 2015)

All meetings during the pre-scoping visit were facilitated using semi structured interviews. The list of interview questions, used during this visit are available in Appendix 2. Interview questions were customized for different stakeholder groups: government, civil society, and communities. Most meetings were conducted in the local language (a dialect of Bangla) and translated by colleagues from JJS. These meetings were set up by JJS through their local networks. Respondents were contacted through structured and snowball sampling methods (Harrell & Bradley, 2009). All discussions were recorded and transcribed by the author upon approval by respondents. Verbal consent for storing, recording, and using the data collected for research purposes were taken.

Thereafter, priority issues were identified between Sept 2016 and Feb 2017. Representatives from Hogladanga community identified, through a next round of FGD's, the most pressing issues from this initial list of concerns. These issues reflect those that are most important to the community from a problem solving standpoint. A secondary approach was also used to cross-verify the feedback from local NA meetings (JJS). It involved quantifying the number of times peri-urban issues were raised during meetings held until between 2015 and 2017.

Based on these inputs, boundaries for the selected problem were drawn. The next section presents the results from the original problem definition. Problem boundaries, over time, were re-defined several times based on community discussions after 2017. NA meetings in 2017 were particularly useful in this regard (Fig. 4.7). By this time, the community had formulated negotiation plans for three priority issues. These plans provided additional insight into other details about the problem. Around this time also, a second field visit was conducted in February 2017 by the author. Details regarding this visit are provided later in chapter 5, as they primarily served as the key input in step 2 (institutional mapping). However, as it was also contributed to the refinement of problem boundaries, it has been included in Fig. 4.7.

Alongside community meetings, regular project meetings were also held. During these meetings the key issues identified during step 1 were discussed with technical and local experts. These inputs also contributed to the selection of issues for further analysis through the APIA. These discussion helped align community interests and needs with the aim and focus in the Shifting Grounds project.

4.3.2 Results from problem identification in Hogladanga

As illustrated in Fig. 4.7 and previously in the outline of the APIA approach (Fig. 3.1), step 1 consists of the following three activities with Hogladanga residents. First, locals prepared an inventory of problems facing them. Second, they prioritized their main problems and third, they defined the boundaries of their most-pressing problem for further analysis.

a. Inventory of local problems in Hogladanga

Hogladanga village, like other nearby peri-urban areas were adversely affected by urbanization in a number of ways. The initial mapping activities conducted in Hogladanga revealed a broad range of problems as shown below in Table 4.1. They can be broadly categorized into those related to urbanization, water access, water quality, resource management and climate change. Although discussions with the community were centred around the topic of groundwater management, the problems identified in Table 4.1 are much broader.

Category	Problem
Urbanisation	Migration to peri-urban areas
	Peri-urban administration
	Implementation of Khulna city expansion plan
	Competition between urban and peri-urban areas over water access
	Insecure agricultural livelihoods
	Urban waste management
	Fish-farming value chain
Water access	Restricted water access for agriculture and shrimp farming
	Domestic water access
Water quality	Groundwater quality
	Surface water contamination
Natural resource and infrastructure management	Canal encroaching
	Water logging
	Sluice gate mismanagement
	Sedimentation in canal
	Selling of top soil
	Seasonal groundwater scarcity
Climate change	Rainfall variation

Table 4.1 Summary of local problems in Hogladanga (Gomes et al., 2018b)

For example, local farmers explained that access to surface water was restricted by many factors as described in a mango tree report from March 2016 (Jagrata Juba Shangha, 2016a). This included mismanagement of the nearby Alutala sluice gate, broken dredging equipment that has prevented the dredging of the Kazibacha river near the canal entry point and increased siltation, canal encroachment by local musclemen, and blocked sections of the canal (using a fence) for fish cultivation. Moreover, illegal canal encroachment also contributed to water logging problems during the monsoon season. Fig 4.9 indicates the locations of these problems in relation to Hogladanga.

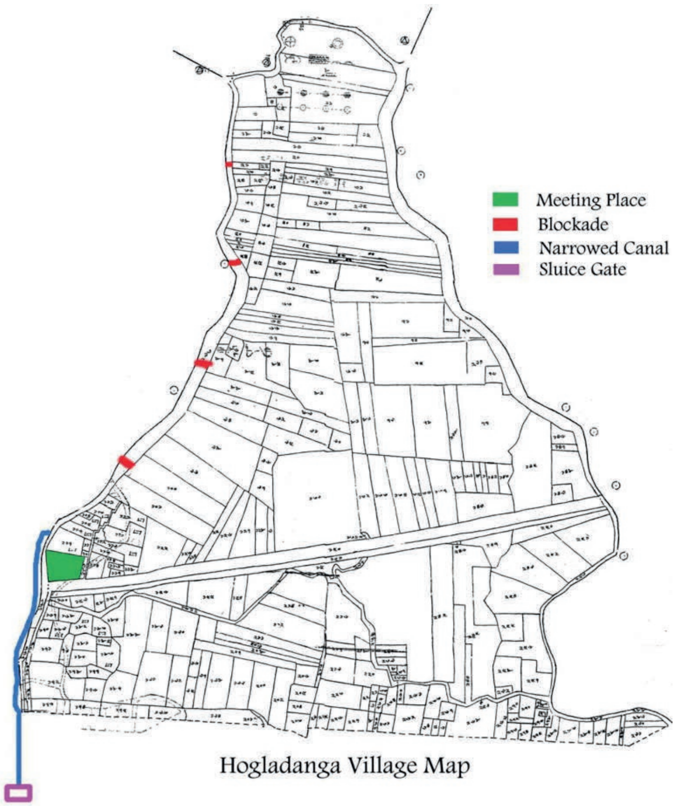


Figure 4.9 Map showing the location where the canal has narrowed (Blue) in Hogladanga (Green). Factors responsible include the blocking of the canal with fences for fish cultivation (Red), and sluice gate mismanagement (Pink)(Map courtesy JJS, 2016)

Another problem faced by local fish farmers in Hogladanga were problems in the value chain. The report explained that although there are fish processing industries near Hogladanga, farmers could not sell their fish directly to them but needed to use a middleman. Furthermore, the price of dropped during the harvest season (November-December). The price was, according to local fish farmers, controlled by the syndicate of the fish processing company in order to increase profits. Residents felt the government needed to monitor and regulate the price in the fish farming industry (Jagrata Juba Shangha, 2016a).

b. Priority concerns in Hogladanga village

Next, Hogladanga ranked these problems in order of importance. The prioritization of local problems identified three potential problems that could be addressed through the next steps of the APIA. They included access to drinking water, canal encroachment, and urban waste disposal. Problems concerning access to drinking water supply in Hogladanga stemmed from the lack of sufficient tube-well infrastructure to access groundwater. In Hogladanga, public tube wells are installed by the DPHE, following the approval by a Water and Sanitation (WATSAN) committee at the sub-district level. However, residents had failed to successfully get additional tube-wells approved by the committee and therefore, needed to rely on just a few-functioning tube-wells. Canal encroachment problems were the result of illegal filling of the canal by musclemen as described earlier in this section. Hogladanga's waste management problem was due to KCC's use of an area right next to the village as a landfill (Fig. 4.10).

In this research, the problem of access to drinking water supply was taken up for further analysis with the APIA. In addition to being an important concern for the community, the problem aligned well with the objectives and focus of the Shifting Grounds project. The project expected to offer valuable insights (e.g. groundwater models) to support problem solving. Moreover, waste management and canal encroachment problems were eventually taken up in other ways through the NA process.

For the waste disposal problem, JJS assisted the village in presenting their concerns to the government. For this, a NA workshop was planned where Hogladanga could discuss the problem and potential solutions with representatives of the urban administration. To support the discussion between the community and government, a field visit in 2017 was partly used to research the ongoing waste management programs of KCC. The findings were then presented to the community as part of a brief. Subsequently, KCC officials committed to take steps to deal with the odour problems of the nearby waste dumping site and in the future locate new locations for waste disposal (Jagrata Juba Shangha, 2017).

Figure 4.10 Burning of waste at the landfill near Hogladanga. (Top) Trucks brining waste from Khulna city; (Bottom) Burning of waste (Photos courtesy Gomes, 2017)

Meanwhile, the canal encroachment problem was proposed to representatives from 'Blue Gold', a Dutch-Bangladesh program active in the Khulna region. Reports from JJS in November 2017 indicated a positive expression of interest to undertake canal dredging activities (Gomes, Hermans, & Thissen, 2017). The progress reported with regards to canal encroachment and waste management, demonstrates how local interventions facilitated by the project partner supported problem solving, despite not being pursued for further analysis using the APIA.

c. Definition of problem boundaries

The boundaries of the water access problems went through several iterations over the course of this research. Early NA meetings revealed the existence of a domestic water access issue. This was the initial problem boundary. It was much broader and included both drinking as well as other household water uses such as cooking, bathing, washing etc.

Following the 2015 pre-scoping visit, problem boundaries were revised. This was due to the discovery of spatial and temporal changes in water supply problem. The definition of rural and urban boundaries, meant that water access was likely to change in the near future due to the expansion of urban boundaries. For this reason, it was important to consider not only the existing problem situation, but likely scenarios that could arise in the future.

The 2015 field visit also highlighted an important distinction between drinking and domestic water access. Problems concerning water access were more severe for drinking water purposes than domestic water uses. Residents who were interviewed were less strategic about the sources used for domestic uses, unlike drinking purposes. NA reports towards the end of 2017 also confirmed this. Furthermore, poor groundwater quality was later discovered to be significant in the water access problem. The negotiation plans for addressing drinking water access showed that in addition to a lack of sufficient drinking water infrastructure (specifically, public tube-wells), drinking water quality was equally important. By comparison, households were less concerned about the quality of domestic water sources. Therefore, both infrastructure and water quality aspects had to be considered while examining Hogladanga's water access problem. These findings were used to revise the problem boundaries.

Yet another adjustment to the problem boundary was made in later stages of this approach. Over time, NA reports and the 2017 field visit gave the impression that community knowledge about the formal institutional (and actor) arenas was weak. Part of the solution space was expected within these formal arenas, making it worthwhile to spend more time with the community to be familiarized with them. Focusing solely on the operational or informal arenas, would limit the range of solutions considered by the community. Therefore, subsequent steps of the approach include these formal, higher-level arenas and the strategic behaviour within them. In this way, the institutional analysis centres around the problem solving gaps of Hogladanga residents. Further details regarding these revised problem boundaries are elaborated in chapters 5, 6, and 7.

4.3.3 Discussion of results from Steps one

Results from step 1 offers insights about problem understanding (by the community as well as broader analytical insights), the methods and process used in step 1. The following sections discusses these inferences using the evaluation framework of the APIA described earlier in chapter 3 (Section 3.4).

a. Community's understanding of local problems

The problem identification stage provides Hogladanga with a clear definition of their drinking water problem. These insights offers direction for the institutional mapping that follows in step 2. Based on their problem definition, Hogladanga faced a safe drinking water access problem.

Problem identification led to the realization that both infrastructure access and water quality are part of the community's drinking water problem. It also highlights the dynamic nature of the problem, given the likelihood of urban expansion from nearby

Khulna city. Understanding the existing institutional context of the problem is useful as it serves as a baseline scenario for comparing alternatives later on. Besides this, the future situation is also important to consider given the results from step 1. These findings shape the scope of the institutional analysis in step 2.

b. Analytical insights: Characteristics of peri-urban problems in Hogladanga

Step 1 also offers more general research insights into the nature of problems faced by peri-urban communities like Hogladanga. First, it highlights the wide variety of problems affecting the lives and livelihoods of peri-urban residents. Moreover, these problems are not restricted to one particular source of water. Rather, they permeate into all existing water sources in different ways. In this context, the source of water varies based on its use, however, both surface water and groundwater are changing as a result of peri-urban activities. This points to a growing water crisis in this peri-urban region of Khulna.

Hogladanga's problems are cross-sectoral. Land development for example, affects access to surface water for fish farming activities when development occurs in close proximity to local canals. Meanwhile, waste disposal of KCC in peri-urban land adjacent to this village, is blamed for the contamination of local water bodies. Similarly, mismanagement of sluice gates and canal sedimentation during the monsoon period also affects drainage in the village.

Although many water related problems were found to exist in Hogladanga, some are more directly linked to water resources while others, appear to be indirect associations or causal factors. For example, problems listed under the urbanization category, shows how urban processes (e.g. meeting urban water demand), negatively affect peri-urban areas in terms of competition for water access respectively. Similarly, there is link between disposal of urban waste and water quality issues in peri-urban areas, situated in close proximity to landfills. These problems can also be arranged along a space-time continuum. They relate to peri-urban dynamics. For example, climate change is believed to affect rainfall patterns. However, in the future, the severity of this problem could increase. Similarly, urban expansion is likely to occur in the near future when city boundaries are re-drawn. On the other hand, canal encroachment problems were already existing problems as competition for land and water resources is commonly associated with the dynamics of peri-urban areas.

These findings highlight the complexity of peri-urban problems, given that many of them are inter-connected. Peri-urban residents from Hogladanga were aware of this, as evidenced from the way these problems were described during meetings. For example, the expansion of fish-processing industries was claimed to be responsible for the diversification of peri-urban livelihoods. However, these livelihoods were, at the time, not threatened by the growing competition for land and water resources (eg. canal encroachment) and the fish-farming value chain. Residents also explained that drastic changes in water availability over time from delayed monsoons can affect water security in the dry season, and cause water logging during the monsoon period. It suggests that peri-urban communities are, to some extent at least, aware of these complex relations evidenced by the fact that these were mentioned despite lines of inquiry focusing on water management.

c. Evaluation of methods and facilitation process in step one

Implementation of step one benefitted significantly from local NA activities. Both workshops and small mango tree meetings allowed for regular discussions with the community to identify and prioritize problems (Fig. 4.11). This was essential for supporting active engagement of Hogladanga residents in step 1 of the APIA. The implementation of step 1 in this way also helped integrate the research and community level activities. The timeline in Fig. 4.7 reflects this. It allowed for the research activities to be guided by the inputs from the local NA process.

Figure 4.11 Discussing the inventory of problems during mango tree meetings in Hogladanga (Photos courtesy Jagrata Juba Shangha, 2016)

The time-line of activities from step 1 further shows that problem identification is an intensive process. In peri-urban villages like Hogladanga, sufficient time must be spent to build rapport with the community and conduct regular discussions before the community's main problems become visible and well-defined. This in part also stems from the complexity of peri-urban problems. In this case-study, problem boundaries were re-defined several times over the course of this intervention based on new information. For example, Hogladanga's water access problem was, at first, considered to be a domestic problem until further discussions discovered that it was actually largely about drinking water supply. Similarly, apart from infrastructure, water quality aspects of this problem were found to be equally important. At the same time, field research discovered the dynamic nature of this problem due to urban expansion. The implementation of step 1, therefore shows how a thorough first step in the APIA can lead to a better problem definition. The next chapter of this thesis, examines step 2 - the mapping of institutions in Hogladanga's drinking water problem.

Chapter Five

Applying Step 2 in Hogladanga village: Institutional Mapping


Photo courtesy: Jagrata Juba Shangha (2016)

5.

APPLYING STEP 2 IN HOGLADANGA VILLAGE : INSTITUTIONAL MAPPING

This chapter builds on the following journal and conference papers: Gomes, Hermans, & Thissen (2018) - sections 3.2, 5.2 and 6; Gomes & Hermans (2018)- *sections 3,4 ,5; Gomes, Hermans, & Thissen (2018) - sections 3,4,5*

In the preceding chapter, activities and results from step 1 of the APIA application in Hogladanga village were discussed. Based on this, chapter 5 describes the application of step 2 which involves mapping the institutional context of Hogladanga's drinking water problem. The structure of chapter 5 is as follows. Section 5.1 explains the methods used to facilitate institutional mapping and analysis. Next, section 5.2 describes the results of step 2. Results from the institutional analysis are differentiated into the initial (formal) situation (section 5.2.1), the existing (informal) situation (section 5.2.2) and a future (urban) situation with both formal and informal institutions (section 5.2.3). Section 5.3 evaluates these insights in terms of community, problem understanding (Section 5.3.1), analytical insights (Section 5.3.2) and finally methods and process used in step 2 (section 5.3.3).

5.1 Methods used for institutional mapping in Hogladanga village

5.1.1 Data collection methods

Institutional analysis was undertaken using both primary and secondary data. Secondary data collection and analysis began at the start of this project in October 2014. Secondary data sources include stakeholder workshop reports from the proposal development stage (2013), government websites, institutional documents, and other published research conducted in this context. A stakeholder analysis was performed using this data, which served as a basis for planning the pre-scoping visit in 2015. The result of this stakeholder analysis can be found in (Gomes, 2015c).

A summary of primary data sources is shown below in Fig. 5.1 which includes field visits and NA meeting conducted by JJS. Chapter four has previously described the primary data collection activities during the pre-scoping visit (in sub-section 4.3.1). Not only was this visit used to prepare an inventory of local problems, it was also designed to fulfill the analytical objectives of step 2. Therefore, meetings were used to identify the key formal and informal rules concerning different problems in peri-urban Khulna, one of which was drinking water supply and water quality. Data collection activities were undertaken at the local village level up to the state level decision-making arenas.

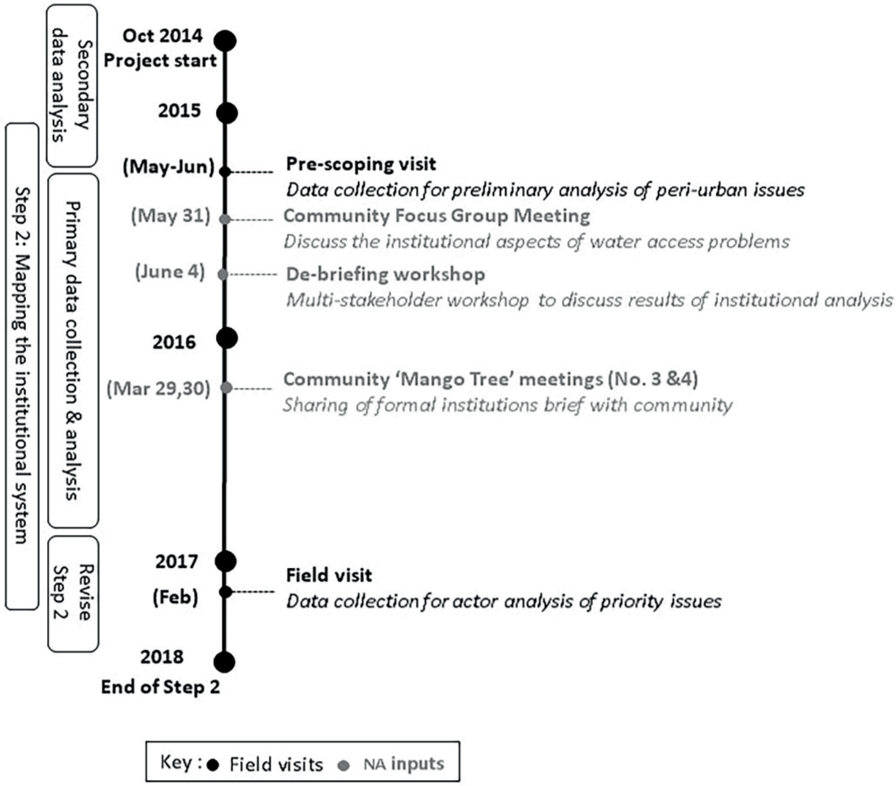


Figure 5.1. Timeline of activities in step 2: Mapping the institutional system

A second field visit, was then conducted in February 2017. It provided additional details and refinement of the institutional analysis. The information led to further revisions in steps 1 and 2 (in terms of problem boundaries and institutional mapping), in preparation for strategic analysis in step 3. Further details about this field visit are provided in chapter 6 (section 6.1.3). In this chapter, the results from step 2 are based on the primary data from the 2015 pre-scoping visit only.

5.1.2 Mapping the variables of the IAD framework

The pre-scoping visit (2015) served as an opportunity to test the IAD framework, as shown previously in chapter 3 (Fig. 3.2), to structure data collection and analysis in step 2. Therefore, interviews and FGD's were designed around the components of the IAD framework. For this, indicators were created for each component in the IAD framework. From these indicators, specific interview questions were prepared (Appendix 3). The set of questions were customized based on relevance and their framing for different stakeholder groups e.g. community, government and civil society representatives.

Primary and secondary data was then coded in Excel around the main components of the IAD framework. First, the action arenas were organized into operational, collective-choice, and constitutional levels. Second, formal and informal institutions were coded for each level. Third, participants in each action arena were coded. This was done by identifying the actors associated with one or more rules, their actions (referring to how they implemented the rule), and action conditions. Other contextual variables such as biophysical conditions and community attributes were also coded. This dataset provided an overview of Hogladanga's water access problem.

From this, it was possible to identify different stages in the evolution of Hogladanga's drinking water problem. For each stage, a snapshot of the action situation was mapped using the IAD framework. Additional details about the action arenas (structural elements) including the participants, positions, actions, control, information, costs & benefits, and potential outcomes were coded, providing an additional level of detail in the institutional analysis. Here also, a differentiation between institutional levels was maintained throughout the coding process. During the data analysis, other previously unknown institutions were highlighted, requiring additional desk research using secondary sources and data collected during the follow-up field visit in 2017. This data was also mapped around the IAD framework and analysed.

5.1.3 Facilitating capacity building in Step two

a. De-briefing workshop

Community participation during step 2 was facilitated in two different ways. First, Hogladanga residents participated in the discussions during both field visits (in 2015 and 2017). During the pre-scoping visit, an FGD was held with 27 residents from Hogladanga village (13 male and 14 female). They represented residents from different ages (e.g. students, retirees), and occupations (agriculturalists, labourers, teachers, and housewives). Discussion topics at this time can be found in the interview design for community stakeholders (Appendix 3).

Towards the end of the pre-scoping visit, a de-briefing workshop was held in Khulna city on June 4, 2015 (Fig. 5.1). It was attended by 16 participants representing government, civil-society, and three different peri-urban communities from the Khulna region. From Hogladanga, seven residents attended this meeting, all of whom had previously attended the FGD held in the village. The workshop started with each participant introducing themselves, their organization or village, and their occupation. The workshop facilitator, ATM Zakir Hossain (from JJS) gave a brief introduction to the Shifting Grounds project and the field work conducted by the researchers earlier that month. Results of the institutional analysis were then discussed with the workshop attendees. At this time, the institutional analysis of several problems were presented by the author based on the information collected during the field visit. One of the problems discussed was peri-urban water supply and groundwater quality. For each problem, details about the institutional context, problem dynamics, objectives and roles of the different actors, and possible solutions were shared. Participants were asked to comment and reflect on the results as part of a group discussion facilitated by JJS (Fig. 5.2). This half-day workshop was conducted entirely in the local language with translation provided by Mr. Hossain.

Figure 5.2. Multi-stakeholder de-briefing workshop in Khulna in June 2015 (Photo courtesy Jagrata Juba Shangha, 2015)

b. Institutions brief

A brief about the key institutions related to water management in peri-urban Khulna was developed for the community in early 2016. The brief focused on access to water for both drinking and livelihood purposes. Relevant formal institutions were briefly explained along with references to the specific articles from policies, laws, and ordinances where they are codified. Initial drafts of this brief were also discussed with project partners to further simplify the language, and thereafter translate the texts into Bangla for use in Hogladanga.

The brief covered the following topics relating to water access: ownership of water resources, rights for accessing water resources, responsibilities for water resource management, water supply responsibilities, the community's role in water management, and the procedures for obtaining a public tube-well. The latter was also explained using an infographic.

A community and facilitator version of the brief was developed. The facilitator version included suggestions to guide the discussion of the brief with the community. A separate evaluation form was also created and translated by JJS into Bangla. The evaluation covered the usefulness of the brief to the community, clarity of the information provided, participants familiarity with the information in the brief, missing information needed by the community, impact of the brief on the community's understanding of water related institutions and suggestions for improvement.

The brief was discussed several times during the third, fourth, fifth, and sixth Mango Tree meetings in Hogladanga on March 29, 30 and June 18, 19 of 2016 (Fig. 5.3). Evaluation results were thereafter translated and shared with the author.

Figure 5.3. Facilitators presenting the institutions brief to Hogladanga residents (Top) ; Filling of the evaluation forms (Bottom) (Photo courtesy Jagrata Juba Shangha, 2016)

5.2 Results of institutional mapping in Hogladanga village

Step 2 centred around drinking water access, and in particular, drinking water infrastructure (supply) services. In other words, water quality was not explicitly part of the problem boundaries at the time this analysis was performed but were briefly included in the analysis. Previous iterations of step 2 have since been published in (Gomes & Hermans, 2016b, 2018; S. L. Gomes et al., 2018b), although the analysis in these papers also includes other peri-urban communities that faced a same type of problem. In this section, only results from Hogladanga village are presented.

During the analysis, three turning points were identified in Hogladanga's drinking water access problem. They are referred to below as the initial (formal) situation, existing (informal) situation, and future (urban) situation.

5.2.1 Initial (formal) drinking water supply situation in Hogladanga

Like most rural areas of Bangladesh, groundwater forms the primary source of drinking water in Hogladanga. As shown below in Fig. 5.4, there are different kinds of exogenous variables affecting drinking water availability in Hogladanga. One of them is the biophysical conditions. Hogladanga faces seasonal groundwater scarcity, caused by declining groundwater levels during the summer season. Moreover, threats to groundwater quality include iron and arsenic contamination. The second exogenous variable are community attributes which relates to the role of women in water collection, increasing demand for drinking water due to migration, and at a higher level, limited political connections of the community within the government administration. These are discussed further below.

Drinking water supply in Hogladanga is defined by a number of formal rules within the institutional context (Fig. 5.4). As mentioned previously, Hogladanga village is formally part of the rural jurisdiction. This means that drinking water supply is managed by rural service providers. As per (1998) National policy for safe water supply and sanitation, this is the responsibility of the Department of Public Health Engineering (DPHE) (Local Government Division, 1998). The process of allocating public tube-wells is defined by two institutions in particular. Section 3, article 2 of the Bangladesh Water Act (2013) states that access to potable water for hygiene as the highlight priority right (Ministry of Law, Justice and Parliamentary Affairs, 2013). Section 8.1 of the National policy for safe water supply and sanitation (1998) also gives priority to under-served rural areas (Local Government Division, 1998). The actual installation of public tube-wells is outsourced to a contractor. Contractual rules specify the conditions under which mechanics are paid. It depends on whether the installed tube-well meets the drinking water quality requirements of DPHE (Gomes, 2015c).

Together, these exogenous variables define the dynamics within the action arena. Fig. 5.4 specifies the steps taken for a Hogladanga residents to obtain a public-tube well. Based on the formal rules, the strategy to obtain drinking water supply is to apply for a public tube well by submitting an application at Jalma union (Steps 1 in Fig. 5.4). In Hogladanga, applications are typically submitted at a village level. As mentioned earlier, DPHE is the lead government agency in rural water supply development. DPHE works in coordination with local government units. For this, there is a Water and Sanitation (WATSAN) committee located at the sub-district level. The committee is headed by the sub-district chairman with representatives from local unions, DPHE (member secretary), and representatives from several other government departments including fisheries, agriculture, education, family planning. (Gomes, 2015b; Local Government Division, 1998). It’s role is to supervise all water and sanitation related activities within the jurisdiction of this sub-district (Local Government Division, 1998).

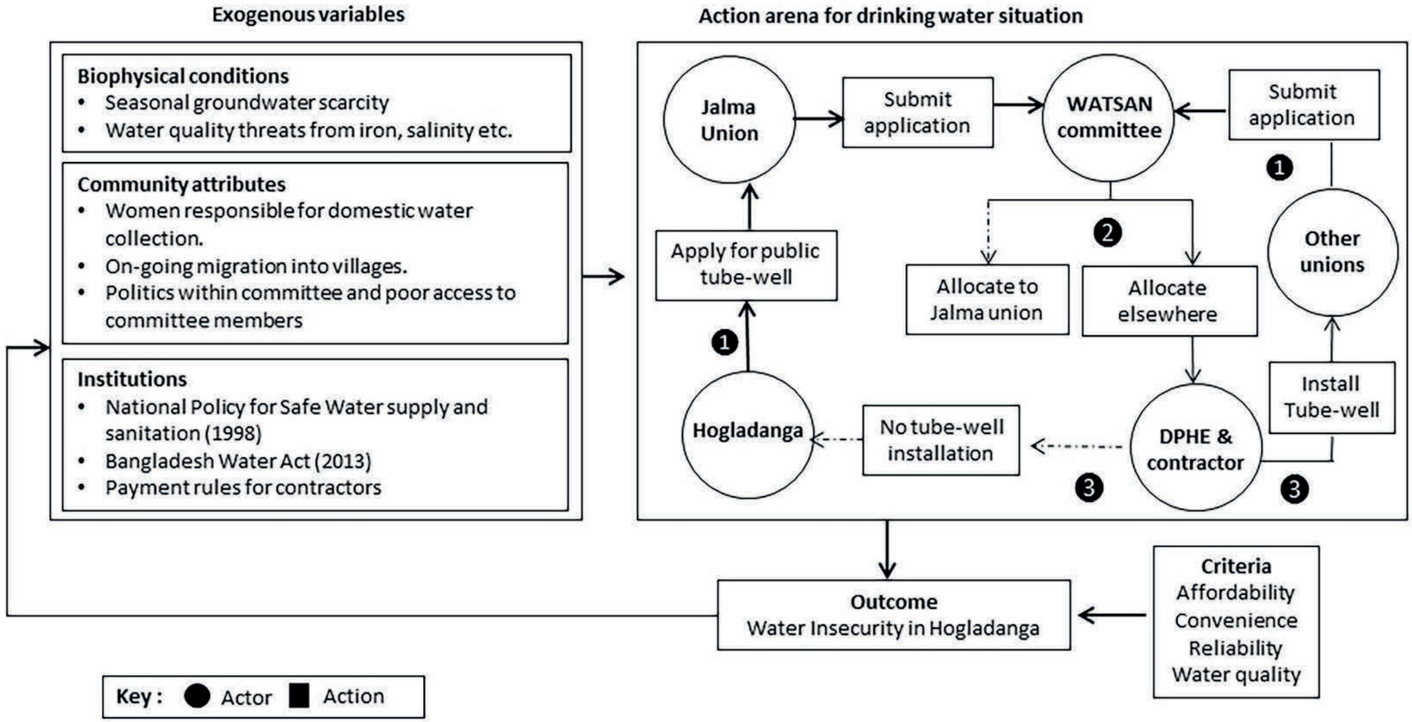


Figure 5.4 Initial (formal) drinking water situation in Hogladanga (Steps 1,2,3 outlines the key interactions occurring within the action arena and results of these interactions)

As per formal institutions, applications for public tube-wells from villages like Hogladanga requires the approval of the WATSAN committee. Jalma union forwards tube-well applications to the sub-district level (Step 2 in Fig. 5.4). However, Jalma is one of seven unions within Batiaghata sub-district. Step one in Fig. 5.4 shows that other unions can also submit applications. The committee must decide which unions receive licences. This is decided during monthly meetings by committee members. Allocation is supposed to be based on specific criteria. These criteria are not explicitly mentioned in the Bangladesh Water Act (2013), and local administrative offices were unable to share operational guidelines which included this. However, interviews with DPHE and committee members confirmed this to be the official procedure (Gomes, 2015c). Furthermore, the (1985) Groundwater Management Ordinance lists criteria for abstracting groundwater. They include assessment of local aquifer conditions, distance from neighbouring tube wells, beneficial area, effect on existing tube wells, and suitability of the selected site (Bangladesh Agricultural Development Corporation, 1985).

Once a license is approved by the committee (Step two in Fig. 5.4), then tube-well installation activities can commence. This is the responsibility of DPHE. A local contractor (mechanic) is typically hired to install the tube-well (Steps three in Fig. 5.4). Public tube-wells in this village are all hand-operated and at a depth of approximately 400-450 ft. (Gomes, 2017b). The costs of public tube-wells are subsidized by the government so applicants pay a fraction of the cost (approximately €53 per tube well). Thereafter, residents do not pay for volume of groundwater pumped, however, they are expected to bear the costs of operation and maintenance (O&M) (Local Government Division, 1998). By comparison, the costs of a private tube-wells ranges from €200 to nearly €800 depending on the depth, excluding O&M fees (Gomes, 2015c). In Hogladanga at least, the strategy to invest in a public tube-wells stems from its affordability. Although household income statistics for Hogladana village is not known, the average reported monthly income for rural areas of Bangaldesh is €192 (PPRC, 2016).

Drinking water quality is also part of water service provision in peri-urban Khulna, the responsibility for which is borne by DPHE. Water quality is checked at the time of tube-well installation. If test results are not within DPHE's acceptable limits, then an alternate tube well is provided (at no additional cost) at another location. It is recorded by DPHE for future reference during site selections (Gomes, 2015c).

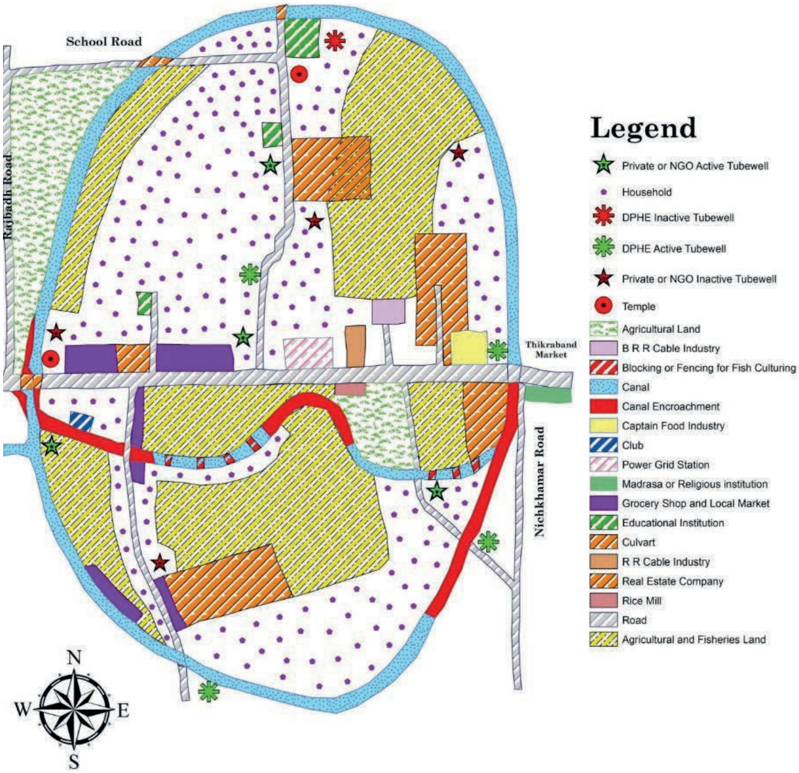


Figure. 5.5 Social map of Hogladanga village indicating the locations of the two funtional DPHE public tube-wells (Green asterisk) in Hogladanga village. Also shown are inactive DPHE tube-wells (Red asterisk), and Private or NGO tube-wells (Active-Green star, Inactive- Purple star) (Photo courtesy Jagrata Juba Shangha, 2017)

This formal mechanism for drinking water supply has failed to result in satisfactory outcomes for Hogladanga. Residents care about affordability, convenience, reliability, and water quality when it comes to drinking water (Fig. 5.4). However, peri-urban residents are unable to meet their drinking water needs due to insufficient public tube-wells. In 2015, there were only 2 operational public tube-wells installed for the entire village (Fig. 5.5). As a result, local women have to spend a lot of time and walk a significant distance to collect water. Lack of sufficient drinking water infrastructure has been a concern for several years. Interviews in 2015, for example, showed that in the last five years only one tube-well application was approved. This is true not only for Hogladanga village, but elsewhere in Jalma union (Gomes, 2015c). The outcome of this situation is that of drinking water scarcity in Hogladanga.

5.2.2 Existing (informal) drinking water supply situation in Hogladanga

Given the gaps in formal institutions, residents from Hogladanga village have adopted alternate strategies to manage their drinking water needs. For this, they created mutually agreed upon informal rules. These rules coordinate the practices of household water collection by Hogladanga residents (Fig. 5.6). Besides the rules, community attributes also play a role in this drinking water supply situation. For example, pre-existing health conditions of some households restrict the tube-wells they can utilize for drinking water, as the quality of groundwater is found to vary between them.

These exogenous variables define the new action arena in Hogladanga's existing drinking water situation. One strategy for the village is to continue applying for more public tube-wells from the union council (Action 4 in Fig 5.6). In the interim, locals share the existing public tube-wells (Action 3 in Fig. 5.6). Women are typically the ones responsible for household water collection. They have developed a simple mechanism to share the few, existing public tube wells. A queue system is followed (first come first serve) while waiting to collect drinking water everyday (Gomes, 2015c). Operation and maintenance costs are also shared between households. People contribute whatever they can afford (ranging between €0.05 - €2.08) as needed. It is typically someone from the village who conducts the repairs (Gomes, 2017a).

Other households with sufficient financial means have invested in private tube-wells (Action 2 in Fig. 5.6). In the village, there are around 20 privately owned deep tube wells, however, most of them are no longer functioning due to poor water quality as shown below (Fig. 5.7a). At the time of this research, interviewed residents relied upon 3-4 private tube wells (Fig. 5.7 b,c,d). These tube-wells are typically between 380-480 ft. (Gomes, 2017a; Islam, personal communication, January 27, 2019). Shallow tube-wells (380-400 ft.) cost around €260, while another (480 ft.) was more than double (approximately €625) as the first installation attempt was unsuccessful (Gomes, 2017a).

These tube-well owners also act as informal drinking water providers for other households in the village, offering to share the use of the wells for free (Action one in Fig. 5.6). One such shared private tube-well was used by as many as 40-60 households from Hogladanga and other neighbouring villages that visit by bicycle. Operation and maintenance costs are also covered by the owners themselves. This typically ranges between €2.08 and €5.21 BDT per year (Gomes, 2017a). This has provided an interim solution to the problem.

A household's preference for a particular groundwater source is motivated by several factors (Fig. 5.6). Water quality is obviously an important factor. In general, locals highlight iron and arsenic contamination, depending on the aquifer layer as well as declining water tables felt particularly in years with delayed monsoons (Gomes, 2017a). The quality of groundwater in public and private tube-wells varies in the village. Similarly, an NGO funded tube-well relatively close-by has salinity and iron issues. NGO funded tube-wells do exist, but are less common and therefore not included as a signficant action possibility for households in Fig. 5.6. Those with pre-existing health issues, prefer private tube wells of a deeper depth. One such option exists, and is believed to have the best quality groundwater in the village.

Others use DPHE tube-wells out of convenience. Thus, distance is also important. One such DPHE tube-well is used by nearly 100 families, so the time spent collecting water is significant. Depending on the distance from the well, women can spend between 40 - 60 minutes each time. Furthermore, water is typically collected as many as three times a day (Gomes, 2017a).

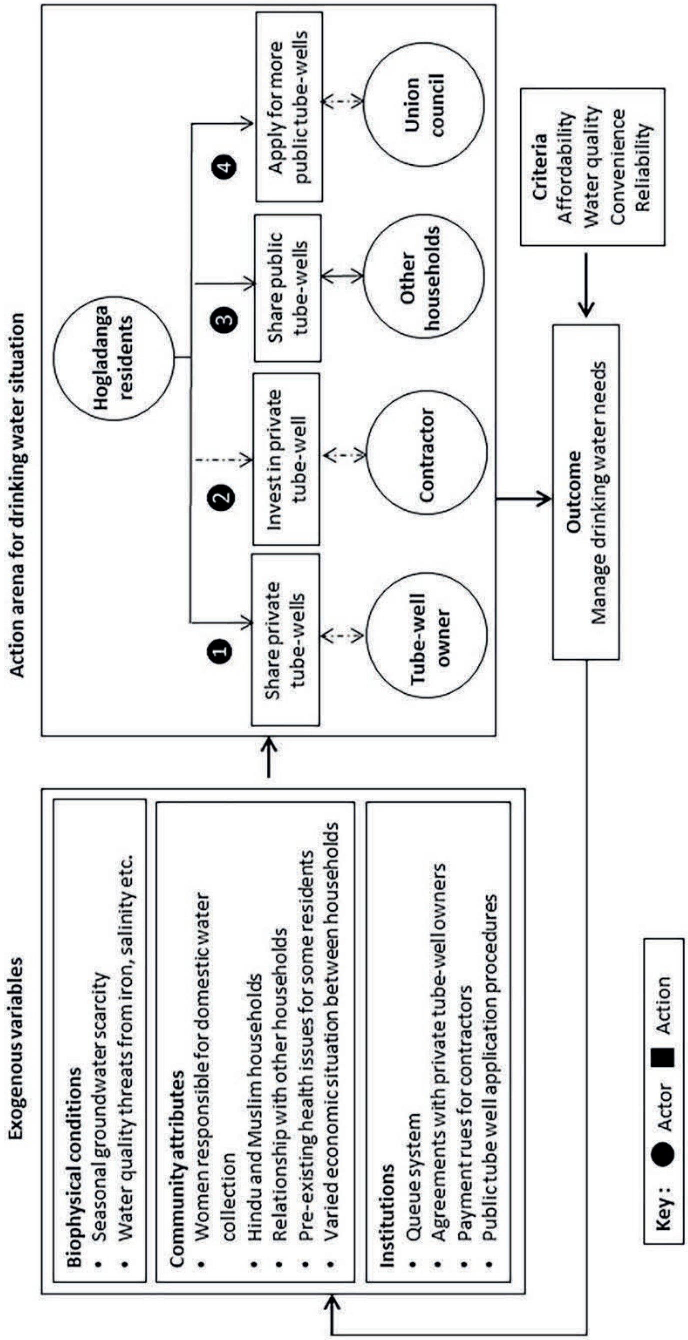


Figure 5.6 Existing (informal) drinking water situation in Hogladanga (Steps 1,2,3, 4 outline the key interactions occurring within the action arena and results of these interactions)

Figure 5.7 (clockwise from left) Private tube wells in Hogladanga: (a) failed private tube-well installations; (b,c,d) operational private tube wells (Photos courtesy Gomes, 2017)

Affordability of water supply is also important. Not everyone can afford private tube wells. Previously (around 2002) households had pooled their resources (approximately €312) for a private tube-well. However, the water was high in iron so it could no longer be used for drinking (Gomes, 2017a). Similarly, sharing of private tube-wells has its own challenges. For example, religious differences between tube-well owner and another local household are believed to sometimes create issues when it comes to water sharing. Moreover, access to private tube-wells is restricted when the owner is away (Gomes, 2017a). These examples show that reliability of drinking water supply is also important. The preference for each of these criteria, however, varies between households depending on the economic situation and their location in the village.

This existing (informal) situation shows how Hogladanga has adapted to the gaps in formal institutions. While continuing to apply for public drinking water infrastructure, interim strategies are used. Local women highlighted that although they are able to manage with the informal rules, the installation of an addition 2 - 4 public wells is preferred (Gomes, 2015c). Community negotiation plans around this issue called for 4

- 5 public tube wells at 1000-1500 ft. in depth to be installed, further affirming this view (Hossain, Huda, & Islam, 2018).

5.2.3 Future (formal and informal) urban drinking water supply situation

A future change in the drinking water situation is expected due to urbanization. Currently, Hogladanga lies outside the jurisdiction of Khulna City Corporation (KCC). However, with urban expansion, future changes to the institutional context are expected (Fig. 5.8). Currently, KCC jurisdiction covers 45.65 km^2. In 2007, KCC submitted a proposal, followed by revision in 2014 to extend city boundaries from 45 km^2 to 114 km^2 based on the Khulna master plan (Gomes, 2015c). If and when this proposal is approved by the central government, nearby peri-urban areas like Hogladanga will become part of Khulna city, and within the jurisdiction of KCC. It is currently not known, which areas are included in the latest expansion proposals. However, given that Hogladanga is situated only 7 kms away from the existing boundary, it is likely that the village will eventually be absorbed by the urban jurisdiction, if not in the current proposal, then in a future one.

When this happens, Hogladanga can see a change in formal institutions from rural to urban. This will affect the drinking water supply services available to them. In Khulna city, drinking water supply is the responsibility of the Khulna Water Supply and Sewerage Authority (KWASA). Their operations are based on the Khulna WASA Act (2008) (Fig. 5.8). KWASA is responsible for construction, O&M of WATSAN infrastructure which includes piped connections and around 10,000 tube wells for Khulna's 1.5 million residents (KWASA, 2013a). KWASA has a goal of achieving 100% water supply coverage 24 x 7 by 2020 (Gomes, 2017a; KWASA, 2013b).

Drinking water supply within this action arena starts with the strategy of KWASA to extend piped water supply to newly urban areas of continue installing public-tube-wells (Step one in Fig. 5.8). As of 2015, 95% of water supply in Khulna city was from groundwater resources via private and shared tube-wells (Gomes, 2015b). 85 groundwater pumping stations supply around 140 million liters/day (MLD) from aquifers at a depth of approximately 984 ft. (Gomes, 2017a). Only 5% was from other sources such as surface water treatment plants. Moreover, KWASA is facing a supply gap. Estimated demand in 2015 was around 240 MLD but supply was only 112 MLD, which is 47% of total water demand leaving underserved areas to rely on private shallow or deep tube wells (Step 2 in Fig. 5.8) (Gomes, 2015c).

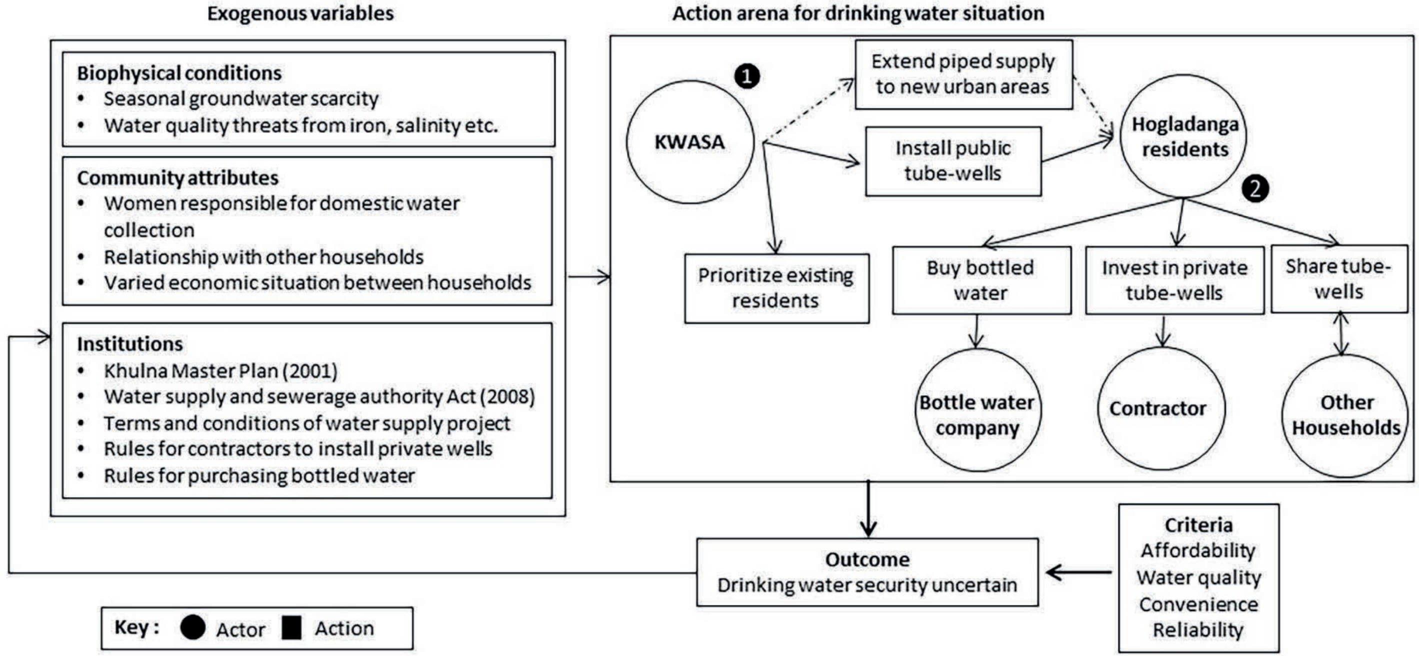


Figure 5.8 Possible future (formal & informal) drinking water situation in Hogladanga (Steps 1,2 outline the key interactions occurring within the action arena and results of these interactions)

Figure 5.9 Construction activities in Sarkarpara area of Khulna city as part of KWASA's new pipeline project (Photo courtesy Gomes, 2017)

As a result of this, KWASA is exploring a number of strategies to close the supply gap and reduce the pressure on groundwater resources. This includes an ongoing project to extend water supply coverage through surface water projects funded by donor agencies. For this a new surface water treatment plant with a capacity of 110MLD is under construction (Gomes, 2017a). It was expected to begin supplying water by 2018. This project also involves extending and replacing the existing piped network that is old and leaking (Fig. 5.9). At the time of this study, the city had 282km of pipelines. After this project, distribution network will be 650km (Gomes, 2017a). Metering of tube-wells began in 2013 for the purpose of calculating non-revenue water through creation of district metering areas (Gomes, 2017a).

KWASA is also in the process of revising its tariff structure to become more financially sustainable. In 2014, the cost for piped water supply was a flat rate of approximately €1.53 per month. This fee has increased over time. For example, it was only €0.71 in 2007. As of January 2017, 40% of households connections were metered and the tariff was €0.05 per meter[3]. However, even this rate only covered 80% of total production costs (electricity costs). So KWASA has plans to further increase the rate annually (Gomes, 2017a).

Although, these efforts are expected to improve the quality and supply volumes for existing Khulna city users, it is unlikely that these projects will benefit new areas.

KWASA's pipeline project described above are expected to meet existing KCC areas, but not future expansion or increase in population (Gomes, 2017a). For this, additional projects will be needed. Furthermore, KWASA is unable to extend water supply in new areas until basic infrastructure (e.g roads and houses) has been provided. With this uncertainty and rapidly rising costs of drinking water services, it is unlikely that the residents of Hogladaga will get access to better services in the near future.

In addition to formal drinking water providers, a future urban scenario is also likely to have informal drinking water suppliers. Besides sharing the already existing tube wells, residents can invest in private tube wells. Private installations are supposed to be regulated by KCC as per the groundwater management ordinance (1985) (Staff Reporter, 2017). Previously, KWASA did not strictly monitor licenses given the gap in water supply, but by 2017 this had changed (Gomes, 2017a). Khulna city is also serviced by around 20 private bottling companies. Some of these companies have a production of 4000 bottles per day, each 20 litres in capacity, which is sold for €0.52 BDT with a profit of around €0.15 per bottle. Together, these are potential drinking water supply options and outcomes that will exist in Hogladnga in the future, following urban expansion. Improved drinking water security is uncertain given the challenges described above.

5.3 Discussion of results from Step 2

This section evaluates the impact of step 2 on community's problem understanding, analytical insights, and lessons about the methods and proess followed in step 2. The following sections discusses this using the evaluation framework of the APIA described earlier in chapter 3 (Section 3.4).

5.3.1 Community's understanding of the institutions underlying their drinking water problems

The process of mapping the institutional context of Hogladanga's drinking water problem offers insights to the community at two levels- their understanding for formal rules, and the relationship between institutions and drinking water outcomes.

During field activities, it was discovered that Hogladanga residents could easily describe their informal operational level rules during meetings. This isn't entirely surprising given that they are the ones who develop and apply them on a day to day basis. On the other hand, knowledge regarding formal institutions and higher level action arenas in which these formal rules were developed was limited (Gomes, 2015c; Jagrata Juba Shangha, 2016d). A conceptual understanding of institutions and their role in society was also limited, as interviews and FGD questions about institutions often needed to be rephrased. This is based on local observations and experiences of the research team during community meetings. For this reason, emphasis was placed on improving residents' understanding of what institutions are and the most important formal rules. This was facilitated with the help of institutions briefs.

The institutions brief was considered useful to most of the participants and they were happy with the contents and information presented. The information on water management was partially new for the participants. For example, some participants were previously unaware that all water resources were owned by the state and that officially permission is needed before using groundwater and surface water resources (Jagrata Juba Shangha, 2016b).

Community's understanding about water management was changed during the discussion of institutions. It helped them realize that, according to the institutions, numerous public bodies exist in Bangladesh for water related issues, and that it is necessary to work with these departments for securing their water entitlements (Jagrata Juba Shangha, 2016b). Hogladanga water rights farmers group highlighted the fact that "water is their right and is the highest priority of the government is managing water resources of Bangladesh" to be the most valuable information they received thus far. Furthermore, they also learned that special attention for low income users and women is specified in the formal rules (Jagrata Juba Shangha, 2016c).

Apart from the discussion of formal rules, the multi-stakeholder de-briefing workshop provided an opportunity to improve the understanding of how formal and informal rules shape drinking water outcomes. In general, participants at this workshop recognized the information presented from the institutional analysis. Other peri-urban communities who attended this workshop (eg. Phultola residents) agreed that there should be one tube-well for every 10-20 households and questioned the implementation of the tube-well distribution process. Government representatives also confirmed the existence of a gap in the implementation of licencing rules due to politics and irregular meetings by the committee members. In this way, the de-briefing workshop helped the community zoom into the institutional context of their drinking water problem from the perspectives of different actors.

Hogladanga residents highlighted that they recognize the limits of their problem solving abilities. They explained that they are unable to request for assistance at the union level, as even the union lacks tube-well funds. And further that applications sent directly to the upazilla chairman, still failed to result in a positive outcome. For these reasons, they stressed that site selection should be based on the applications received, rather than political clout (Gomes, 2015a). It can be argued that through step 2, the community recognized the importance of certain formal rules for ensuring equitability with regards to drinking water supply.

The discussions also highlighted gaps in the institutional analysis. For example, in reference to groundwater monitoring, the Ministry of Local Government, Rural Development, and Cooperatives (LGRD&C) was absent despite their role drinking water services (Gomes, 2015a). Other peri-urban residents also stressed the importance of groundwater quality monitoring, given that most diseases are waterborne (Gomes, 2015a). This revealed the importance of groundwater monitoring, and therefore also, drinking water quality in the problem scoping. Interestingly, discussions revealed that the main challenge with groundwater monitoring stems from the limited capacity of government agencies. This view was shared by several government representatives at the workshop. They were aware that drinking water quality in Khulna city is perceived to be poor, with alternate technologies and surface water resources as the only solution to this problem (Gomes, 2015a). In this way, the institutional analysis prompted actors to think beyond the results that were presented, and identify other gaps in the analysis that were relevant but missing.

5.3.2 Analytical insights: The effect of peri-urban institutions on drinking water problems in Hogladanga

The analysis in step two reveals valuable insights about how institutional arrangements influence the drinking water outcomes and how peri-urban actors respond to these outcomes via institutional mechanisms, both now and in the future. In Hogldanga, drinking water supply is affected by exogenous changes in the biophysical, community, and institutional settings. These exogenous changes influence drinking water access in Hogladanga and marginalized local users from public drinking water infrastructure.

In peri-urban Khulna, drinking water problems stem from gaps in the implementation of formal rules. This is evident from the repeated failures of tube-well applications by Hogladanga residents. Residents are less confident, and thus dependent on formal rules. Thus, (formal) institutional function and credibility has been eroded over time. Outside this village, it is unclear whether actors consider the same rules as credible or not.

Instead of investing in institutional change, Hogladanga residents rely upon informal mechanisms to meet drinking water needs. Informal responses in the form of private tube-wells and tube-well sharing arrangements suggests that institutional change has either not been attempted or not been successful thus far. These informal responses highlight the importance of resources in effecting institutional change. Limited access and influence within the action arena (at the sub-district level) makes it difficult to influence formal rules or their implementation. Thus, solution finding in Hogladanga is similar to the satisficing approach as described by (Simon, 1972). Informal rules for sharing tube wells are most likely not newly devised rules, but existed and were used for other purposes. In other words, institutions from other arenas are utilized to mediate drinking water problems.

In the future, new formal (urban) rules will replace the previous rural institutions, but these also are unlikely to be more effective in areas like Hogladanga. Despite the emergence of new drinking water options, new urban residents may only be able to access them based on the conditions set by the service providers. Thus, the credibility of institutions depends on which actors stand to benefit at a given point in time. In this way, spatial and temporal variations in institutional function (and credibility) can be expected in peri-urban areas with regards to drinking water problems (Ho, 2014).

5.3.3 Evaluation of methods and facilitation process in Step 2

The IAD framework offers a useful template to structure and analyse institutions over time with respect to a particular problem. The analysis draws significantly from the underlying theories of the IAD framework, however, there are limitations in the IAD theories in explaining the process of institutional change. (Gomes & Hermans, 2018) highlight how the credibility thesis (Ho, 2013, 2014) and satisficing (Simon, 1972) adds value to the understanding of institutional change, particularly in peri-urban contexts.

Implementation of institutional mapping activities also offers lessons for this research. Through interviews and FGD's with numerous stakeholders from peri-urban Khulna, a detailed picture of the drinking water access problem could be obtained. However, admittedly, a few data gaps continue to exist. For example, the process of tube-well allocation followed in practice by the WATSAN committee. The research highlights multiple potential causes behind the village's inability to get their tube-well applications approved, however, it was not possible during the field visits to prove or disprove them. Especially the supposed inequitable tube-well allocation practices due to local politics. Interviewed members of the WATSAN committee either did not regularly participate in the meetings or wish to discuss this topic. It could very well be that formal service providers are simply unaware of the gaps in water services or changing drinking water needs of peri-urban areas due to the limited interactions with these more remote areas. On the other hand, it is also plausible that the funding (quotas) for tube-well provision at the sub-district level is simply insufficient to keep up with growing demand for groundwater or that the licensing processes is misused for political purposes.

Focusing capacity building on both the institutions and its relation to actor interactions and outcomes was also valuable in retrospect. The de-briefing workshop provided an overview of the institutional context in the drinking water problem. Yet, the community was still missing a conceptual understanding of institutions, especially formal institutions, for which the institutions brief was valued by the community, despite being initially challenging to understand. Focusing the brief on the formal institutions at different levels helped address this gap in knowledge. Similarly, using tube-well applications as a way to describe the rules, helped demonstrate the impact of formal rules on operational-level practices undertaken by the community, thus making it relatable. The use of infographics, also helped make institutions a less abstract concept for the community.

The information presented in the institutions brief was considered by majority of the participants to be easily understandable (Jagrata Juba Shangha, 2016a; Jagrata Juba Shangha, 2016b). Although other topics (e.g sanitation issues) were also discussed in the same meeting as the institutions brief (Jagrata Juba Shangha, 2016b). Therefore, the responses filled by participants in the evaluation questionnaire after the meeting may have included feedback on more than just the institutional brief about water management. Participants also commented positively on the presentation and language used (Jagrata Juba Shangha, 2016c). The contents in the brief was considered interesting and useful, however, participants found it difficult to understand and cover all the information in a single meeting (Jagrata Juba Shangha, 2016a; Jagrata Juba Shangha, 2016b). For this reason, the brief was discussed in a total of four meetings. This points to a need for separate capacity building sessions for different topics or alternate planning of such types of workshops.

This study, did not evaluate the long-term impact of the institutions briefs. It is unclear whether the materials were shared by the participants with other residents in the village in some way or featured in the preparation of the negotiation plans. Future research, can develop tools to measure and monitor wide outcomes of the APIA activities.

The other activity organized to facilitate research uptake is that of the de-briefing workshop. The decision to organize a multi-stakeholder workshop to discuss the results of step 2 was overall helpful as this brought the community and government actors together to openly share their reflections. The fact that other peri-urban villages facing similar problems also attended this workshop helped Hogladanga village residents feel more comfortable in expressing their opinions. However, as there was no formal evaluation conducted after this workshop, such observations cannot be confirmed by the participants. In the future, such activities should also be evaluated in the same way.

The questionnaire also covered workshop setting and facilitation, both of which were considered helpful in understanding the information and thus, positively evaluated. Participants were satisfied with the workshop contents but also requested additional details on institutions relating to agricultural water use (e.g. re-excavation of canals, where to communicate water logging problems etc) (Jagrata Juba Shangha, 2016a; Jagrata Juba Shangha, 2016b). This was expected, given that canal encroachment for example was also a concern in the community. This was outside the scope of this study, and due to time and resources constraints a similar brief on this topic was not developed. However, it goes to show that the community does benefit in some ways from short briefs about their institutional context.

The medium for discussing the result of step 2 can be improved. In the de-briefing meeting, a the IAD framework was used to visualize and summarize the analysis to participants by facilitators. However, slides had to be translated into the local language by a facilitator on the spot. This was unavoidable due to time constraints but should be done in advance for future applications. In retrospect, the structure of the de-briefing workshop could have also benefitted from a more interactive format. An alternative would be to separate participants into smaller groups to discuss different aspects of the drinking water problem (eg. Infrastructure, water quality, urbanization) and asked to map the basic elements around the IAD framework themselves. Future applications can explore this and other interactive workshop styles.

Photo courtesy: The Researcher (2019)

Chapter Six

Applying Step 3 in Hogladanga village: Strategic Analysis

6.

APPLYING STEP 3 IN HOGLADANGA VILLAGE : STRATEGIC ANALYSIS

This chapter builds on the following papers: Gomes et al. (2018) - section 4, (Gomes & Hermans, 2018)*- section 3, and Gomes, Hermans, & Thissen (2018a)- section 3.*

The institutional analysis from step 2 provided a system level understanding of Hogladanga's drinking water problems over time as a result of the institutional set-up. However, attention must also be given to the strategic behaviour occurring within actor arenas. Chapter 6 explains how game theory methods were used to facilitate this. This game theory analysis helped identify strategies for the community to address their drinking water problem.

The chapter is structured as follows. Section 6.1 describes the methods used to construct game theory models of the community's drinking water problem. Cooperative and non-cooperative game theory models are then described in section 6.2 together with the results of strategic behaviour analysis. A discussion of key findings in section 6.3 concludes the chapter, focusing first on potential solution strategies to relevance to the community followed by the evaluation of step 3 in terms of its impact on community problem understanding as well as methods and process related choices.

6.1 Methods used for strategic analysis in Hogladanga village

6.1.1 Defining the problem boundary for strategic analysis

Similar to the previous steps of the APIA, strategic analysis was an iterative process. Inputs from NA activities and the 2015 field visit contributed to the boundary selection and scope for the strategic analysis. Game theory models were constructed in early 2016 based on this. These initial models reflected the action situations described in chapter 5 and have since been published in Gomes et al. (2018).

By 2016, however, reports from NA activities revealed additional concerns that were not considered in previous problem definitions. This led to revisions in step 3. Several versions of the game theory models have been considered since then based on a combination of methodological constraints and analytical needs. In this chapter, only the results from the final model versions are described. It is not very useful to discuss each iteration as the emphasis is ultimately on the analytical insights the models provide with regards to Hogladanga's most recent definition of their drinking water problem. Instead, a brief description of the modelling approach and its evolution is provided below.

Initial game theory models of water access problems, included both domestic and livelihood water access as well as multiple water sources such as surface water, and rainwater. Once the problem boundaries were defined for drinking water access, subsequent iterations experimented with different ways to structure this problem. In one version, actors were grouped into different categories and included in the model. This was done to overcome the limitations of the number of players that can be considered for game theory analysis. Here, the model consisted of service providers (eg DPHE, KWASA), the community, and regulatory authorities (eg. Department of Environment (DOE), WATSAN committee). Not only did this approach over-simplify the problem, but differences between actors made it impossible to define the inputs for each category.

Another version focuses on the dynamic nature of the problem. Here, game theory models were designed to compare the short and long-term solution strategies. The kinds of strategies available under the existing and future problem situations differed, allowing for such comparisons. The goal was to help local communities to think beyond what solutions currently exist and if system changes in the future offer other, more favourable solution strategies.

Once negotiation plans created by the community highlighted the need for more insights into drinking water quality aspects, a third version was considered (Jagrata Juba Shangha, 2016e, 2017). This approach developed several models, each adding more complexity in terms of problem solving challenges and actors involved. The first model focused on the existing drinking water access problem, the second also considered water quality aspects, and the third incorporated (future) urban expansion plans. It was also possible to further differentiate between the institutional levels in all three games, and subsequent models experiments with this. The latter resulted in six different models with data gaps, that prompted a reflection of how results from step 3 would eventually be used by the community. This led to a deliberation over what kinds of insights into strategic behaviour were most relevant for Hogladanga's problem solving efforts. This led to the following scoping for analysis in step 3.

A timeline of modelling approaches is shown below in Fig. 6.1.

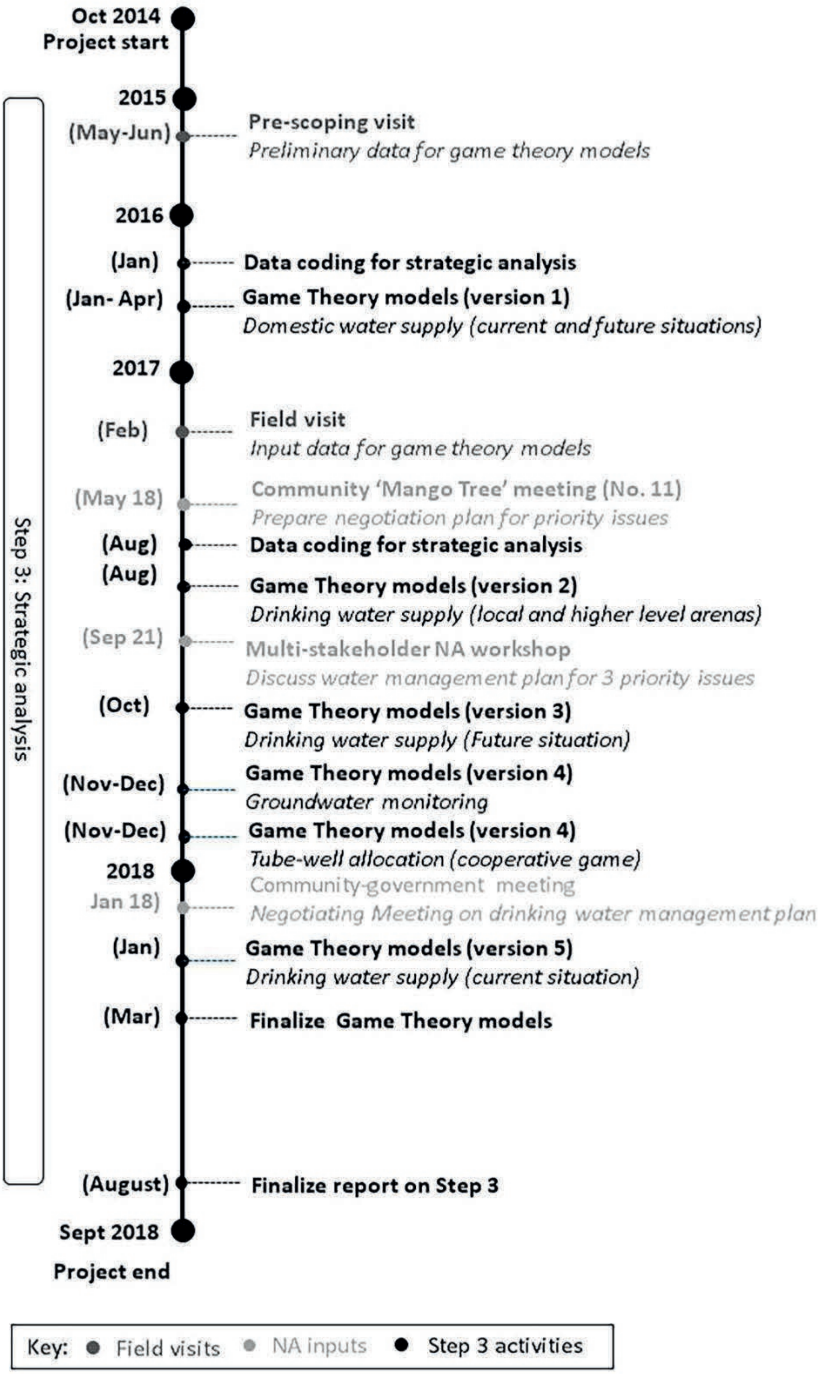


Figure 6.1 Timeline of activities in step 3: strategic analysis

6.1.2 Modelling approach for strategic analysis in Hogladanga

The focus for strategic analysis was on two institutional levels that were most relevant for problem solving by a marginalized community like Hogladanga. This included the operational level (village) and the higher collective choice arena (sub-district). Game theory models were constructed around these two institutional levels where the community was most likely to have access to for future problem solving and negotiations.

Using the APIA to support problem solving required Hogladanga residents to understand strategic interactions in both the infrastructure and water quality aspects of the problem. As the actors and their strategies differed in action arenas for infrastructure and water quality situations, these aspects of the drinking water problem were modelled separately. Previous interactions with the community showed that their familiarity with interactions relating to the process of obtaining drinking water infrastructure. Therefore, the model about drinking water infrastructure served as the baseline situation in step 3. A non-cooperative game theory model was constructed for the drinking water supply problem that existed at the time.

A second model was developed for the water quality problem. Field visits in 2017 highlighted the fragmented nature of groundwater monitoring efforts in Khulna where coordination was considered to be the biggest roadblock in securing sufficient data to manage this resource. As groundwater was the primary source of drinking water in peri-urban areas around Khulna, it made sense to focus on how groundwater quality was currently being managed and explore alternatives for this. A cooperative game theory model was suited for this. For Hogladanga, this model not only gave insight into the existing water quality management strategies, but also cooperative strategies to improve the situation. Moreover, cooperative strategies would helps the community consider their own role and resources they have to offer during the negotiation process.

The third model, focused on the future (urban) scenario as it relates to drinking water supply. Chapter 5 highlighted the dynamic nature of the problem due to urban expansion, and the future uncertainty of drinking water security as a result of this. As actors in an urban scenario differed significantly from the present (peri-urban) scenario, it made sense to model them separately. Fieldwork in 2017 also revealed the community's gaps in knowledge of drinking water services in Khulna city. This model took urban water supply strategies that were used by urban actors in 2017 as a proxy of what could be expected in the future, once the village was brought under urban jurisdiction. This future situation was modelled as a non-cooperative game.

6.1.3 Data collection methods

The timeline of data collection activities in step 3 is shown above in Fig. 6.1. The results of step 2 served as inputs for the construction of game theory models in this study. In particular, data about the players, their actions and potential outcomes. This was used to formulate a basic game tree of the strategic game. However, other essential inputs for step 3 (eg. players values) were not included in the data collection activities of the pre-scoping visit. Initial versions of the game theory models highlighted several gaps that had to be addressed (Gomes et al., 2018b). Therefore, data collection activities during the field visit in 2017 provided other essential inputs.

The 2017 field visit was conducted from February 10 - 15. The goal for this visit was to clarify actors' objectives, strategic options, and valuing of decision-making criteria with regards to drinking water problems. It was also helpful in terms of clarifying details about the water quality and urban water supply aspects of the problem. During the visit, a FGD was held with 10 Hogladanga residents (including 6 from the community negotiation group) to broadly summarize the key concerns. A tour of the village was also provided by the residents (Fig. 6.2). In addition, there were 19 key informant interviews with residents (including peri-urban residents Hogladanga and urban residents from Khulna city), government, private sector and a local university. A summary of meetings is available appendix 4.

Figure 6.2 Focus group discussion during the field visit to Hogladanga in 2017 (top); Tour of Hogladanga village with residents (bottom) (Photos courtesy Gomes, 2017, Jagrata Juba Shangha, 2017)

Key informant meetings were semi-structured based on the interview design shown in appendix 5. Most meetings, apart from a few meetings with government representatives, were conducted in Bangla with translation by JJS. The use of flash cards to facilitate discussions about strategies and values was also experimented with in some interviews. The cards were prepared based on the data available about the actors and were written in Bangla. Audio and written recordings were made with permission from the interviewees. In many cases, interviewees were known from earlier visits, others were identified through snowball sampling methods through JJS.

Meeting notes were later transcribed and coded in Excel according to key inputs for game theory models: problem situation, players, objective, role, actions, resources (or constraints), criteria (values).

6.1.4 Model development

As explained in section 6.1.2, there are three game theory models in step 3: a non-cooperative model of the existing drinking water problem, a non-cooperative model of the future drinking water problem under an urban scenario, and a cooperative game theory model of groundwater monitoring.

Tables in Excel were used to set up specific inputs for each game theory model. Such tables are often used by game theory modelling practitioners as a starting point for model development (Hermans et al., 2018). The game specifications table described the structure of the game in terms of the number of players, player names, player actions (or moves), and the order in which the game is played. Outcomes were specified in a separate table. Based on the number of moves and players included in the model, several outcomes were possible. These outcomes were numbered and briefly described. The combination of actions producing each outcome was also included.

Player's values were described in another table. These values corresponded to the tags used to describe the outcomes. A short description of each tag is also provided. Separately, player's values were assigned a weightage, reflecting the importance of each value to that player during decision making. The ranking of values was done using a cardinal scoring method. A total of 10 units was assigned to each player in the game, which was distributed across the different values belonging to that player. A justification for different weights were included as a reference. These are referred to as game tags and used to calculate the payoffs in the models.

Payoff calculations were in a separate table also. Each outcome was described using the appropriate tags. The payoff for each player was calculated for every outcome. This was done by adding the scores for the tags associated with each player. In some cases, a player would only receive part of total score for that tag. Here, a justification for these calculations was also included.

These tables were used to construct the two non-cooperative game theory models. The tables for the cooperative models differed slightly. The game specification table for the cooperative model included additional details about the players role, resources, constrains, and values. Here, the ordering of the players in the game was not required. Meanwhile, the outcome table specified different coalition possibilities in that game, along with a description and rationale. Based on the number of players (in this case, three), outcomes could result from null coalitions, individual efforts (non-cooperation), two and three player coalitions (the latter is referred to as a grand coalition). Resources used in each outcome were also included in this table. The payoffs in the cooperative model was calculated in the same way. The only difference is that in the non-cooperative models, payoffs are calculated per player, whereas payoffs in the cooperative model are specified per coalition. Appendix 6, 7, and 8 includes the tables used for the construction of the three game theory models in this chapter.

The two non-cooperative games were modelled in extensive form and analyzed using Gambit (McKelvey et al., 2016). In each model, we identified the Hicks and Pareto optimal outcomes and also ran basic game theoretic analyses such as Nash equilibrium and elimination of dominated strategies. The cooperative game was represented in characteristic function form after which the core, Shapley value, and nucleolus were calculated in R (R Development Core Team, 2008).

6.2 Results of strategic analysis in Hogladanga village

6.2.1 Overview of strategies in Hogladanga's drinking water problem

This section presents the strategic choices in the drinking water problem. It differentiates between the existing and future drinking water supply situations as well as the water quality aspects of the problem.

a. Existing drinking water supply situation

As mentioned previously, groundwater is the main source of drinking water in Hogladanga. At present, residents have two strategic options to improve access to groundwater. One is to apply for a public tube well from the Water and Sanitation (WATSAN) committee. The other option is to invest in a private tube well. Compared to public tube wells that are subsidised by the government, private tube wells are expensive. Therefore, most households prefer public over private tube-wells, as not everyone has the financial means to invest in the latter.

Approval from the WATSAN committee is needed before a public tube-well can be installed. This committee operates at the sub-district (*upazilla*) level, as per the formal rules of the rural administration. They can either reject an application or approve it by issuing a tube-well license. In this village, experience shows that applications are rarely approved. There are two reasons why the committee might not approve an application. First, given that most members of the WATSAN committee are elected, there is a need to appease their local constituency. This can lead to preference for villages with stronger ties to WATSAN members. Second, license quotas (or tube-well funding) are limited.

If a license is approved, the Department of Public Health Engineering (DPHE) manages the installation process. This begins by selecting a site to install the public tube-well. This can be done based on an assessment of local groundwater conditions, or based on the preference of the applicant. Discussions suggest a preference for the latter, as local aquifer data is limited. Thereafter, DPHE hires a mechanic to install the tube-well. Mechanics are hesitant to accept these installation contracts, as the terms state that payment depends on the success of tube-well installations. In other words, mechanics are not paid for tube-wells that supply poor quality or limited groundwater volume. If sites are selected without assessing local groundwater conditions first, then installation contracts can be risky for mechanics.

As mentioned, the village can also invest in a private tube well. Officially, this also requires a license; however, it is currently unregulated, as the local government is aware of the gap in rural drinking water supply. Here also, mechanics are hired to install a private well, except they are paid irrespective of the viability of the tube-well site. Therefore, there is no risk for mechanics to accept private tube-well installation contracts. The risk instead is borne by the village, as a non-viable tube-well would result in financial losses for the investor.

b. Future drinking water supply situation

In the future, drinking water supply in this village is likely to change from rural to urban service providers as proposals to expand city boundaries were at the time of this research, under review. Thereafter, peri-urban villages will become part of the urban jurisdiction. In this urban scenario, residents have four strategies to obtain drinking water supply.

First, they can apply for piped water supply at the city's Water and Sanitation Authority (WASA). Currently, Khulna WASA supplies treated surface water via pipelines. To reduce the pressure on groundwater, they are investing in new supply projects to increase the capacity and coverage of the piped supply network. However, these on-going projects are designed to meet the needs of the current population. Piped supply in these future urban areas depends on the availability of additional water supply projects. Therefore, in the near future, this option may not be available to residents.

A second strategy is to apply for a public tube-well from the city's WASA. Here, there is the risk that public-tube-wells might be unusable if the installation site is non-viable. However, the costs for using a public-tube well are less than those of piped supply. It is also less convenient compared to a household connection. Depending on their financial capacity, residents might prefer public tube-wells.

A third strategy is to invest in private tube-wells. Similar to the peri-urban scenario, mechanics are hired to install private tube-wells, and there is a risk for residents that the site will be non-viable. Moreover, the costs to citizens for a private tube-well are significantly more than those of a public-tube well, making it a less affordable option.

The fourth and final strategy is to purchase drinking water from (private) bottled water companies. In Khulna, there are several informal suppliers. They typically sell large jars of packaged groundwater. This option is only accessible to households who can afford it. These companies are expected to test drinking water quality; however, it is likely that this is not always done, especially by those operating illegally. Similarly, in the future, bottle water companies can only supply if they are able to meet the demand and recover the higher distribution costs (from supplying to customers in more remote areas of the city).

c. Drinking water quality situation

The village's drinking water problem also relates to groundwater quality. Residents have the impression that good quality groundwater is only accessible from deeper aquifers. Rural providers are unable to ensure safe drinking water quality due to limited knowledge of local groundwater conditions. This points to a gap in groundwater monitoring. This monitoring gap is also a concern for other government actors. Several actors highlighted a need for coordinated groundwater monitoring. In Bangladesh, groundwater is monitored by several government agencies as part of their mandate. Residents also informally monitor groundwater to meet daily household needs. They mentally record the quantity and quality available from different tube-wells in the village. This is done by observing seasonal changes in the volume available from tube-wells, and using sensory signals like taste, odour, and colour of groundwater. Health issues from drinking contaminated water is also an indicator of poor water quality.

The following section analyses the strategic behaviour in these three situations using the game theory models.

6.2.2 Strategic analysis of Hogladanga's existing drinking water access situation

This non-cooperative model represents a snapshot of the strategic behaviour of actors in peri-urban drinking water supply. The model shown below in Fig. 6.3 represents Hogladanga's existing drinking water supply problem. It represents a snapshot of the strategic game between actors involved in peri-urban drinking water supply. The game consists of four strategic players : (Hogladanga) Residents, WATSAN committee, DPHE, and mechanics. Nature is included as a chance player. It can also influence the outcomes in the game but is non-strategic in its behavior. Each player (including Nature) has a set of actions to choose from. The players (nodes) and their respective actions (branches) are color coded in the game tree below.

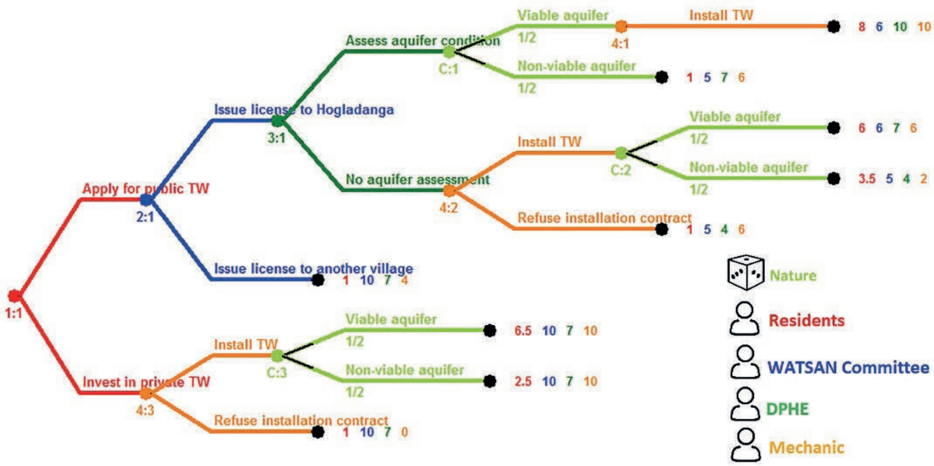


Figure 6.3 Non-cooperative model of Hogladanga's existing drinking water supply situation

Residents move first, as (formal) drinking water supply is only initiated through applications. Residents can either [Apply for public tube-well] or [Invest in private tube-well]. Based on their move, other players enter the game to select their action. The action taken by a preceding player determines who moves next. Each of the remaining players also have two moves each to choose from (Fig. 6.3). Unlike the other players, Nature (chance player) has a 50% probability assigned to each move. A 50% probability was assumed as rainfall variability data was not available at this time.

Each combination of actions produces an outcome in the game. These outcomes are represented by black end nodes in fig. 6.3. In total, there are 9 possible outcomes. Table 6.1 below describes each of these 9 outcomes, that corresponds to end nodes in Fig. 6.3 in the order of top to bottom. For example, [Apply for public tube-well] + [Issue licence to another village] results in outcome 6.

Each player receives a payoff from each outcome (represented by colour coded numbers found beside each end node fig. 6.3). The only exception is Nature as they are a non-strategic player. For example, in outcome 6, Residents receive a payoff of 1, the WATSAN chairman a payoff of 10 and the remaining two players (DPHE and Mechanic) a payoff of 7 and 4 respectively. Different outcomes result in different payoffs. For example, residents receive 8 payoff units from outcome 1 versus outcome 9 which only produces 1 payoff unit. This is because unlike outcome 9, outcome 1 results in drinking water supply. Details about payoff calculations are available in Appendix 6 (Tables a-f).

Outcome No.	Description
1	Safe, affordable, drinking water supply for Hogladanga via public tube well
2	Public tube well installation in Hogladanga is cancelled as location is not viable in terms of resource availability or safe drinking water quality
3	Risk pays off as public tube well with safe, affordable water supply is available in Hogladanga
4	Risk does not pay off as the result is a failed public tube well in Hogladanga
5	No public tube well installed due to lack of contractors
6	No public drinking water supply for Hogladanga residents
7	Risk pays off and Hogladanga has access to good quality but costly drinking water supply
8	Risk does not pay off for Hogladanga as the result is a failed private tube well, however, mechanics are still paid for their services
9	No private tube well installed due to lack of contractors

Table 6.1 Description of outcomes in the non-cooperative model of existing drinking water supply

Strictly dominant strategies always lead to a better payoff for the actor, irrespective of how the other players in the game behave. The dominant strategy for Residents is to [Invest in private tube well]. This is because the dominant strategy for the WATSAN committee is to [Issue license to another village]. With this strategy, Residents are guaranteed a payoff of at least 2.5 which is marginally better than the outcome of [apply for public tube well] and [Issue license to another village] where the payoff for Hogladanga is 1. Moreover, if the site is found to be viable, then Residents can expect to receive an even greater payoff of 6.5.

This analysis explains why Residents existing strategy to [Apply for public TW] will never result in better drinking water supply outcomes. It sheds light on why their applications for public tube-wells have not been approved for 4-5 years preceding this research. This is because the dominant strategy of the WATSAN committee in this model, is to [Issue licence to another village]. This is likely due to the fact that other areas within their jurisdiction have stronger connections with committee members, or have a greater need for additional public tube wells. This is perhaps why Hogladanga has so far been unable to solve the infrastructure problem through formal mechanisms.

Changing the allocation decisions of this committee requires creating better incentives for the committee or securing additional funding for public tube wells so that the allocation process at the sub-district level can cater to peri-urban villages like Hogladanga. Without changing the game, residents are better off investing in private tube wells. In reality, however, this dominant strategy is not always feasible. Interviews show that only some households have the financial means' to invest in private tube-wells and even then, bear the risks of losing their investments if the site is non-viable (Gomes, 2017a).

The dominant strategy for DPHE is to [Assess aquifer conditions]. Formal rules specifies that DPHE is expected to check aquifer conditions at the time of installation (Gomes, 2017a). Still, it is unexpected given the lack of groundwater data which prevents this in reality (Gomes, 2017a). Fig. 6.3 also shows that there is no single dominant strategy for Mechanics. Their strategies are based on the decisions taken by the other players in the game. For situations where payments are guaranteed for tube-well installations (outcomes 1, 6, and 7), the Mechanic will always [Install tube well]. However, when public tube wells are installed without prior aquifer assessments, Mechanics will [Refuse installation contracts] given the risks of non-payment. This is expected, given the risks involved for this player.

Only one Nash Equilibrium is found in this game (Fig. 6.3). The Nash Equilibrium represents the set of strategies where all players have no incentive to change their strategy irrespective of how the other players do in the game. It refers to the best responses. The dominant strategies of the individual players creates the Nash Equilibrium solution found in this game. Here, residents can expect to receive a payoff of 1 for [Invest in private TW], 10 for the WATSAN committee for [Issue license to another village]. Even though Hogladanga does not receive a license, this solutions still gives a payoff of 7 to DPHE for [Assess Groundwater conditions] and 4 for the Mechanic for installing tube-wells in another village. Note that this is a pure strategy Nash equilibrium.

6.2.3 Strategic analysis of Hogladanga's future drinking water access situation

A likely (future) drinking water supply situation is modelled as a non-cooperative game. Here, the model assumes that urban boundaries have expanded such that Hogladanga village is now part of the urban jurisdiction. In this game, (formal) drinking water supply is the responsibility of service providers in Khulna city. There are five players in this model including four strategic players (Residents, KWASA, Bottled Water Company, and the Mechanic) and one chance player (Nature). Similar to the peri-urban scenario, Residents move first in the game as urban drinking water supply is also initiated through the applications from local users.

The reasoning behind the players moves in this game are as follows. For KWASA, the action [Do not extend piped supply] is valid, given that their ability to offer piped water supply services to newly urban areas depends on the availability of new water supply projects. Similarly, although they will continue to offer public tube-wells in the future, their action [Do not install] reflects a strategy of reducing groundwater dependency in Khulna city for drinking and domestic purposes. Finally, bottled water companies also have two possible actions. They can [Sell] or opt for [Do not sell] if they are unable to meet demand or if the distance to the customer is too cost prohibitive for delivering bottled water. Finally, in the future, former Hogladanga residents can either obtain drinking water supply from one of the service providers (either KWASA or bottled water companies) or [Invest in private tube wells].

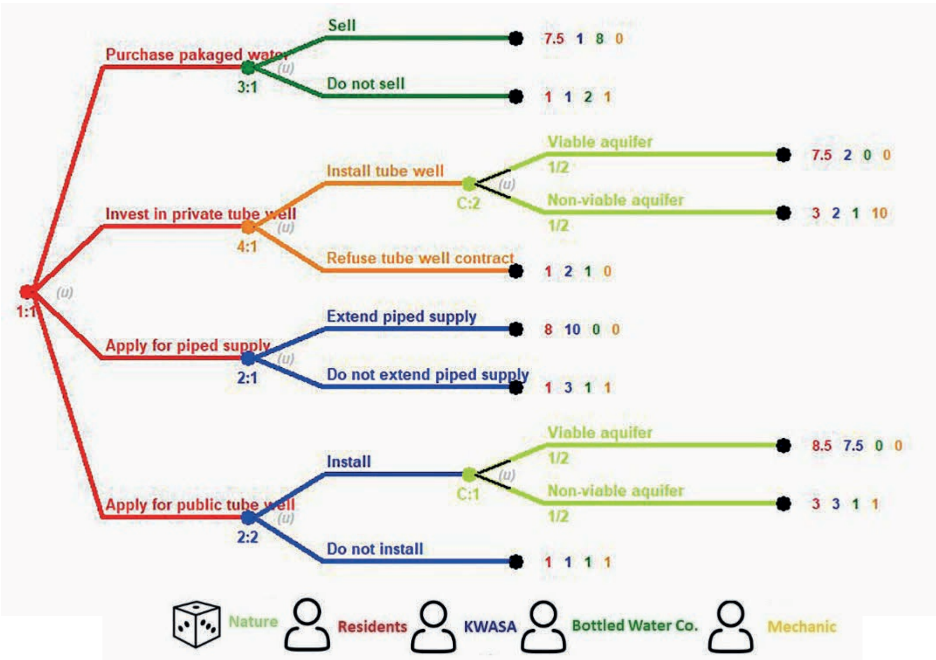


Figure. 6.4 Non-cooperative model of Hogladanga's future drinking water supply situation

The players, their actions, and corresponding payoffs are colour coded in the model (Fig. 6.4 above). There are 10 possible outcomes in this game. Table 6.2 describes these outcomes in further detail (corresponding to the end nodes in Fig. 6.4 in the order from top to bottom). For example, in outcome 6, the actions [Apply for piped supply] by Residents and [Extend piped supply] by KWASA result in piped drinking water services for Hogladanga residents. This outcome gives Residents a payoff of 8, KWASA a payoff of 10, and 0 payoffs to the remaining two players. Detailed payoff calculations for this model are available in Appendix 7 (Tables a-f).

Outcome No.	Description
1	Costly, convenient, good quality, reliable drinking water supply via informal suppliers (packaged water companies)
2	Return to status quo scenario where urban resident needs to either rely on existing DW options or look for alternate options
3	Good quality, reliable, convenient but costly groundwater supply for urban resident
4	Poor quality and/or unreliable and outweighs the convenience of having drinking water supply close to home. Moreover it is a loss for the residents who invested in installing this costly option.
5	Return to status quo scenario where urban resident needs to either rely on existing DW options or look for alternate options
6	Good quality, reliable, convenient but costly surface water supply connection for urban resident
7	Return to status quo scenario where urban resident needs to either rely on existing DW options or look for alternate options
8	Reliable, affordable groundwater supply for urban resident but the quality conditions are not always monitored and it is less convenient than the piped connection as public TW's are shared with other families and request residents to walk/ wait in line for water supply
9	Poor quality and/or unreliable groundwater supply outweighs the convenience of having drinking water supply close to home
10	Return to status quo scenario where urban resident needs to look for alternate options

Table 6.2 Description of outcomes in the non-cooperative model on future drinking water supply

Analysis revealed the dominant strategies of the players in his game. The dominant strategy for Residents to access drinking water supply in the future situation is [Apply for piped apply] as KWASA's dominant strategy is to [Extend piped supply] resulting in a payoff of 8 and 10 respectively for these two players. In comparison, the dominant strategies for Bottle Water companies, Mechanics and KWASA (for public tube-wells) is also positive for Residents, however, [Apply for piped supply] produces a marginally better payoff in comparison to [Purchase bottled water]. Similarly tube-well options (outcomes 3,4,8 and 9) come with the risk of sites being non-viable, affecting the expected payoffs from these strategies as a result.

This dominant strategy for KWASA is not surprising. Interviews with KWASA representatives, showed that providing 24 x 7 water supply to all city residents is their main objective (Hermans et al., 2018). It is reflected also in KWASA's recent investments in new water supply projects. However, in the future, it is uncertain whether KWASA's water supply will be sufficient to also cater to newly urbanised areas. For example, the project currently being implemented was designed to meet the current population in Khulna city. This was not considered in this analysis, but may be explored in future research.

The above result also corresponds to the Nash equilibrium solution in the future drinking water supply game. Residents can expect to receive a payoff of 8 for [Apply for piped supply], KWASA a payoff of 10 for [Extend piped supply]. Note that this is a pure strategy Nash equilibrium given the mixed strategy adopted by the Mechanic. In this solution, both Mechanics and Bottled water companies receive a payoff of 0.

The feasibility of piped supply, however, depends on other factors assumed in model 2 to exist in the future. For example, the affordability of piped water supply depends on the financial situation of individual households. With urbanization, it is safe to assume that more people from Hogladanga will become employed in other economic sectors. However, this is not guaranteed to improve their socio-economic situation.

The quality of piped water supply is another factor to consider. While the quality of piped water supply in 2017, was unreliable and not fit for consumption (Gomes, 2017a), model 2 assumes that on-going efforts to replace the existing distribution network would eventually result in better quality supply in the future. However, this cannot be guaranteed as it depends on KWASA's ability to manage their distribution network and water quality.

Note that applying for piped water supply is much more costly for Residents than applying for public tube-wells. The model reflects this in the marginally higher payoff (8.5) in outcome 8 in comparison to outcome 6 (8). However, similar to the private tube well strategy, applications for public tube-wells have the same risks of aquifer viability. Failed installations will result in a drastically lower payoff for the residents.

In the future, private tube well installations will require a license from the service provider (KWASA). While the model does not show this additional step, it can also be an additional risk for this strategy, if in the future, KWASA decides to reduce private tube-wells to protect local aquifers from over-exploitation.

6.2.4 Strategic analysis of Hogladanga's water quality situation

The cooperative game theory model, shown below in Fig. 6.5 examines actors' strategies with regards to water quality monitoring in Khulna. Note that this analysis only relates to groundwater resources, as it is the main source of drinking water in peri-urban Khulna.

The three players in this game are the Monitoring agency (M), DPHE (E), and Residents (R). In this model, the monitoring agency comprises all other actors who undertake some type of groundwater monitoring as part of their mandate. This includes the Bangladesh Water Development Board (BWDB), the Bangladesh Agricultural Development Corporation (BADC), the Department of Environment (DOE), and KWASA.

There are 8 possible outcomes in this game (Fig. 6.5, Table 6.3). Players can chose to not monitor groundwater at all. This is represented by the null coalition (Ø). They can monitor groundwater individually, show as {M}, {E}, and {R}. They can also form a coalition with one other player ({ME}, {DR}, and {MR}). They can form a grand coalition {MER}. Table 6.3 below describes each outcome in further detail.

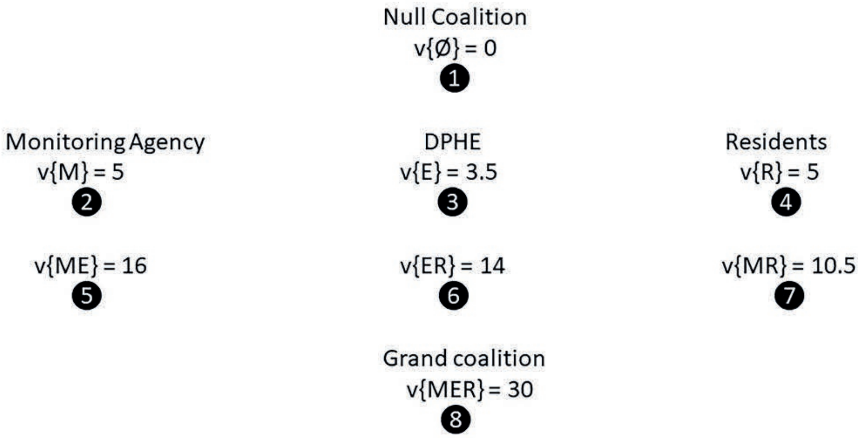


Figure. 6.5 Cooperative model of groundwater monitoring situation

Number	Coalition	Outcome description
1	None	No monitoring of groundwater resources
2	M	Fragmented groundwater monitoring partially fulfils agency specific objective
3	E	Minimal groundwater monitoring of public tube wells in rural areas for drinking water management only
4	R	Basic village-level groundwater monitoring for the purpose of selecting tube well to meet drinking water needs
5	ME	District level groundwater monitoring across water-use sectors and administrative boundaries via inter-agency agreements to share monitoring resources and data
6	ER	Survey of all local drinking water tube-wells (both public and private) through government assisted community monitoring and data sharing
7	MR	Improved data on local groundwater conditions through community-led groundwater monitoring with use of government training and testing facilities
8	MER	Local and district-level mapping of groundwater conditions across water-use sectors and administrative boundaries regions through government-community collaboration

Table 6.3 Description of outcomes in the cooperative model on groundwater monitoring

The payoff values (v) for each outcome are also shown above in Fig. 6.5. As this is a model about cooperation, (v) for multi-player coalitions are shown as the total combined utility for that coalition, not the individual members. For example, v{Ø} receives 0 payoff units, while v{MER} receives 30, the highest possible payoff in the game. Calculation of payoff in this model are available in Appendix 8 (Tables a-i).

For all players, including Hogladanga, the model indicates that cooperation is a more rewarding outcome in terms of payoffs than non-cooperative or individual groundwater monitoring strategies. This is perhaps obvious, given that each actor has limitations in the areas, frequencies, and resources available to them to undertake monitoring activities. Here, understanding what Is the best way to cooperate is perhaps the most useful insight gained from this cooperative model.

From the two-party collaborations, [ME] has the highest payoff compared to those where government actors, either the Monitoring Agency or the DPHE cooperates with Hogladanga residents. In other words, government actors are more likely to cooperate with each other than the local community on groundwater monitoring. In the real world, these outcomes are perhaps more feasible if there are institutions that encourage through committees, or databases cooperation with regards to groundwater monitoring. It can also be argued that government players and communities have simply not explored the added benefit of cooperative as they have limited interactions, different kinds of expertise or use different terminology to discuss this topic.

Three solutions were calculated for this model. The first is referred to as the Core. It denotes voluntary participation in reaching cooperative agreements. It relates to the concept of market rationality, wherein actors can freely trade with each other or agree to collaborate on productive agreements without coercion (Hermans et al., 2018). In this game, the three players will only cooperate if they stand to get at least as much as they receive from acting individually. This means a minimum of 5, 3.5, and 5 for player M, E, R respectively. This is referred to as individual rationality and can similarly be applied to two-player coalitions. Two player coalitions, ME, ER, and MR will similarly not enter into a 3 player coalition (MER) unless they receive a minimum value of 16, 14 and 10.5 respectively.

Cooperative efficiency is also important in the core. Efficiency relates to the distribution of points available on the negotiation table (i.e. the utility of the grand coalition, in this case a total of 30 points) (Hermans et al., 2018). Cooperation is efficient when the full 30 points are distributed across its members and there is nothing left on the table. In other words, there is a maximum value that players can receive by cooperating. The distribution of units, however, can produce inequalities between players, affecting the desire to cooperate. Sustaining cooperation requires bridging these inequalities to prevent actors from defecting and is the idea behind the core. Finding the core requires calculating the minimal and maximum payoff values for each player. These are as follows:

$$5 \leq M \leq 16$$

$$3.5 \leq E \leq 19.5$$

$$5 \leq R \leq 14$$

The core solution is visualized on a ternary plot below in Fig. 6.6.

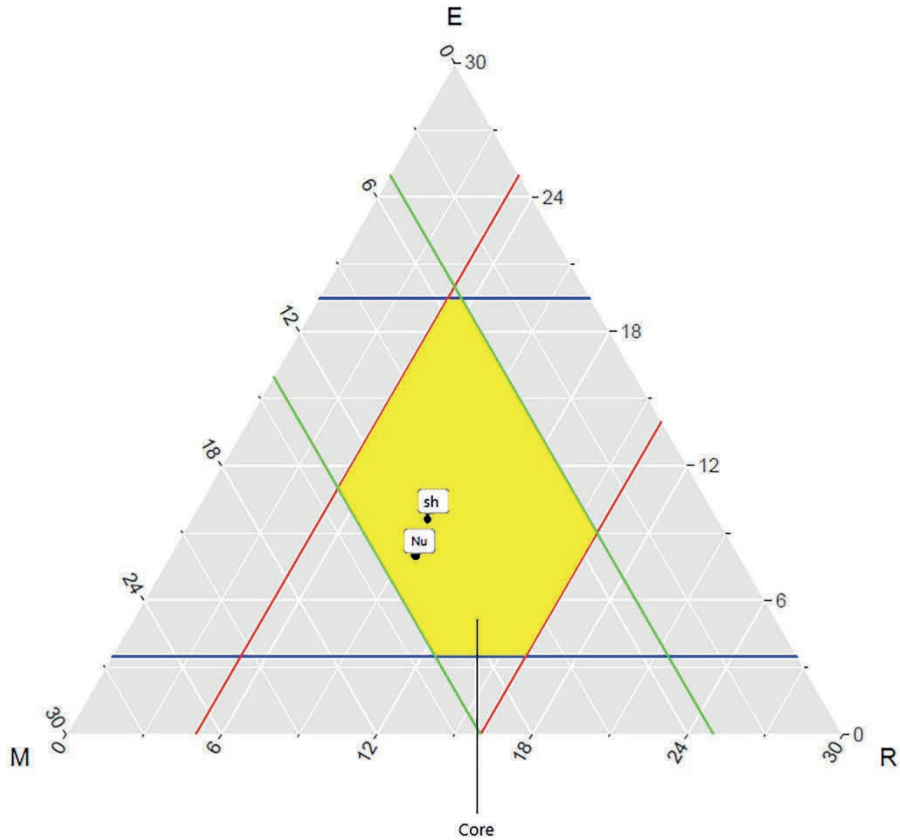


Figure 6.6 Possible solutions in the cooperative game between Monitoring Agencies (M), DPHE (E) and Residents (R) with regards to water quality monitoring: Core solution (Yellow), [Nu] Nucleolus solution, [sh] Shapley value solution

The core is the space in which cooperation can be achieved through voluntary participation by the players in this game. The core in this game is indicated in the above ternary plot in yellow (Fig. 6.6). Here, there can exist numerous possible cooperative solutions. Therefore, it is not a specific solution to the monitoring problem, but more so a voluntary solution space.

Therefore, two additional solutions were calculated for this game. The Nucleolus represents the egalitarian solution to the problem. Here, all players are considered equal (in terms of worth) and so this solution makes the most unhappy coalition less unhappy without negatively affecting the other coalitions. The excess is used to calculate the Nucleolus. It is the difference between the payoff given to a coalition and the payoff to each player if they monitor groundwater individually. The nucleolus in this game is plotted on the ternary plot as [Nu] in the Fig. 6.6. In this game, the Nucleolus is located within the core, which means an egalitarian solution to the groundwater monitoring game is possible voluntarily by the players. This solution may be pursued if there is limited trust between the players, as this solution gives offers a better or just as good a payoff from all alternative outcomes, thereby allowing the actors' to still pursue their individual payoff maximizing objectives from the situation.

The Shapley value [sh] is also calculated for this game, and also indicated in Fig. 6.6. This solution is representative of a 'fair' solution, one in which the payoffs are equitably assigned to the actors within a coalition. Here, payoffs are distributed in a coalition based on what each actor beings to the table. It is also dependent on the order in which these coalitions are formed. So, if player M starts the coalition with 5 points, E would bring in an additional 12.5 points by forming ME (as v{ME}- v{E}= 12.5), and R would add in 15.5 units by entering the coalition to form MER. All possible combinations are taken into account while calculating the Shapley value. This solution may be pursued if the actors hold fairness as an important normative value in the problem solving process.

This cooperative model makes assumptions about what resources are traded in two or three player coalitions by way of cooperation. This is based on a limited understanding of the actors resources in relation to water quality monitoring (and more generally, groundwater data) in reality. These resources can be found in Appendix 8 (Table 8a.). However, there may be other ways of cooperating also, which the model has not taken into account. The core solution is useful here, as it provides a space where voluntary collaboration is possible, yet offering players room to come up with their own cooperative arrangements. This allows for a broader solution space to be explored.

6.3 Discussion of results from Step 3

Results from step 3 are discussed in this section using the evaluation framework described previously in chapter 3 (section 3.4). The focus is on the impact on community's problem understanding, broader research insights from strategic analysis, and lessons from the implementation process in terms of methods and facilitation.

6.3.1 Impact on community's understanding of strategic behaviour in the drinking water problem

It is difficult to evaluate the impact of step 3 on community capacity building as the findings of the game theory models were not discussed with Hogladanga residents following the analysis, unlike step 2. This is not to say that community participation in the analytic efforts in step 3 is entirely missing. The community (along with other stakeholders) were indirectly involved in the model development process by way of providing the necessary data inputs. However, there was no de-briefing workshop following strategic analysis and the models were not shown to the community in a later mango-tree meeting or NA workshop either. This decision was a purposeful choice made in the APIA design that was later justified during the field activities in 2017. Even with the use of flashcards, it was difficult to discuss game theory inputs like their values and strategic preferences. It was thereafter expected that similar challenges would be faced when discussing the payoffs from the model and different solution concepts.

The expectation was that game theory models, although useful as a method for structuring decision making in multi-actor peri-urban problems, are less suitable for sharing and discussing strategic insights with peri-urban communities. The models presented earlier in this chapter, also require some explanation in order to interpret them. Translating real-world problems into a game tree or cooperative game, makes the problem itself more abstract. It was assumed that such a representation would not be easy to interpret by the community, even with the use of local translators. This concern was especially considered for interpretation of payoffs in the model, where the local reality of drinking water supply or water quality is represented by numerical values.

Therefore, although step 3 is a necessary step in the problem structuring efforts undertaken through the IAPP, it is an intermediate step in terms of capacity building of the peri-urban community. In other words, sharing results from the strategic analysis of Hogladanga's drinking water problem is achieved primarily in step 4. Here, the three game theory models in this chapter serve as the starting point for the design of a game-based strategy exploration workshop for peri-urban communities. This is explained in further detail in Chapter 7.

6.3.2 Analytical insights: Strategic behaviour in Hogladanga's drinking water problem

Analytically, step 3 offers further insights into Hogladaga's drinking water problem. More specifically, about strategies within the action arenas. The analysis helps better understand and interpret the existing outcomes in the problem as well as what strategies could benefit the community from a problem solving perspective.

Model 1: Non-cooperative model of the existing drinking water supply situation

Model 1 provides answers to the question of why Hogladanga is unable to improve their access to drinking water supply. In the present situation, Hogladanga village relies entirely on groundwater for drinking purposes.

From this model, it can be inferred that for Hogladanga to improve drinking water access via formal mechanisms, they need to incentivize the WATSAN committee to behave differently. For the WATSAN committee, the expected payoff from [Allocate to Hogladanga] would need to be higher than the one received from their current dominant strategy. Changing the allocation decisions of the WATSAN committee requires incentivizing a more equitable allocation.

The community can explore ways of cooperating with committee members. Like other villages, Hogladanga elects local representatives so political support is one of the resources that can be used during negotiations. Another option could be partnering with other similarly marginalized peri-urban villages to build social capital in getting their voices heard at the sub-district level. Alternatively, residents can explore other sources of funding for public tube wells. This means changing the resources in the game. This can be achieved by introducing new players such as Members of Parliament for example who have their own quotas for water supply projects at the local level. Alternatively, cooperative strategies between the community and the WATSAN committee might include the joint funding of public tube-wells.

Even if residents are successful in obtaining a tube-well license, the best outcome, particularly with regards to drinking water quality, is outcome 1. To reach this outcome, DPHE must avoid risky tube-well installation practices and overcome the existing data constraints. In other words, residents need to incentivize DPHE to assess local groundwater conditions before installing tube wells. Currently, this strategy is constrained due to insufficient groundwater data. This prevents DPHE from playing their otherwise dominant strategy. Residents can try to think of how they can help DPHE close these data gaps. This is explored in more detail in model 3 about water quality monitoring. There, several cooperative strategies are explored, one of which, involves the community being part of monitoring efforts.

Given the challenges for Hogladanga to reach Outcome 1 (the preferred optimal strategy for this player), the only other alternative is the Nash equilibrium solution where residents invests in private tube-wells. In reality, this strategy has limited potential given that not all households have the financial means to do so and furthermore, are willing to bear the risks of losing their investments if the site is discovered to be non-viable.

Hogladanga residents can explore collective action to make the private tube-well strategy accessible for all households in the village. For example, pooling finances and jointly investing in private tube-wells. Alternatively, improved knowledge of local aquifer conditions may also help reduce the risk of failed installations.

Model 2: Non-cooperative model of the future (urban) drinking water supply situation

In Model 2, the future (urban) drinking water supply game was analysed. Results show that Hogladanga's current strategy to address drinking water supply situation is also available in the future. Outcomes 3 and 4 correspond to residents choosing to Invest in private tube wells with the help of local mechanics. Here also, there is a risk that the site will be non-viable. This would result in investment losses for Hogladanga residents and is reflected in the significant difference between the payoff differences between successful and unsuccessful tube-well installations.

In the future, private tube well installations will require a license from the service provider (KWASA). While the model does not show this additional step, this also may be an additional risk in this strategy, if in the future, KWASA decides to reduce private tube-wells to protect local aquifers from over-exploitation.

In order to avoid failed tube-well investments, the recommended solution in the future for residents is to apply for piped supply. This strategy will produce a better payoff than the private tube-well strategies. This is also the Nash Equilibrium solution in the game. In reality, however, this strategy requires that KWASA extends piped supply which is dependent on the availability of piped supply projects to cater to the needs of new urban areas. Planning of new water supply projects occurs in a different multi-actor arena involving other players such as for example, KCC and project contractors. Residents should therefore be aware of strategic games in these parallel arenas, if they wish to pursue this drinking water strategy. Furthermore, households own socio-economic situation in the future and the quality of piped water supply are for now uncertainties in this future problem solving strategy.

The only other option for residents is to purchase bottled water, given the risks associated with tube-well installations and uncertainty of piped water supply. This is only an affordable and reliable option if bottled water companies strictly adhere to water quality standards. To achieve this, urban residents should explore ways to ensure the safety of bottled water supply by lobbying municipal regulatory authorities to better enforce drinking water standards ad testing protocols.

Model 3: Cooperative model of drinking water quality situation

In Model 3, cooperative strategies to change the outcome of the drinking water quality situation were explored.

For all players, including Hogladanga, it appears that cooperation is more rewarding a solution in terms of payoffs than non-cooperative or individual groundwater monitoring strategies. This is perhaps obvious, given that each actor has limitations in the areas, frequencies, and resources available to them to undertake monitoring activities. Here, understanding what Is the best way to cooperate is perhaps the most useful insight gained from this cooperative model.

Model results indicate that the highest payoff can be obtained if residents cooperate with the other actors in a grand coalition. The analysis of the core, shows that such an outcome is achievable through voluntary participation by the individual players. Distribution of payoffs in this solution, however, varies. In some cases, it is possible that certain players benefit more than others.

Therefore, in the water quality situation, cooperation can lead to a better outcome but the ways in actors cooperate can vary. If the underlying value is fairness, then Hogladanga and the other players should explore further the Shapley value solution. Here, each of them stand to gain as much payoff as they bring to the coalition. This solution recognizes that in groundwater monitoring, certain actors have more to contribute that others. This is also observed in peri-urban Khulna, where groundwater data, and monitoring resources was unequally distributed among the players. On the other hand, this solution is perhaps less desirable for Residents, if they contribute the least to the coalition.

However, if the chances of cooperation are constrained due to lack of trust between the players, the Nucleolus solution, reflecting an egalitarian outcome, is a better strategy. This way, actors can still pursue their individual interests while also contributing to a shared objective. This solution might be explored in peri-urban Khulna given that there is already limited interaction between government and local communities, thereby affecting the trust levels between these types of actors.

6.3.3 Evaluation of methods and facilitation process used in Step 3

The experiences with game theory modelling in this case study are mixed. This case study offers lessons regarding the analytical value of game theory models as well as the implementation of the method in such a content.

Game theory models rely on just a few key inputs. This is one of the benefits of using this method in contexts where data is not readily available. In peri-urban Khulna, the input data involved identifying the actors, actions, outcomes, and payoffs. Data collection was largely through key informant interviews with different stakeholders involved in Hogladanga's drinking water problem.

It was expected that some of these topics would be a challenge to discuss with peri-urban communities. This was experienced during field visits. Variables such as objectives, values, and institutions have a relatively abstract nature compared to for example, physical infrastructure, resource dynamics, or groundwater-dependent livelihoods. Therefore, even before step 3, limitations in the extent that peri-urban communities would be able to participate in the formulation of game theory models was recognised.

The field visit in 2017 further supports the concerns regarding participatory strategic analysis in this context. During this visit, meetings focused solely on the key inputs needed to construct these models. However, these variables were not easily understood by local actors, especially, the questions regarding values and preferences. They often required additional explanation by translators or were re-framed. This highlights the importance of good interview design, with consideration given to the terminology used. However, this field visit also highlighted potential challenges of participatory model building exercises in such a context.

The research team also experimented with flashcards during meetings, with examples of values such as affordability, convenience etc. However, they were not always used during discussions. Typically, meetings would occur spontaneously while walking through the village, allowing limited opportunity to display and explain the purpose of these materials. When used, however, those interviewed were able to use the flashcard to rank their values in order of importance. It also made it easier for the researcher to follow along with the discussion, limiting interruptions due to translation. These materials, were not systematically evaluated in terms of usefulness, clarity etc. Again, because there were only limited opportunities to use them. However, it is recommended that future of game theory model applications with similar kinds of stakeholders, explore this and other visual communication tools to facilitate discussions about game theory inputs.

Framing actor interactions as a game theory model was an iterative process. There are multiple ways to structure the same drinking water problem as evident in section 6.1.2 This stems from the problem's complexity. There were several action arenas, each with its own set of interacting actors. These arenas were further defined by institutions at different levels, action situations, and spatial-temporal boundaries. Therefore, it took several iterations to find the appropriate problem boundaries for strategic analysis. This is perhaps an unavoidable part of arriving at a working problem boundary. Yet, it raises the question of whether stakeholder participation during this stage, would result in a more efficient process? Future research should experiment with more collaborative forms of model development to improve the efficiency of addressing data or game design related questions as they arise during the process.

Limitation of the methods influenced the choices made during step 3. Game theory analysis is best suited for a limited set of players (between 2 - 4 players). Therefore separate models were designed around sub-arenas occurring in the drinking water problem. Modelling every single strategic game in the arena associated with the drinking water problem is a difficult undertaking and inefficient use of project resources. Therefore, it was necessary to make a selection of the most relevant actors, arenas, and actions for strategic analysis. Here, three problem situations were examined using game theory models. They represent important aspects of the drinking water problem, even at a very abstracted level. However, in constructing these models, several players and/or strategic moves were eliminated. In other words, these models represent a simplified view of Hogladanga's drinking water problem which can have implications for decisions based on model findings.

Despite access to first-hand information about the actors modelled in step 3, the modelling exercise revealed several data gaps. For example, strategic preferences by certain actors was not available (e.g. members of the WATSAN committee and local mechanics). Verification of the supposed bias in license allocation by the WATSAN committee also could not be verified as members were unavailable or were hesitant to openly discuss this. Therefore, assumptions were made in game theory models using secondary sources, and communications with project partners with insight into these topics.

Therefore, strategic analysis findings in chapter 6 should be considered as indicative. It is common for game theory applications to experiment with different model inputs (e.g. payoffs)as a way of validating models. In this study, models were constructed for the most part, using first-hand information from local actors. A sensitivity analysis was not performed in step 3 and is admittedly one of the limitations of this research. However, multiple iterations also improved the reasoning behind the final models.

Ultimately, the use of game theory models depends upon on how the results will be used. In this study, game theory models were not intended to serve as decision-making tools. Instead, they help familiarize researchers and peri-urban communities with strategic insight into action arenas. These models animate what can expected in terms of outcomes for different strategies taken by the community. The following chapter describes step 4 of this APIA application, elaborating how strategic exploration was facilitated with peri-urban communities using the results from step 3.

Chapter Seven

Applying Step 4 in Hogladanga village: Strategy Exploration

Photo courtesy: Author (2016)

7.

APPLYING STEP 4 IN HOGLADANGA VILLAGE: STRATEGY EXPLORATION

This chapter builds on the methods, results, and discussion section of the following papers: Gomes et al. (2018a, 2018b) *about game-based strategy exploration workshops conducted in peri-urban Khulna.*

Continuing from the case study findings in the previous three chapters, Chapter 7 representes the final step of the APIA application in Hogladanga village. Based on game theory models from step 3 (strategic analysis), Chapter 7 describes how these results were used to support strategy exploration with the community.

This chapter describes the use of game-based simulations to facilitate strategic analysis of Hogladanga's drinking water problems and evaluates its impact on community's problem understanding. Section 7.1 explains the design of three role-playing games based on earlier game theory models of problem. Results from a strategy exploration workshop with Hogladanga residents are presented in section 7.2. Evaluation results are discussed in section 7.3, starting with the impact of step 4 on the community's problem understanding, highlighting also the strengths and weakness of methods and facilitation process. Section 7.4 synthesizes the key results from step 4.

7.1 Methods used for strategy exploration

The following sections describe the game design process, the role-playing game used for strategy exploration by Hogladanga, and the evaluation protocols for the workshops conducted as part of step 4.

7.1.1 Overview of strategies in Hogladanga's drinking water problem

The purpose behind step 4 is to communicate the game theoretic findings from step 3 in an easily understandable way for Hogladanga residents. This is expected to help the community become aware of strategic interactions occurring within action arenas concerning their drinking water problem. Moreover, strategy exploration as the name suggests, also helps the community explore a range of potential problem solving strategies to support future actions and negotiation plans.

Strategy exploration was facilitated with the help of gaming-simulation methods. The game theory models from Chapter 6 capture strategic behaviour in different institutional arenas relating to Hogladanga's drinking water problem. Three short role-playing games were designed using elements from corresponding game theory models. The models provided information about the players, their roles, actions, resources, and potential outcomes for these games. The timeline of the activities undertaken in step 4 are shown below in Fig. 7.1.

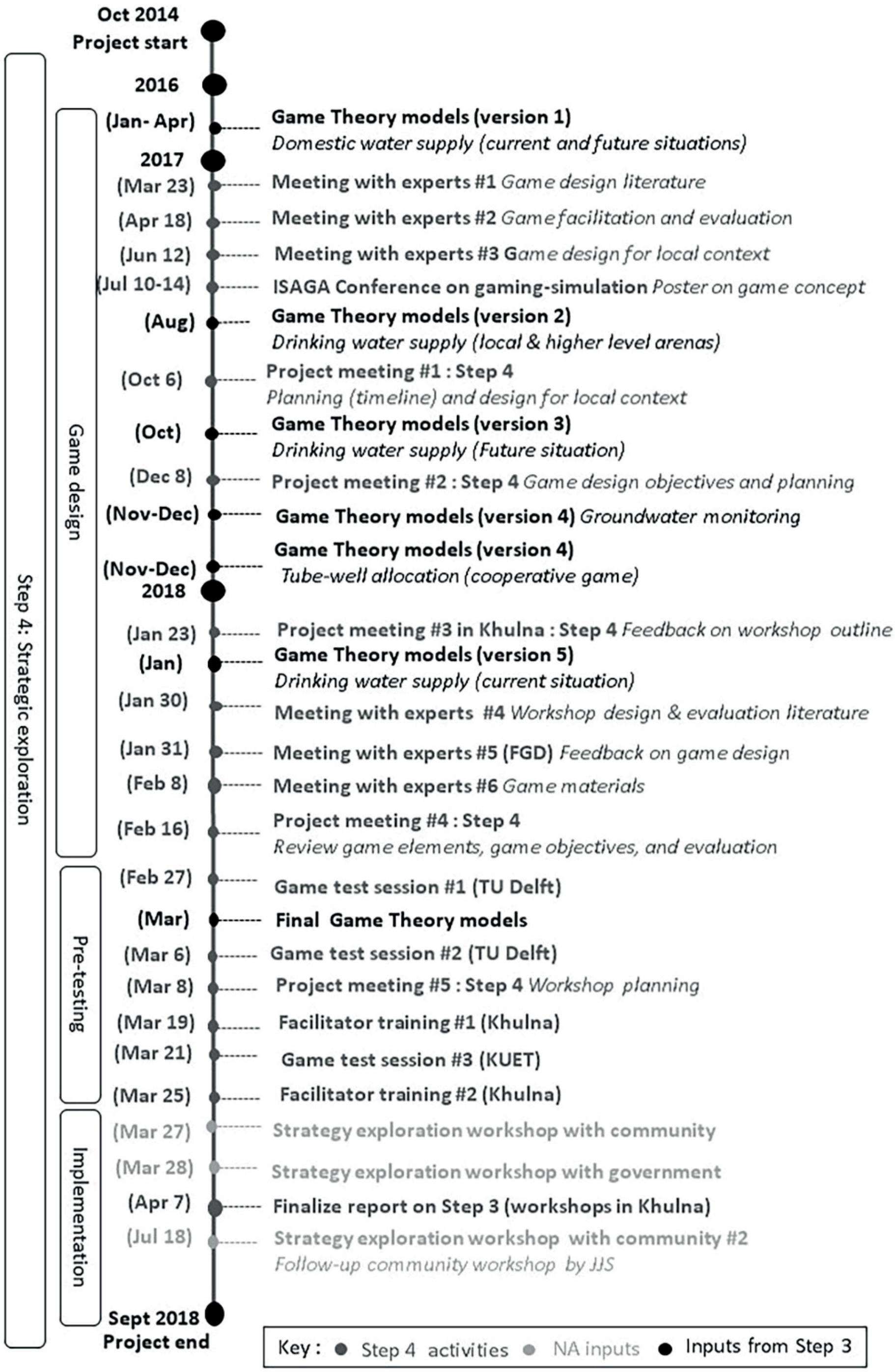


Figure 7.1 Timeline of activities in step 4 : strategy exploration

The first game was about the existing drinking water supply situation, the second about the future drinking water supply situation, and the third game about water quality monitoring. In each game, the objectives for the players differed slightly. In game 1, the aim was for the residents to improve drinking water access in the existing peri-urban situation. Game 2 had a similar goal but here the players explored a future situation following urban expansion. In game 3, players through role-play explored non-cooperative water quality monitoring (existing situation) followed by cooperative strategies to improve monitoring outcomes.

Revisions were made to the 3 games during the game design process. Initial game design proposals were discussed at TU Delft with experts who were familiar with the context, researchers experienced in gaming-simulation methods and participatory workshops, as well as project team members (Appendix 9). This was needed to ensure that the game and its facilitation suited the context and needs of the workshop. Their feedback was incorporated into further revisions to the games (Fig. 7.1).

A prototype of all three games was tested with colleagues from the faculty of Technology, Policy, and Management at TU Delft (Fig. 7.1). Two half-day test sessions were conducted with groups of 5 - 6 people in each session. A short demonstration of the role-playing games was also give to researchers at Khulna University of Engineering Technology (Khulna) on March 21, 2018, as a final testing of game mechanics with local experts.

The game was played by actors from peri-urban Khulna on three separate occasions. First, a one-day workshop was conducted with residents from Hogladanga village on March 27, 2018. The following day, a half-day workshop was conducted with representatives of different government agencies in Khulna. Then, on July 18, 2018 a second strategy exploration workshop was facilitated by JJS on their own with the community (Fig. 7.1). In this chapter, only the results of the first community workshop are presented and discussed. The results from the government workshop can be found in chapter 8 whereas details regarding the follow-up community workshop is available in a published report by Jagrata Juba Shangha (2018).

7.1.2 Game description

Three role-playing games were designed to help the community understand strategic behaviour within their local drinking water problem. In these games, behaviour was supported and constrained by underlying formal and informal rules. Through role-play, players explored strategies to address this problem.

In each game, participants were assigned the role of one of the actors involved in the drinking water problem. Participants took on these roles individually or in groups of 2-3, depending on the number of roles available in each game and the number of participants. Each player was provided with several game materials, each describing their actions, resources, objectives, and values in the game. These materials also helped facilitate the role-playing activity by indicating who moved when during the game.

Fig. 7.2 below shows examples of the cards provided for the player 'Peri-urban residents'. The role description card (Fig. 7.2a) specified the player's name, their affiliation (with a government department, company, or village), role in drinking water management, objective, and values that guide decision making. Action cards (Fig. 7.2b) specified what actions can be taken and any conditions associated with each action. Resource cards were also player specific, indicating their assets available for use during the game (Fig. 7.2c). Each participant also received a scorecard which described their players values. These scorecards were used to score the outcomes in the games (Fig. 7.3).

Just like the game theory models, games 1 and 2 also had non-strategic (or chance) players. These players could randomly influence the game's outcome based on the roll of a dice. Depending on whether the dice landed on an even or odd number, they had to play a certain action card. These players also received a role description card. It specified the conditions for when they can enter the game and instructions on how to move during the game.

A game board was used in all three games (Fig. 7.4a). It depicted the physical geography of a fictional peri-urban area outside a city boundary, although its design is closely based on the geography of peri-urban Khulna. The city boundary was indicated by a red dotted line while the location of actors (or players) in each game was marked in the orange circles (Fig. 7.4a) on the board. Actions taken by each player during the game could be placed in the blank spaces (top right in Fig. 7.4a) during the game. This was to allow all the participants to view the different actions and any resources exchanged during the games.

The board could be customized with movable pieces during the game. In games 1 and 2, outcomes were visualized with yellow icons describing the type of drinking water supply (Fig. 7.4b). In session 2, urban expansion was visualized by customizing city boundaries (using coloured tape) and adding city icons in the newly urban areas (Fig. 7.4c). In session 3, players explored individual water quality monitoring, before attempting cooperative water quality monitoring strategies. To differentiate between monitoring strategies between these rounds, each player was initially given different coloured monitoring icons (green, purple, and pink) to describe their individual monitorinig locations (Fig. 7.4d). In the cooperative rounds, players who cooperated instead used blue monitoring icons to indicate the locations of their actions. Coloured tape was also used to connect different players on the board that decided to cooperate.

Game play was guided by the game's objective. The objective and the role description cards determined the behaviour of each player. Their actions in the game produced an outcome. This outcome was based on the combination of actions selected by the players. However, there was a fixed set of possible outcomes that could occur in each of the three games. These outcomes were pre-determined from the corresponding game theory models. Game facilitators were provided with outcome description tables that summarized this. During role-play, the outcome was explained by the facilitator using the game board. Participants were then asked to score the outcomes using their scorecards (Fig. 7.3). Multiple rounds were played in each game giving participants a chance to explore a range of different strategies in the problem. However, each round had the same starting situation.

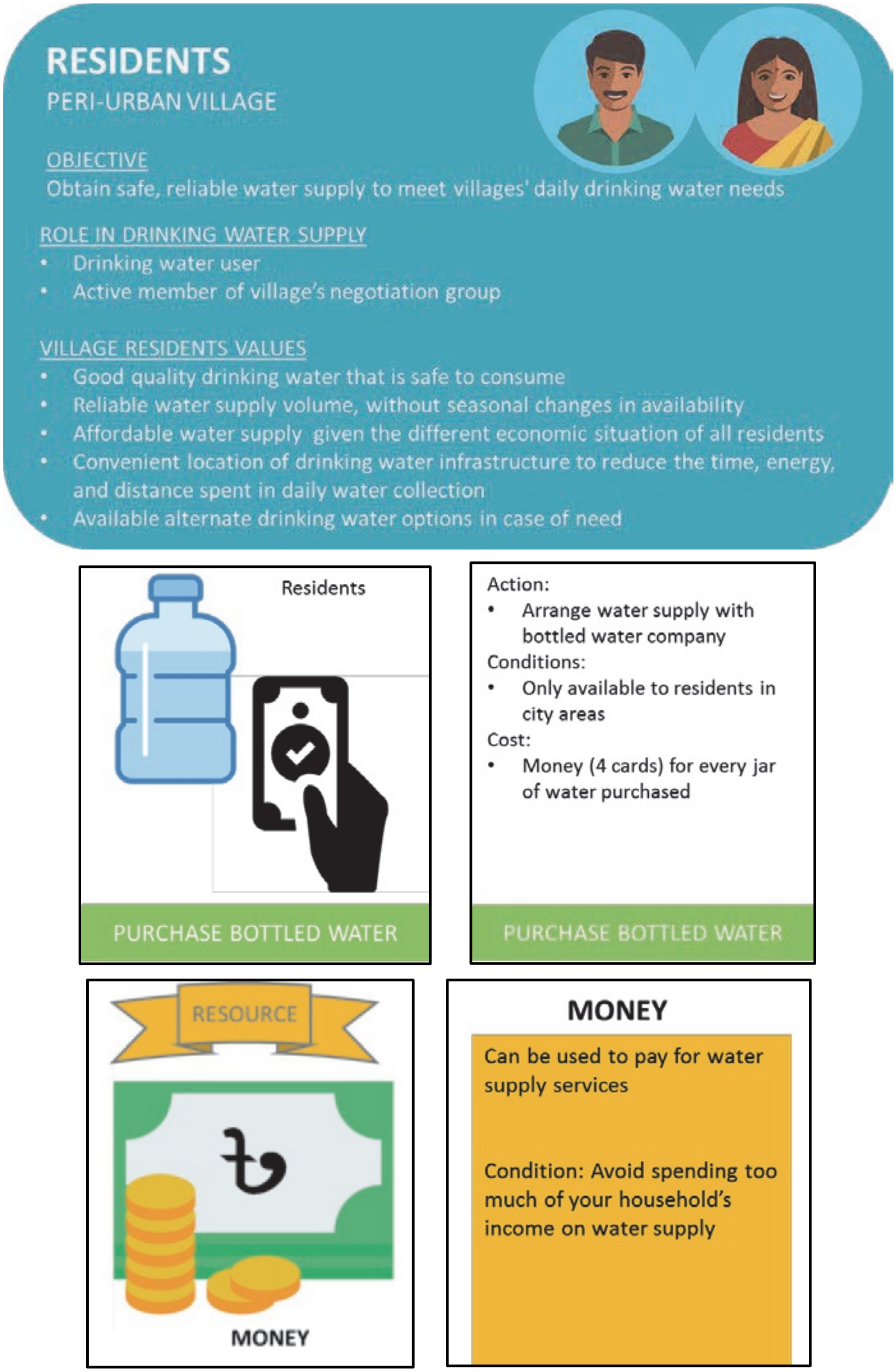


Figure. 7.2 Game materials for the player 'Peri-urban Residents': (a.) (top) Role description card for peri-urban residents (b.) (middle) Action card for residents (Left: front, Right: back) (c.) (bottom) Resource card for residents (Left: front, Right: back)

SCORECARD

Place a ✓ under the appropriate face (happy, indifferent or sad) to indicate how well the outcome satisfies your player's values. Repeat at the end of every round.

PLAYER: Village residents	**SESSION 1 (PERI-URBAN WATER SUPPLY)** ROUND 1			ROUND 2			ROUND 3		
SATISFACTION ➡ VALUES ⬇									
Safe drinking water (quality)									
Reliable water supply (availability)									
Affordable water supply (cost)									
Convenience of water supply (eg distance, time, effort)									
Availability of alternatives									
Other ___________									

Figure. 7.3 Scorecard for the player 'Peri-urban Residents'

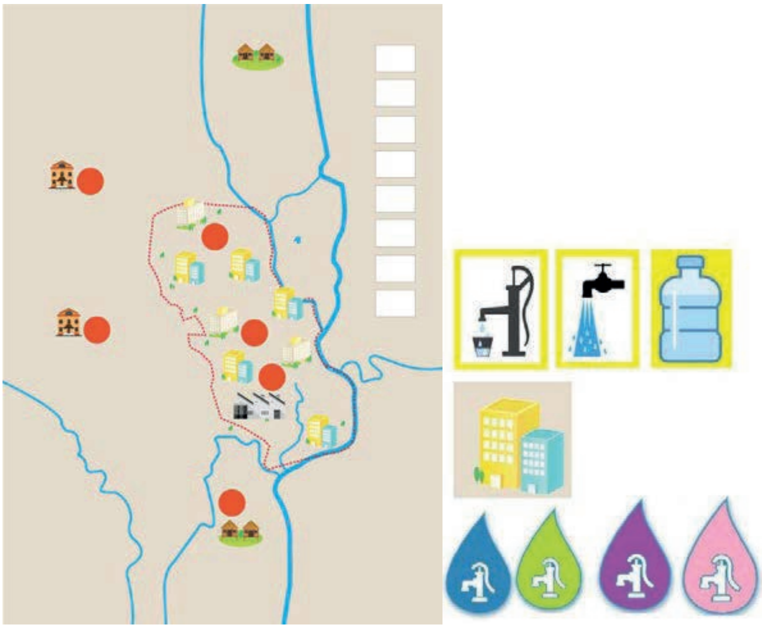


Figure 7.4 (a.) (left) Game board with game pieces (right) : (b.) (top row) drinking water icons used to describe outcomes in games 1 and 2, (c.) (middle row) city icons to show future urbanization in game 2, (d.) (bottom row) groundwater monitoring icons used in game 3; cooperative monitoring (blue) and individual groundwater monitoring (green, purple, pink).

7.1.3 Design of the strategy exploration workshop

The three role-playing games were played as part of a larger capacity building workshop. This one-day workshop was held on March 27, 2018 in Khulna city. Four facilitators from JJS managed the workshop: one main facilitator who led the workshop activities in the local language, one observer who recorded workshop proceedings, and two co-facilitators who distributed game materials, answered participant questions, and recorded discussions during the debriefings. A facilitator script and other materials (process record form and outcome description tables) were provided to the facilitators beforehand. The game designer (author) was also present to help facilitators and answer questions.

This workshop was attended by nine participants from the peri-urban village that were formally invited by JJS. They included six female and three male participants. Participants represented key stakeholder groups from the community. Six participants were from the negotiation group that regularly participated in earlier NA meetings, the remaining three represented recent migrants and low-income households from the village. Participants signed a consent form and were remunerated for travel costs to the venue. Video recordings and photographs were taken throughout the workshop for reporting purposes.

The overall workshop design, including its structure, specific activities, and time management plan, is shown below in Figure 7.5. In the introductory session, facilitators presented the workshop's objectives, introduced the role-playing format, and conducted a pre-workshop evaluation. This was followed by the three role-playing games. The sequencing of games was important. It was assumed that the existing situation being most familiar to peri-urban residents, serves as a suitable starting point. The (future) urban water supply game was played next, given that it closely resembled game 1, extending it with a long-term perspective to the problem. This was followed by game 3, where participants focused on water quality aspects of the problem, and explored non-cooperative and cooperative groundwater monitoring strategies.

Facilitators began each game with an introduction to the drinking water situation to be examined and the objective of the game. Next, game materials were distributed and roles were assigned. Multiple rounds were played in each game, and each outcome was evaluated by the players. For example, 3 rounds were played in games 1 and 2, while game 3 had two rounds. Game 1, also included a trial round to familiarize players with the game materials. Each game concluded with a de-briefing exercise, led by the facilitator.

A wrap-up session concluded the workshop with a summary of activities and final evaluations of the game, workshop, participant experience, and learning.

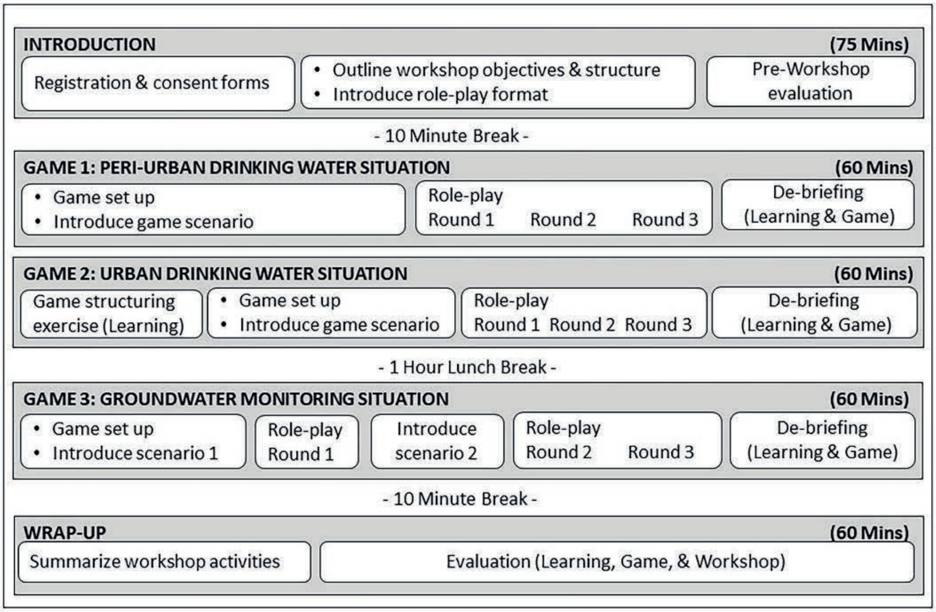


Figure 7.5 Overview and structure of strategy exploration workshop

The evaluation of step 4 follows the same protocols outlined in chapter 3 (Section 3.4). Evaluation of participant learning, gaming-simulation method, and overall workshop was designed into the workshop design.

Participant learning reflects the impact of step 4 on community's problem understanding. This was done by comparing problem understanding at the start of the workshop (as a pre-workshop discussion) and after each game during the workshop (de-briefing). Second, we identified higher-order learning outcomes. For this, a game-structuring exercise was conducted after the first game. Participants were presented with a new problem situation and asked to name the actors, actions, resources, and values. This exercise was used to assess whether knowledge and insights from the previous game could be applied to similarly structure other types of peri-urban problems. The methods were evaluated in terms of the appropriateness of role-play, real world representation, and clarity of the game. Workshop evaluation criteria included the structure and facilitation.

The evaluation medium was facilitated group discussions using flip charts. Different evaluations were structured throughout the workshop (Fig.7.5). Participants also filled out a post-workshop questionnaire in the wrap-up session. It was used to assess their overall workshop experience. During the workshop, observations were recorded by one of the facilitators on a process record form. This included the questions asked by participants during the games and outcomes of role-play activities. Evaluation results were later translated into English, coded in Excel, and analysed qualitatively.

7.2 Results of strategy exploration in Hogladanga village

This section describes the role-play activities conducted by the residents of Hogladanga during the strategy exploration workshop.

7.2.1 Strategies explored by participants during game 1 (Peri-urban drinking water supply)

In game 1, participants explored the existing (peri-urban) drinking water supply situation. The players included the peri-urban (residents), WATSAN committee (chairman), DPHE (engineer), a mechanic, and the two chance players—nature and other unions. Nature determined the viability of a tube-well installation site, whereas the chance player 'Other unions' decided the total number of applications received by the WATSAN committee.

Residents applied for a public tube-well in round one, the cost for which was paid using the monetary resource cards available to them. The WATSAN committee approved a tube-well license for the village. Thereafter, DPHE opted to assess aquifer conditions beforehand, as groundwater data was available (as one of DPHE's resource cards). However, nature revealed (by rolling the dice) the site to be non-viable, therefore installation was halted. Therefore, the outcome of round one was no additional drinking water supply for the village (the status quo in Hogladanga village). Figure 7.6 shows how game play was depicted on the game board in round 1. Scorecards indicated mixed feelings towards this outcome. Participants who played the residents and mechanic were likewise unhappy, whereas those playing the WATSAN committee and DPHE were satisfied overall, despite the outcome.

In reality, applying for additional public tube-wells is the village's preferred strategy to the drinking water problem, however, with the expectation that it is situated in a viable aquifer. In this round, that was not the case. In their negotiation plan, residents have explained that good quality groundwater is only available at 1000 ft., suggesting that DPHE provide public tube-wells of 1000 ft. depth instead (Jagrata Juba Shangha, 2018a).

In round 2, residents explored a different strategy. Residents used their monetary resources to invest in a private tube-well by hiring a mechanic. As groundwater data was unavailable (as a resource card) to both residents and the mechanic, no aquifer assessment was conducted prior to installation. This time, however, nature discovered the site to be viable, resulting in reliable, good quality, although more expensive drinking water supply. All players except DPHE were satisfied with this outcome.

In round 3, residents decided to re-visit the public drinking water option. This time, other unions also submitted tube-well applications to the committee. In this case, the committee decided to allocate all licenses to the other unions. This meant no drinking water supply for residents. As expected, they were unhappy with this outcome, while the committee and DPHE had mixed feelings, and the mechanic was satisfied.

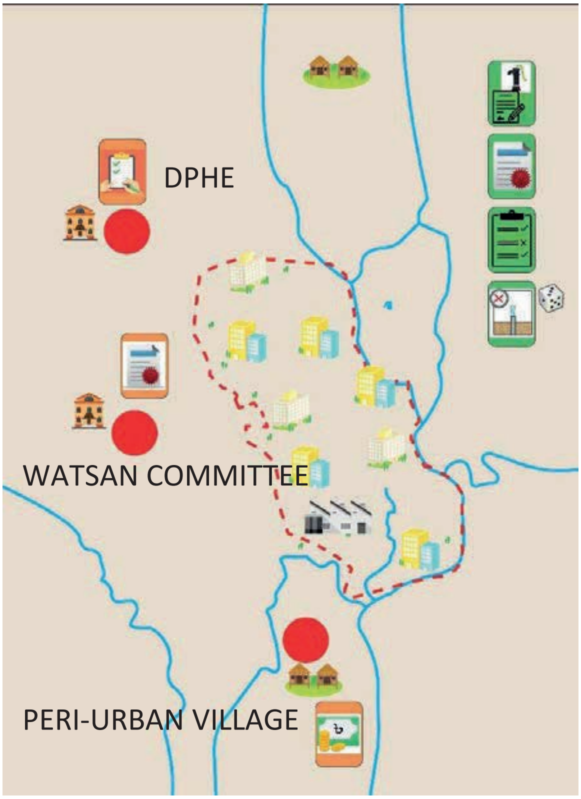


Figure 7.6 Game play in round one (Game 1) (Image courtesy Shawna Gomes, 2017)

7.2.2 Strategies explored by participants during game 2 (Urban drinking water supply)

In game 2, participants explored the (future) urban drinking water supply situation. The roles in this game included former peri-urban village (residents), Water Supply and Sewerage Authority (WASA) (engineer), bottled water company (manager), the mechanic, and nature (chance player).

In round one, residents applied for a piped water supply connection from WASA (paid using resource cards). The availability of piped water supply projects (a resource for this player) made it possible for WASA to extend good quality, reliable piped water supply (Figure 7.7). In this game, the assumption was that the new piped water supply project would also improve the condition of the infrastructure, thereby improving the quality of piped supply. After round one, a small discussion took place to explain to participants the current state of piped water supply in Khulna city in reality. It was explained that urban residents find the quality of piped water supply poor and unsuitable for drinking. This is the result of leakages in the infrastructure that KWASA had, in 2017, been working to address.

In round two, participants were asked to explore other strategies that afford better quality or more affordable water supply. Here, residents opted to purchase bottled water; however, they were refused by the bottled water company due to low production volumes (as stated on their resource card). This meant a return to the status quo of no drinking water supply for residents. Thereafter, they reverted to a familiar strategy in round 3 and paid a mechanic to install a private tube-well. However, following installation, the site was discovered to be non-viable by Nature. Thus, the outcome of this round is a failed tube-well installation, financial losses, and no water supply.

The scorecards in game 2 shows that residents were successful only in the piped water supply strategy (round 1). This outcome was considered satisfactory by both WASA and residents, although it scored poorly with respect to affordability by residents. The mechanic was indifferent, and the bottled water company was unhappy with this outcome. By comparison, round 2 was considered unsatisfactory by almost all players except for the mechanic, who was indifferent to the result. In round three, the outcome was poorly scored by residents as well as the bottled water company, while WASA was indifferent and the mechanic was happy, as they were paid for installation services despite the outcome.

Figure 7.7 Game play in round one (Game 2) (Image courtesy Shawna Gomes, 2017)

7.2.3 Strategies explored by participants during game 3 (Water quality monitoring)

There were three players in game 3: DPHE (engineer), village (residents), and the DOE (water quality analyst). These players were based on model 3, although it included the Monitoring agencies (M) which consisted of several actors including the DOE. However, in the game, this player was labelled as DOE as this actor was most familiar to the community. Participants were split into three groups to take on the roles of one of these three players.

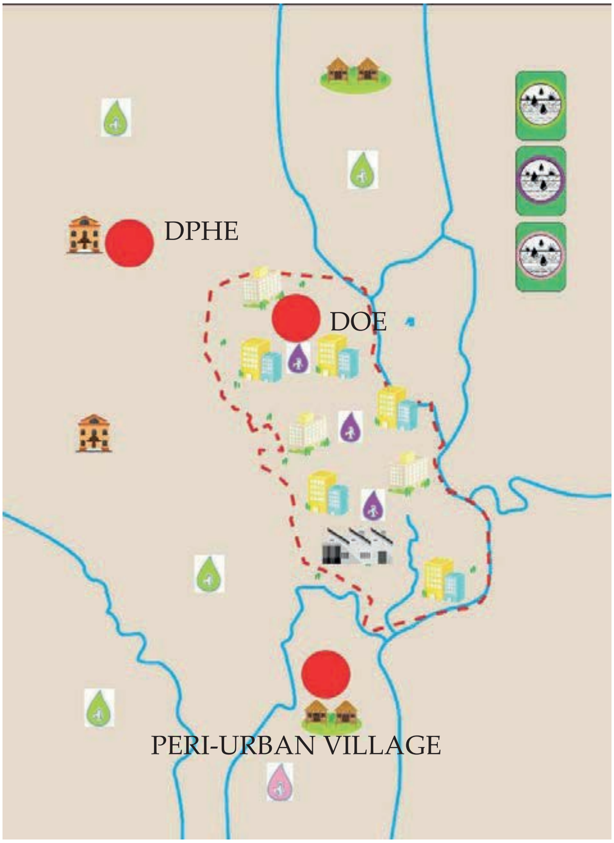


Figure 7.8 Game play in round one (Game 3) (Image courtesy Shawna Gomes, 2017)

In round 1, players identified the locations in which they individually collect groundwater data as part of their monitoring efforts. This is based on each player's role description card. The outcome of round one is shown in Figure 7.8. The monitoring icons shows that DPHE collects groundwater data only in non-urban areas from public tube-wells at limited times of the year (Green coloured icons in Fig. 7.8). Residents monitor both private and public tube-wells used for drinking purposes within their village (Pink coloured icons). The DOE's monitoring locations meanwhile are only within city areas, as per the instructions from higher levels of the department (Purple coloured icons). Scores in this round varied. Residents were indifferent to this outcome, as informal methods are, to some extent, helpful in managing daily water needs. DOE was satisfied overall, while DPHE was only partially satisfied, presumably as the data collected is insufficient and unreliable for decision-making purposes.

In round 2, players explored cooperative groundwater monitoring strategies in response to a groundwater crisis. Following negotiations, participants explained that a full consensus between all three players could not be reached, as they were unable to partner with the DOE. Only residents and DPHE agreed to share knowledge and information about groundwater conditions from their respective monitoring areas. Periodic meetings were arranged for this. Compared to round 1, all three players were satisfied with the outcome of round 2. Only groundwater availability was scored poorly by residents. A likely explanation for this is that collaborations with DPHE might improve groundwater quality given the shared interest, more so than groundwater level monitoring.

A summary of role-play activities in games 1, 2 and 3 are shown below in Table 7.1.

Game	Strategy	Outcome
Game 1. Peri-urban drinking water supply		
Round 1	License for public tube-well application approved but aquifer assessment pre-installation finds site non-viable, so installation is halted.	No drinking water supply in peri-urban village available
Round 2	Investment in private tube-well is successful, as installation site is discovered to be viable for groundwater.	Peri-urban village receives drinking water supply via private tube-well
Round 3	Application for public tube-well not approved by WATSAN committee as all licences are issued elsewhere.	No drinking water supply available for peri-urban village
Game 2. Urban drinking water supply		
Round 1	Application for piped water supply is approved by urban drinking water provider.	Residents get drinking water supply via piped network supplying treated surface water
Round 2	Bottled water companies refuse to sell water to residents of former peri-urban area.	No drinking water supply available for newly urban residents
Round 3	Failed investment in private tube-well as installation site is discovered as non-viable after installation.	Residents must either use the poor quality, unreliable groundwater from private tube-well or look for other alternatives
Game 3. Water quality monitoring		
Round 1	Individual (non-cooperative) monitoring by residents, DPHE, DOE	Fragmented groundwater data from different areas is insufficient for decision-making purposes
Round 2	Joint (cooperative) monitoring by residents and DPHE, while DOE monitors groundwater separately.	Sharing of groundwater data and better knowledge of aquifer conditions in peri-urban areas only

Table 7.1. Strategies explored during the community workshop in Games 1,2 and 3

7.3 Evaluation results from Step 4

This section presents the evaluation findings from the strategy exploration workshop. The effect on learning is presented first, which refers to the effect of step 4 on community's problem understanding. This is followed by the evaluation of the methods and facilitation process.

7.3.1 Effect on community understanding: Participant learning during workshop

The strategy exploration workshop in Khulna was designed to offer Hogladanga residents insights into their drinking water problem. A gaming-simulation workshop was used as a medium for local residents to explore strategies to address different aspects of this problem, and in doing so, also understand the strategic behaviour of other actors involved. It also intended to introduce the community to a new conceptual way of framing multi-actor problems. Evaluating participant learning helped assess the impact of step 4 on community's problem understanding with regards to these learning objectives.

Baseline problem understanding

The pre-workshop assessment in the introductory session (Fig. 7.5) represented the initial problem understanding among the participants from Hogladanga village. Community members explained that their drinking water problem relates to several aspects: poor groundwater quality (due to salinity and iron contamination), inconvenience of water collection from distant sources, groundwater depletion (seasonal scarcity), and wasted investments in tube-wells (as residents do not know the exact layer to abstract groundwater from). When asked which actors were involved in this problem, participants only listed women. It is true that women are most affected given their responsibility for household water collection. As six of the nine participants in this workshop were female, this response is not entirely surprising. In reality, however, the problem involves several actors. It is possible that this question was misinterpreted by participants as the actors 'affected' by the problem, or it represents a very narrow perception of the problem's scope or boundary.

Participants described two potential solutions to this problem. First, they see a need to identify the appropriate groundwater layer. This solution relates to the community's negotiation plan, which recognized that deeper tube-wells were needed to access better quality drinking water. This strategy requires support from the sub-district chairman and local Members of Parliament. Until now, the village has been unable to achieve this. Their second solution would be the installation of a water treatment plant nearby, although participants did not mentioned who would be responsible for providing this solution. The community realized they have a role to play in the problem solving process. Participants explained that they needed to present a united front while requesting solutions from the authorities. This type of collective action was not new to the village, but was practiced regularly, i.e., every time they apply for a public tube-well.

Insights from game 1

Short de-briefings were conducted following each game (Fig. 7.9). It highlighted the learning that resulted from each game. Participants' understanding of the tube-well licensing process was improved through game 1 (peri-urban situation). They learned that access to financial resources did not guarantee access to groundwater, given the important role of nature in the success of tube-well installations. Tube-well quotas was also a previously unknown factor in the decision making process of the committee prior to this workshop.

They discovered several new actors during game 1, including DPHE, WATSAN chairman, nature, and villages. Participants likely misunderstood this evaluation question, as these actors were mentioned by them earlier during field interviews and the pre-workshop evaluation. Although game 1 did not result in a new solution strategy, the strategy in round 2 was considered most satisfactory, and is reflected in the scorecards. Furthermore, participants learned that not all strategies led to satisfactory outcomes (especially for peri-urban residents), and that different strategies required interaction with different actors.

Figure 7.9 Evaluating problem understanding during the workshop (a) (top left) Comments from the pre-evaluation discussion (b) (top right) Recording the de-briefing in game 2 (c) (bottom) De-briefing led by workshop facilitator

Insights from game 2

Game 2 (future situation) provided insight into the application process for piped water supply. It highlighted the fact that the option to purchase bottled water depended on the availability of financial resources. This was a newly-discovered problem for participants. Moreover, in the event that future drinking water options (piped water supply or bottled water) wase unavailable, residents needed to fall back on existing strategies (private or public tube-wells) to access drinking water.

Participants learned that not all actors are satisfied with the same outcome. This was also reflected in the scorecards for different players. For example, bottled water companies were unhappy in all three rounds, although generally, round 1 (piped supply) was considered satisfactory by most players. In this way, participants discovered a new solution to the drinking water problem from game 2, namely, piped water supply. The session also led to the discovery of two new actors: bottled water companies and WASA.

Insights from game 3

The main learning from game 3 related to coordination with regards to groundwater monitoring. Participants noted that, in reality, both DPHE and residents are unwilling to monitor groundwater. But residents now felt they had a role to play, by informing the authority about the (local) groundwater situation. They saw a benefit from collaborating with the other players to identify a suitable groundwater layer. In round 2, residents successfully managed to collaborate with DPHE only. Both players did not see a need to collaborate with the DOE, as DOE operated primarily in city areas as shown in the game. It is likely that the DOE's role was not fully understood during the game. Players found resources helpful while negotiating agreements. However, it was possible that player resources cards (assets) were mistaken for physical water resources by some participants and/or facilitators. Their responses to this question suggested this.

Ability to apply problem structuring concepts to other peri-urban problems

Evaluating the transferability of problem structuring to other local problems was based on a game structuring exercise at the start of session 2. Participants were asked to list the basic game elements (actors, their actions, values, roles, and resources) in the future drinking water scenario. Only two actors were listed during this exercise: Khulna WASA and KCC, together with some details about their role, values, actions, and resources. This exercise shows that learning from game 1 could be easily applied to structure other peri-urban problems, although only to a limited extent. This is understandable, given the availability of information about this future scenario.

7.3.2 Usefulness of gaming-simulation methods for strategy exploration

Appropriateness of role-play in this context

The appropriateness of role-playing games as method in step 4 was evaluated during the introductory session. Participants expressed their familiarity with role-play through local dramas (e.g., theatre) and cultural events. Moreover, local experts had highlighted that in this context, 'games' are typically associated with informality and playfulness. Therefore, we purposefully referred to the games only as role-play activities during the workshop. Despite participants familiarity, significant time was spent initially to ensure understanding of the game materials (30 min) and to complete role-play activities (50 min) in game 1. Games 2 and 3 by comparison were completed much more quickly (10 min for role-play in game 2), with less assistance and greater confidence observed among the participants. A few pictures from the role-play activities are show below in Fig. 7.10.

Figure 7.10 Hogladanga residents role-playing their drinking water problem during the strategy exploration workshop

Community's perception of role-playing methods

The wrap-up discussion revealed that participants enjoyed the role-play very much, as it provided information about the problem and the institutions. Participants expressed an interest in disseminating knowledge gained from this workshop with others in their village. They requested support from JJS to provide game materials for this. This indicates that knowledge sharing is one of the wider impacts of this workshop. With regards to problem solving, the workshop highlighted the need for collaboration and showed how residents could conduct this with authorities. One participant also suggested that the game-based approach could be applied to examine other problems and used to facilitate multi-stakeholder workshops between the community and authorities.

Game clarity

Local residents from this village varied in their level of education, literacy, and socio-economic background. Therefore, significant effort was made to ensure materials were easy to understand by translating them using a previously-developed glossary of local terms. Game testing and facilitator training sessions helped identify potential questions that might be raised, or points of confusion. During the debriefings, we evaluated the clarity of all three games. Participants felt that role of description cards could be simplified further, and in some cases, be more specific. On the other hand, they were positive about the game board, particularly the visualization of rural-urban boundaries (Game 2) and negotiation outcomes (Game 3). Similarly, scorecards were well received, and were considered useful for comparing strategies.

Real-world representation

The game's representation of the real-world had mixed reviews. Some participants highlighted missing details such as, for example, politics at the WATSAN committee (due to pressure from higher level authorities and local communities). Similarly, the practice of groundwater monitoring was, in reality, much more limited compared to what the participants observed from session 3. On the other hand, preferential allocation of tube-wells by the committee to other unions over the village was considered accurate. On the positive side, participants experienced the complexity of problem solving through this game. Both nature and player's resources (for example, financial constraints) were found to strongly influence the outcome, especially in game 2. In game 3, participants compared negotiations in the game to multi-stakeholder meetings held by JJS as part of the shifting Grounds project. In other words, participants recognised that real-world negotiations to address peri-urban problems often requires third-party involvement and support.

7.3.3 Usefulness of strategy exploration workshops

Workshop design

A post-workshop questionnaire was used to evaluate overall participant experience. Respondents expressed that the workshop made them feel happy (n=8), sad (n=2), and inspired (n=1). The workshop was convenient to attend for peri-urban residents, at an appropriate venue, and with sufficient refreshments and breaks. Finally, six participants would have preferred the workshop to be longer in duration, while the remaining considered it to be appropriate.

The time allocated for each game was considered appropriate, aside from the negotiation round in game 3 and in game 1, where more time was needed. It was suggested that the game materials could be shared prior to the workshops to give residents more time to understand them. Fig. 7.11 below shows the game materials being used by Hogladanga residents during the game sessions.

Figure 7.11 Participants using game materials during the workshop (a) (top left) Facilitator explaining resource cards (b) (top right) Participants filling out scorecards (c) (bottom)

Facilitation

Facilitation was overall positive, although it was highlighted that facilitators needed further training on the order of play. This is also visible from the video footage taken during the workshop. Despite the use of local terminology, participants misinterpreted certain elements of the game. Efforts to involve facilitators—who have knowledge about the local context and culture—earlier in the design process might prevent this. Significant time and effort was spent preparing facilitator scripts and conducting training sessions. This was found to be very valuable during the workshop. Although facilitators had no prior experience with gaming-simulation or game theory modelling, their expertise and relations with the community were valuable during the workshop. Participants felt comfortable, and did not hesitate to ask questions or communicate their feedback as a result.

The three games were explained well according to participants, despite problems understanding the materials in game 1. They noted that some participants needed more help than others, as not everyone had the same level of problem understanding. Those who had participated in project meetings in the past felt more comfortable discussing local issues, whereas additional background information about actors was required by first-time participants.

7.4 Synthesis of results from Step 4

The purpose of step 4 was to support problem solving in drinking water problems by giving Hogladanga residents insight into the institutional context of their local problem. Gaming-simulation methods were expected to facilitate strategy exploration by local communities. Role-play activities shows how this was achieved and its impact on participants problem understanding as a result .

Workshop results highlight learning on several fronts. A fair understanding of problem complexity existed already, as demonstrated by the pre-evaluation discussion. Despite this, several new problems were identified during the sessions. Participants discovered new actors previously unfamiliar to them. Institutional knowledge also improved, particularly formal rules for water supply. The community also attempted to create new rules in session 3 to try and improve groundwater monitoring. Prior to the workshop, there were two solution strategies available. Their preferred solution prior to this workshop was to enlist the help of government actors to identify a suitable groundwater layer.

Although problem structuring did not result in a different negotiation strategy by the community, several strategic insights were found. First, depending on the strategy, the community can interact with different actors in the drinking water problem. Second, not all strategies result in satisfactory outcomes. Third, layers resources (assets) constrain certain strategies (e.g. community finances and committee licence quotas). And fourth, that in the future, urbanization brings in new strategies to access drinking water (e.g. piped supply). However, outcomes are not guaranteed leaving a fall back option which is the reliance on existing drinking water strategies.

The community previously recognized a need for collective action to solve problems. However, it related to the need for jointly raise local concerns and request solutions from the government. After the workshop, the community discovered they also have role in groundwater monitoring, recognizing the benefits of collaborating in this regard and at the same time, acknowledging the unwillingness of some actors to cooperate.

Overall, the experience with gaming-simulation methods to facilitate strategic exploration has both pros and cons. The game theory models used to design the game was limited in the number of players in the game. This led to a simple game. It left out other details which were highlighted by the participants during the de-briefings. Furthermore, during the workshop, strategic analysis did not extend beyond a basic comparison between outcomes. The value of game theory is partly in the analysis of solutions. This was excluded from the workshop's scope in step 4. However, the achieved level of strategic insight was a sufficient first step for the community. At this stage of problem, a simple game was preferred. Game theory models were valuable starting points in the game's design. Chapter 7 shows that model inputs (players, actions, outcomes, and payoffs) can be easily translated into a role-play game.

The role of the facilitators in step 4 is important to highlight. Preparations for this workshop to develop facilitator scripts and conducting training sessions were significant. Despite not having prior experience with this method, facilitators local knowledge and familiarity with the participants was valuable during the workshop. This led to a relatively smooth workshop, with participants openly discussing their problems and their impression of the workshop. Therefore, the facilitator's role should not be undervalued during the design and preparation of problem structuring workshops.

This single community workshop provides a limited basis for more general conclusions about the uses of gaming-simulation methods to support strategy exploration by peri-urban communities. As mentioned earlier, two additional strategy exploration workshops were also conducted, one with government representatives in March 2018 and another with the same Hogladanga residents in July 2018. These workshops provided a basis for broader reflection in the future. The following chapter discusses some of the findings from the government workshop in further detail.

Chapter 7 and the preceding chapters 4 - 6 showed the implementation of the APIA approach in Hogladanga village. The next step is to determine its potential in other case-studies. Chapter 8 describes the generalization of the APIA beyond Hogladanga village. It discusses the experiences of applying different parts of this approach in other peri-urban contexts.

Photo courtesy: The Researcher (2019)

Chapter Eight

Transferrability of the APIA:

Generalizing Beyond the Hogladanga Case Study

8.

TRANSFERABILITY OF THE APIA: GENERALIZING BEYOND THE HOGLADANGA CASE STUDY

This chapter is based on the field reports by Gomes (2014, 2018) which describes research in Thiuria and Badai villages (Kolkata, India) and the paper by (Gomes et al., 2018a) *describing the government workshop in Khulna (Bangladesh).*

The previous four chapters described the implementation of the APIA in the peri-urban village of Hogladanga. Methods and results revealed the kinds of insights this approach provided to the community with regards to their drinking water problems. For this case study application, the approach was adapted to the context of peri-urban Khulna, specific problems faced by Hogladanga, and their unique problem solving needs. These chapters provided a basis to evaluate the usefulness of the APIA for Hogladanga. However, this is insufficient to make broader generalizations beyond this single case study.

Therefore, the purpose of Chapter 8 is to explore other case studies to determine if and how the APIA may be transferred elsewhere. Alongside the APIA application in Hogladanga, parts of this approach have been used in three other case studies in the Ganges delta. Section 8.1, examines the peri-urban village of Badai (India) where steps 1 and 2 of the APIA were used to identify the main challenges faced by this community. Next, section 8.2, follows the case study of Thiuria (India) to highlight process related considerations when implementing the APIA in other contexts. Finally, section 8.3 presents results from a capacity building workshop with government representatives from Khulna (Bangladesh), that made use of step 4 of the APIA, game-based strategy exploration.

8.1 Problem identification and institutional mapping in Badai village

The APIA approach was initially designed for Hogladanga village in peri-urban Khulna. The first step of the APIA is identifying the most pressing community problems. In Hogladanga, this was access to safe drinking water supply. However, the types of problems experienced by local communities can differ across peri-urban areas. This section describes the case of Badai village, in peri-urban Kolkata where the first two steps of the APIA were applied to Badai's water issues caused by industries.

8.1.1 Implementing Steps 1 and 2 in Badai village

Badai village is situated to the north of Kolkata city, in Barrackpore II block in the Indian state of West Bengal. Here, agricultural activities are much less, compared to other peri-urban areas of Kolkata. This is because Badai is situated in an industrial region. Industrial development in this panchayat dates back two decades. The number of industries have increased significantly, especially small scale industries. Many dyeing and bleaching industries operate in Badai due to the good market connectivity to Kolkata. Other industries include chemical, leather, engineering, and electrical enterprises. Fig. 8.1 shows the extent of industrial areas in Badai.

Figure 8.1 Satellite image of Badai village (Image courtesy Mittal 2019)

This village was one of the four project sites in the Shifting Grounds project, but was not a case study where more intensive capacity building and research activities were conducted. Despite this, it provided a basis for applying the initial steps of the APIA approach, namely problem identification and institutional analysis. For this, field visits were carried out in October 2014 and November 2016, with the help of local partners from 'The Researcher' in Kolkata. Prior to the second field visit in November 2016, a case study report by Banerjee (2016) had revealed the presence of industrial related water issues in Badai village. Therefore, the second field visit attempted to understand the impact of industrial activities on the local community, and the institutional context of this problem.

The visit to Badai in October 2014 provided a general impression of the institutional context in peri-urban Kolkata. During this time, 17 interviews were conducted with state, block, and *panchayat* level government departments and elected officials (Appendix 10). Interviews focused on formal and informal institutions and key issues affecting Badai residents (Gomes, 2014). In November 2016, a more in-depth field visit was conducted (Appendix 11). It consisted of eight key informant interviews with government representatives at the state, district, block, and village levels concerned with local administration, irrigation, groundwater regulation, industrial development, and pollution control. At the village level, interviews were with two farmers and two local industries. Site visits to the two local industrial facilities were also provided by the factory owners. Meetings were conducted in either Bengali or English and lasted between 60 - 90 minutes. They were organized through the local partner using snowball sampling. Interviews were semi-structured around actors objectives, role, key concerns, related institutions, day-to-day operations (or activities) and possible solutions (Gomes, 2018). Primary and secondary data sources were used to identify the main problems in Badai and sketch a brief analysis of the underlying institutions.

8.1.2 Badai's water problems and industrial activities

An institutional analysis of Badai's water problems was done using the IAD framework (Fig. 3.2), the results of which are summarize below in Fig. 8.3.

Exogenous variables

The investigation revealed the complexity of problems associated with Badai's industrial sector. All industries, including micro, small, and medium sized (MSME) industries, required various permits to establish and operate as an industry, including permits for land conversion, groundwater abstraction, and effluent disposal. These permits are issued by their respective departments as per the formal rules. The lengthy processing time, political interest in industrial development, and regulatory capacity at the local level were said to be deterring factors for industries to secure the required permits. Many illegal industries are believed to be based in Badai, although the exact numbers were not available during data collection activities. This caused different kinds of water issues in Badai.

Industrial activities affected local water resources. Dyeing and bleaching industries, in particular predominant in Badai, relied heavily on groundwater for their manufacturing processes. Some had experienced a decline in the groundwater level over time, like for example, a large dyeing factory in Badai that pumped around 1.2 - 1.5 million litres of groundwater per day since their operations began six years earlier. It was unclear what the cumulative impact of industrial groundwater abstraction is on the local aquifers.

The Groundwater Act (2005), implemented by the State Water Investigation Department (SWID) specifies the rules for groundwater use. All industries required a permit to abstract groundwater. The entire permit application process at the time of this research (2016) cost €12.83[15] and took up to 20 days. SWID geologists were required to inspect the local aquifer depth to decide the pump capacity. However, there were no limits to abstraction volumes. Penalties for illegal abstraction by industries, however, did exist (€64.19 for a first time offense and €128.38 for a repeated offense).

Actors and Interactions in the Action Arena

Implementation capacity of the formal rules was limited. Local SWID offices in places like Badai were not equipped to manage the application volume and site visits. In the North 24 Parganas district for example, there was one geologist overseeing the entire

[15] Based on a conversion rate on May 23, 2019 of €1 = ₹77.7

district. This was also true for other kinds of permits such as the Land Clearance Certificate, issued by local Land Revenue Offices. The Groundwater Act (2005) also specifies a spacing rule for installing submersible pumps. Industries need to keep a minimum distance of 200ft between pumps. In industrial zones such as in Badai, this was difficult to apply, as industries were densely situated near one another.

Surface water resources were also affected by industrial activities. Industries that released untreated effluents, contaminated local water bodies with chemicals like acids and sodas. Field visits revealed that some small industries in Badai had no drainage system or Effluent Treatment Plants (ETPs) and released untreated effluents directly into nearby fields. This had impacted local water bodies (Fig. 8.2). Pollution of local canals has affected livelihood activities. The Noai canal (*Khal)* for example used to be highly productive with lots of fish (around 2008-2009) and was used a lot for farming. However, pollution destroyed fish populations and irrigation activities, to the extent that entering the canal in 2016 led to some having skin irritations. A local rice farmer explained that approximately 0.1[16] ha of his farmland had been uncultivable for 3 years (prior to 2016) due to pollution from a nearby dyeing factory, highlighting that "even grass does not grow in that area" (Gomes, 2018)(Fig. 8.2). This was causing economic hardships for local farmers. Affected farmers faced losses of as much as €770 per year due to pollution. This action situation is represented in the IAD schematic diagram in Fig. 8.3 as stage one.

Figure 8.2 Clockwise from top left: Dyeing factory situated near farmland; Industrial effluents from dyeing factories entering local drains; Small industries in Badai village (Photos courtesy Gomes, 2016).

[16] In West Bengal, *kata* is a commonly used land measurement unit where 1 *kata* = 0.006 ha

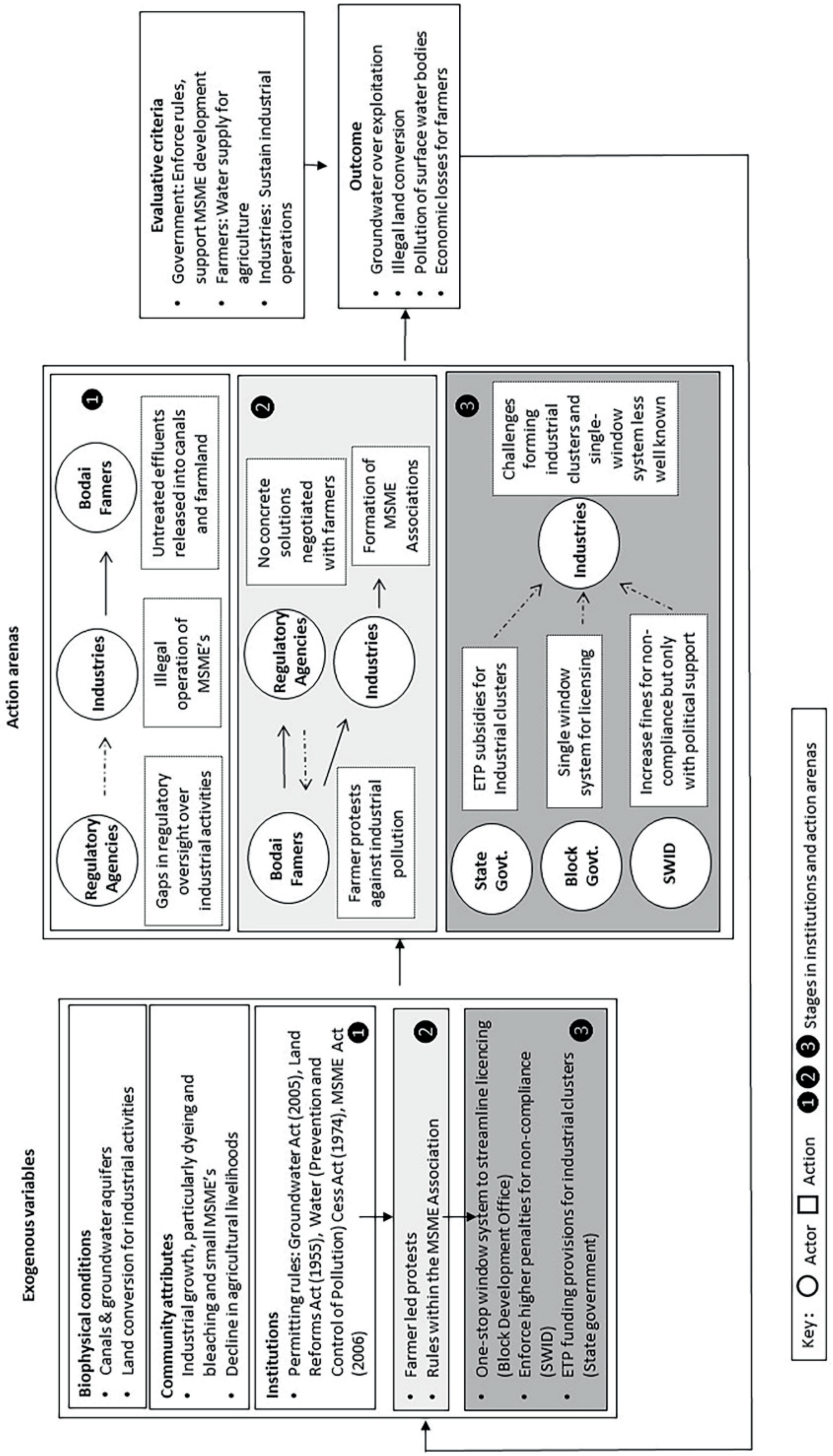


Fig. 8.3 IAD application to Badai's industrial related water problems. Steps 1,2,3 represent different stages of the problem over time.

In 2009-2010, farmers from Badai and other neighbouring villages organized protests against pollution problems caused by industries. The issue was raised with the local Pollution Control Board (PCB), Agriculture Department, *panchayats* and industry association. These efforts , however, did not lead to any solution or assurance from the government. This represents stage two of the problem situation in Fig. 8.3.

However, in 2016 several strategies were being explored by the government to address the water relates issues caused by local industries. For the effluent problems, the state government had agreed to fund common waste management facilities including solid waste, drainage channels, and ETPs for industrial clusters. Industrial cluster development began in 2000-2001 with funding from the District Industries Centre (DIC) for soft interventions like training. In Badai, smaller industries in particular could benefit from a shared ETP. However this required industries to provide the land and the local industries were hesitant to sacrifice their own land for this. Since 2013, the state government was also trying to incentivise investments in pollution control equipment through subsidies. However, this was not an option for older industries in Badai as it only applied to those recently established.

With regards to groundwater abstraction, government agencies were working on ways to improve the licencing process. One way could be through stricter enforcement of permits for land clearance and groundwater abstraction. Increasing SWID penalties (as attempted in N24 Parganas by the previous District Administrator) had previously proved effective in restricting illegal abstractions. Reducing the processing time was another option explored at the time. For example, in 2016 land clearance certificates were issued within 21 days, an improvement from previous turn around times. There were also attempts to streamline the permitting process. The DIC launched a single window system and online application submission system as part of their role stated in the Micro, Small, & Medium Enterprise (MSME) Act (2006). This single window system was expected to improve the ease of doing business, reduce the load on local offices, and eliminate corrupt practices. In the past, permits had to be applied for separately and this was believed to be the reason why many statutory licences were missed or avoided. The DIC also offered guidance on licencing and promoted availability of subsidies, self-employment schemes etc. Although awareness of the new system was limited, as it was still relatively new in 2016, its success had yet to be determined.

Informally, industries were also taking steps to improve manufacturing processes in an attempt to reduce groundwater usage and industrial pollution. One such factory was found in Badai. It had its own, on-site ETP with a capacity of 400,000 litres per day (Fig. 8.4). Not only did it have up-front investments costs, but ongoing costs (e.g. treatment materials and ETP operators) were also borne by the factory. Dyeing processes had been automated to reduce water usage (Fig. 8.4) and the factory owner also expressed interest in transitioning to a zero discharge facility in the future, to further reduce groundwater use.

Figure 8.4 Dyeing factory in Badai village. Clockwise from top left: Scale of factory operations; On-site effluent treatment plant; Automated dyeing machines; Difference in effluents before and after treatment (Photos courtesy Gomes, 2016).

However, not all factories had the necessary resource capacity to take these steps. Some local MSME's had, self-organized as industrial associations. These associations help coordinate infrastructure development, permits and serve as a point of contact between local industries with the DIC. The one in Badai was trying, in 2016, to expand its network with other industries in a 6 km radius. It remains to be seen if such associations will help MSME's to take similar actions to reduce their impact on local water resources. Together, these changes in the action situation reflected stage three in the IAD schematic of Badai's problems (Fig. 8.3).

8.1.3 Potential of the APIA to address different types of problems

The Badai case study shows the different kinds of problems that local communities can experience during urban transitions. It highlights the contextual differences between peri-urban areas of South Asia. This case study was intended to assess the potential of the APIA to address a variety of problems.

Results suggest that the industrial water issues discovered in Badai, bear similar characteristics for which the APIA was designed. First, it was a multi-actor problem, where actors differed in their interests and objectives. Industrial activities impacted local farmers but also posed a problem for government departments responsible for regulating them. There were also differences in the capabilities of MSME's and larger industries to reduce their impact on local water resources. In other words, problem solving in this context required understanding the actor arenas in this problem and taking into consideration their different needs and constraints. The APIA is designed to provide insight into this.

Second, industrial problems in Badai appear to exists in a complex, fragmented, and evolving institutional context. This suggests that the institutional systems in different kinds of problems, can similarly benefit from the structure and analysis offered by the APIA. The Badai case study also highlighted the gaps in institutional implementation, especially at the local level due to resource constraints. On-going efforts, both formal and informal, highlighted several potential solution strategies that could be explored further or supported through capacity building efforts. In this way, it would have been possible to further continue with the remaining steps of the APIA, although this was outside the scope of this research.

Third, the industrial problems in Badai led to marginalization of local farmers. Due to uncontrolled industrial development, agricultural livelihoods were threatened by loss of agricultural land and pollution of local water bodies by industrial effluents. Here, the APIA could also benefit local farmers by helping them explore livelihood strategies under different scenarios of industrial growth and water scarcity. For these reasons, there is evidence that the APIA is suitable to address different types of problems, in other contexts.

The results from Badai village demonstrate the analytical value of the methods used in step 1 and 2. However, research uptake into capacity building efforts lies outside the scope of this case study. In Badai, following initial site selection, further capacity building through the NA was not pursued by the local partner (The Researcher) due to limitations in project resources. Therefore, apart from the participation of local stakeholders in the data collection activities, the APIA application has, thus far, not used the results from step 1 and 2 to structure capacity building. It was only at the final Shifting Grounds project workshop in September 2018, that results were presented to government and community stakeholders in Kolkata, some of whom were from Badai (Fig. 8.5). Therefore, conclusions about how this research influenced the community's problem understanding in Badai cannot be drawn.

It is expected that the same considerations used in Hogladanga are needed when applying the APIA to different kinds of problems. In Badai, insight into the problem is relevant for farmers, but this approach can also be relevant to support on-going strategic government responses to industrial issues. Part of intervening in institutional problems is identifying the appropriate problem owners and ultimate beneficiaries of the intervention. In any case, it is important to consider the sensitivity of the problem in the design of capacity building activities. Industrial development in Badai appears to be a politically sensitive issue, so proper care must be taken in engaging with local stakeholders. It is important to build support and trust with local leaders and private sector organizations such as the MSME's.

Figure 8.5 Sharing results from institutional research in Badai village with local stakeholders during the final Shifting Grounds workshop (Photo courtesy The Researcher, 2018).

8.2 Process related experiences with the APIA in Thiuria village

In Hogladanga, the APIA was used to support the residents, specifically drinking water users, who were involved in each step of this approach. However, it remains to be seen whether similar interventions with communities can be successful in other contexts. This section describes the process-related experiences with a participatory problem solving approach in the village of Thiuria, India. Like Hogladanga, the primary concern in this village was access to safe drinking water supply. However, the implementation of the approach was less intensive from that of Hogladanga.

8.2.1 Drinking water problems in Thiuria village

Thiuria village was selected as one of the two sites for capacity building using the Negotiated Approach in the Shifting Grounds projects. In Thiuria, both research and capacity building was undertaken in an intensive way. These activities were initially structured in a similar way to that of Hogladanga. This included institutional research using the APIA and capacity building led by The Researcher in Kolkata based on the Negotiated Approach. Research activities in Thiuria village were conducted as part of the field visits in 2014 and 2016 (refer section 8.1.1). The list of meetings conducted in Thiuria during these visits is provided in Appendix 10 and 11. The background to Thiuria's water problems below is based on the data from these visits and secondary sources.

Initial discussions with local residents in Thiuria, led to the identification of safe drinking water access as the most crucial problem. Unlike Hogladanga, the nature of drinking water problems in Thiuria varied significantly. In Thiuria, three types of drinking water sources existed. Formal drinking water services were provided by the Public Health Engineering Department (PHED) through public tube wells and surface water supply via a piped network. However, public drinking water infrastructure was only available in the northern part of the village. The southern area was isolated with poor road connections to the rest of the village. This made it extremely challenging for local women and children to collect drinking water (Fig. 8.6).

Figure 8.6 Drinking water collection in Thiuria village (Photos courtesy of Gomes, 2016 and The Researcher, 2018, 2019).

Figure 8.7. Bottled water supply in Thiuria village: (Top) Advertisements for different types of packaged water; (Bottom) Water distributor (Photos courtesy of Gomes, 2016 and The Researcher, 2019)

Infrastructure in the northern parts of the village had several issues. Piped connection in northern Thiuria, supplied drinking water (a combination of surface and groundwater) for only 2 hours a day from a nearby distribution tank. From here, seven to eight secondary connections were available in other parts of the village, but they were insufficient to cater to the needs of the entire village. Moreover, some were affected by seasonal scarcity and are inaccessible during the monsoons. Drinking water quality was also a big concern, given that these areas were situated in an Arsenic prone region. Local residents also revealed the presence of iron in their groundwater. Given the irregularity of water quality testing, high cost for private testing, and poor proximity to the nearest PHED laboratory, Thiuria residents were unaware of their drinking water quality.

Informally, Thiuria's bottled water industry also played an active role in drinking water supply. Several bottled water companies have emerged since 2013, that supply to different areas of the village through local distributors (Fig. 8.7). The cost for bottled water varied depending on the source and credibility of the brand. In Thiuria, it was between €0.19- 0.25 in 2016, which was unaffordable for many households, given their economic background. Furthermore, the quality of bottled water was unknown as these companies were believed to be operating illegally, without commercial permits or water quality standards.

Institutionally also, the drinking water problems of Thiuria village were different. Like all rural areas in India, Thiuria is governed by a *panchayat raj* system[17], where village councils or *panchayats* are the lowest administrative unit. Thiuria village is part of Kheyadah-I panchayat. Prior to 2016, drinking water supply in rural areas was the responsibility of the PHED. Their responsibilities included infrastructure O&M. However, in 2016, the West Bengal government started handing over O&M of all drinking water infrastructure to local panchayats as per the National Rural Drinking Water Program (2009). In November 2016, this had not formally occurred in Kheyadah-I gram panchayat. In general, however, panchayats were ill equipped to handle the technical and financial responsibilities of drinking water infrastructure O&M. A panchayat-level water and sanitation committee should exist. This is mandated by the Ministry of Drinking Water and Sanitation (2011). However, in Kheyadah-I the committee was believed to exist only on paper. For bottled water companies, the SWID was responsible for regulating groundwater abstraction through issuing of permits and inspections. However, the fragmented nature of West Bengal's regulatory agencies, required SWID to coordinate with other permitting authorities which has proved challenging. As a result, the uncontrolled spread of illegal bottled water industries with no formal water quality control, was not only becoming a big problem in Thiuria, but in other areas of West Bengal too.

8.2.2 Implementing participatory problem solving in Thiuria

Efforts for capacity building through the NA in Thiuria were directed towards addressing the above mentioned drinking water problems. However, several challenges were faced in the implementation as a result of vested interests and local politics.

Despite a relatively homogenous community in terms of caste, there was a deep political divide (Banerjee, 2018). The political dynamics also changed over time, during the course of this project, where the ruling party was replaced by its opposition following state elections in 2011 and subsequent panchayat election in 2014. Therefore, earlier connections with panchayat officials and local leaders could not be relied upon for NA activities. The local partner also found it difficult to bring together interest groups, particularly those from opposing political fractions (Banerjee, 2018).

This political reality strongly influenced the kinds of issues that could be taken up during the NA activities with the support of the panchayat chairman (or *prodhan)*. During the initial visits to the village in 2014, support for the project was received from

[17] The *Panchayat Raj* is a decentralized form of governance in India. It was formally recognized in Part IX of the 1992 Constitutional amendment. It serves to "endow the panchayats with such powers and authority as may be necessary to enable them to function as institutions of self-government" (Article 243G).

the then chairman. Even more, this person had provided valuable insights into the socio-economic history of the village and gave the project team a tour of the local village and bottled water plant. The Researcher had also established good connections with the local youth club which played an important role in village development.

However, since these initial meetings, powerful interest groups attempted to disrupt the NA activities for fear that the project would create problems for the local bottling industry (Banerjee, 2018). Given the sensitive nature of this issue, time constraints within the project, and apparent divide between pro- and anti- bottling industry interest groups, the focus of NA activities shifted away from attempting to negotiate between these conflicting interests. Instead, project activities focused on the issue of arsenic contamination in drinking water. This was a less controversial issue in the village, for which there was widespread support to take it up, making this a more feasible starting point to engage the village community in dialogue and capacity building activities (Banerjee, 2018).

Following the 2016 State Assembly elections in West Bengal, previous local connections were no longer able to engage in project activities. It required The Researcher staff to spend significant time and resources on re-establishing local networks. Following this, a series of participatory arsenic awareness and testing programs were developed and implemented, with additional support from the South Asia Arsenic Network (Fig. 8.8) (Banerjee, 2018). In the first arsenic detection program, 40 samples from local domestic tube-wells along with ten samples drawn from public tube wells were tested and the results were shared with local panchayats, Non Governmental Organisations (NGOs), PHED, and residents. Thereafter, a larger arsenic mapping and testing program was conducted in seven villages from the panchayat jurisdiction, in which 55% of domestic tube-wells were found to be contaminated with arsenic above the permissible level. Alongside, local health camps were organized in partnership with the Block Medical Health Officer. These local health camps consisted of medical check-ups for arsenicosis symptoms and arsenic awareness materials were shared with the village (Hermans & Gomes, 2018).

Figure 8.8 Arsenic awareness and testing programs conducted by The Researcher as part of the Shifting Grounds project (Photos courtesy of The Researcher, 2017, 2018)

8.2.3 Reflecting on participatory problem examination in different political contexts

The experiences with participatory problem solving in Thiuria village, demonstrate the challenges of implementing participatory problem solving in different contexts. Unlike negotiations for access to safe drinking water supply in Hogladanga, the nature of Thiuria's drinking water problem appeared to be much more political, given the existence of a powerful bottled water industry and the deep political divide within the village. As a result, the problem boundaries were eventually re-drawn to focus only on the uncertainty of arsenic contamination in drinking water sources. This allowed problem solving to still focus on an issue of significant concern to the village, without putting local residents at risk. Local governments were very supportive of the arsenic campaign set up through the project, and even expressed a desire to broaden the scope of the study.

This suggests the importance of understanding the political context behind local problems, while attempting participatory problem solving. In Thiuria, politics was strongly entangled in daily life. Political changes meant that significant efforts were needed to involve new leadership. Failure to recognize or consider this during the stakeholder engagement process can be detrimental to the momentum and impact of the intervention. First, the political divide within the community calls for appropriate engagement strategies to involve different interests groups, without alienating or creating conflict. In the process in Thiuria, the formal panchayat system could not be bypassed or ignored, even if the staff of The Researcher was well aware of its political colour, and the fact that it could change completely after elections. In the Shifting Grounds project, local partners in Kolkata conducted a formal and informal NA process to overcome this (Hermans & Gomes, 2018).

It is also important to identify whether suitable policy windows are available to take up problem solving in a participatory way. Although research highlighting the important role that the local bottling industry plays in both drinking water supply and groundwater use, the divide across political lines on this issue made it difficult for the project team to address the broader drinking water supply problems. Participatory interventions, in other words, must balance the relevance of the topic for the beneficiaries with its feasibility given the resources available in the project (such as time, social networks etc.). This, naturally might leave the most sensitive, yet pressing issues off the negotiation table, but gives local communities a chance to experience policy interventions in formal arenas.

This case study did not make explicit use of the APIA approach. The lessons learned are based largely on capacity building activities structured around the NA. Despite this, it offers lessons regarding replicating the results in other contexts, experiencing very similar kinds of problems.

At first glance, Hogladanga and Thiuria case studies appeared similar in terms of drinking water problems. However, closer examination revealed several differences between the two. First, there are differences between the institutions, given that they are situated in different countries. Unlike Bangladesh, water management is a state subject in India. A separate groundwater act exists to regulate abstraction which clearly states the authority responsible for implementing this. With regards to drinking water supply, the public service providers are similar in both cases, however, in India certain functions are now shifting to local panchayats.

There are also bio-physical differences between the two contexts. Unlike Hogladanga, urban development was less of a concern in Thiuria. However, informal water markets had already established themselves in Thiuria. Similarly, formal service providers there focused on increasing surface water supply given the high risk of Arsenic contamination in the region (Gomes, 2018). These differences suggests that the results of the APIA application to drinking water issues in one area, may be useful elsewhere. However, differences in the institutional, biophysical, and socio-political aspects limits any direct applications of results. Replicating the APIA even in very similar kinds of problems, requires a location specific analysis and model.

8.3 Using the APIA with different types of problem owners

This section explores the potential of the APIA with other kinds of problem owners. The case study in Hogladanga was focused on using the APIA to support a marginalized group of actors, the local community. As part of this application, a game-based strategy exploration was undertaken in step 4 with regards to safe drinking water supply. At the same time, a first step was made to explore the APIA with different problem owners in peri-urban Khulna. Local representatives from different government departments in Khulna were invited to a separate session of the same game-based strategy exploration workshop that was earlier conducted with village representatives.

For these government stakeholders, the ability to provide safe drinking water supply was also a problem. Research had previously highlighted that the fragmented institutional context had affected the government's ability to effectively manage water resources. Government departments, like communities, also had knowledge gaps in terms of the situation at the local level as well as spatial differences in drinking water supply and groundwater monitoring. Moreover, interviews revealed that there were limited opportunities to discuss and coordinate management strategies on this topic. Therefore, the game-based strategy exploration workshop was expected to serve as an platform to address this. Moreover, it was an opportunity to explore the kinds of insights that government actors could gain through game-based strategy exploration.

8.3.1 Strategy exploration workshop with government stakeholders in Khulna

Background and preparations

On March 29, 2018 a strategy exploration workshop was conducted with five local government representatives in Khulna from DPHE, DOE, KCC, the Khulna Development Authority (KDA), and the BWDB. It was facilitated by JJS and was presented as a simulation exercise, rather than a role-playing game, as recommended by local experts. The workshop was conducted in the local language (a dialect of Bangla). Due to limited availability of the participants, the workshop was half-day in duration during which time two role-playing games were played.

The games were identical to those played with Hogladanga residents in terms of the roles in the game, role-play, and evaluation. The two games were selected as per the backgrounds and interests of the participants. Participants played the groundwater monitoring game first followed by the urban drinking water supply game (Fig. 8.9). Further details on the role-play activities in each game are provided in the report by Gomes (2018). For now, only evaluation results are discussed.

Figure 8.9 Government representatives exploring strategies in Khulna's drinking water problem through simulations (Photos courtesy of Gomes, 2018)

Results from the pre-workshop assessment revealed that the government's perspective of the drinking water problem stems from the naturally occurring biophysical groundwater aquifer set-up. They explained that even at 400ft, groundwater is unsuitable for consumption in the Khulna area. Moreover, with climate change playing a role, the government would be unable to manage this changing hydrological system. Therefore, augmenting alternate sources like rainwater and surface water is considered the only solution, where different government departments have a role to play.

Workshop results

Participants explored groundwater monitoring in the first simulation exercise. The de-briefing showed that this activity demonstrated the benefits of collaborating, although, participants explained that the challenges of collaborating were already known to them. Here, government representatives explained that platforms for knowledge sharing existed, but that limited resources (man-power and information especially) and sanctioning power at the local level prevented further actions. It was also suggested that communities were unwilling to monitor groundwater resources, but that their involvement could help government actors, given the resource constraints.

Next, the participants explored drinking water in the future (following urban expansion). The de-briefing highlighted that in the future, drinking water supply would be uncertain given the gaps in data and availability of new projects. Participants also added that taxation of public services like water supply would likely become an even bigger challenge for the government in the future. This related to the existing problems associated with regulating private tube-well installations and the unsustainable tariff structure for water supply in Khulna city. This showed that government actors were aware of the risks that existing governance gaps posed in the future if unaddressed. It also confirmed the reasons for water supply reforms being adopted by Khulna city's water provider, KWASA.

Evaluation by participants

Like the community, the government representatives who participated in this workshop had never before used simulation (i.e. role-playing games) methods to analyse problems. Therefore, it was understandable that additional time was needed to get acquainted with the simulation materials, especially since this workshop was condensed to a half-day. The participants preferred a longer workshop, as indicated on the post-workshop evaluation forms.

While evaluating the simulation (role-playing game), participants pointed out differences between the simulation and the real-world problem. For example, urban drinking water supply in reality, was different, as residents at the time did not take permission to install private tube-wells. Similarly, bottled water companies were less popular as a source of drinking water in Khulna City, although in the game, it was provided as an option to residents.

Despite this, the simulation method (or role-playing games) was considered useful. Participants explained that it helped familiarize them with some aspects of their institutional context and get a clearer look into other government departments. The simulation was described as an enjoyable way to communicate and share knowledge with other departments. Government representatives also shared ways to design the workshop around their own interests and need. This included insight into groundwater scarcity conditions in urban and peri-urban areas of Khulna. They would also benefit from technical insights into utilization of alternate sources of water, and best practices on groundwater management in the Netherlands.

8.3.2 Adapting the APIA to support different types of problem owners

Results from the government workshop reveals that the definition of problem boundaries is actor dependent. Safe drinking water supply was a problem for the local government in Khulna, yet the nature of this problem was different from that of the community in Hogladanga. Therefore, structuring capacity building using the same problem definition was not suited to the needs of government actors.

Government participants in the strategic workshop considered the simulation as an over-simplified view of the drinking water problem. Here, they pointed out that by focusing solely on the institutions and actor arenas, the simulations provided no insight into the biophysical aspects of the problem. Similarly, these actors recognized the need for augmenting alternate sources of water supply, but required support in the planning and management of such projects. These were, for them, bigger unknowns that could be supported through the APIA, as suggested by the de-briefing comments.

This experience signalse the problem structuring needs of different actors. To peri-urban communities, who are typically not involved in policy-making, the APIA successfully conveyed basic understanding of the institutional set-up and actor arenas. For Hogladanga village, understanding the institutional constraints underlying different water supply options was needed to understand operational level outcomes and strategies to address these. On the other hand, local government departments were more familiar with the underlying institutions, given that they were the ones who operationalized formal rules and more frequently, interacted with other actors as part of the policy-making process.

This is not to say that the strategy exploration workshop was not beneficial for government actors who participated. The problem boundaries selected for the simulation activities shed light on long-term governance of drinking water supply. It fostered discussions regarding gaps in regulation and water pricing, and the risk this posed to formal service providers in the future.

Government participants valued the opportunity to share and discuss problems with each other, and reacted positively to the use of simulation methods. Although knowledge sharing platforms already existed, they were likely not suited for comparing and evaluating strategies. In other words, the simulations offered government actors a space for discussing strategies and exploring their practical feasibility. Therefore, game-based strategy exploration may be used to support on-going policy processes.

This case study highlights a potential to further explore the use of the APIA with other types of problem owners. For example, it is worthwhile to consider if certain steps of the APIA, for example, strategy exploration, may be used to scale up problem solving efforts. For example, in peri-urban Khulna, the role-playing workshops were implemented separately with community and local government stakeholders. However, this type of workshop could also help structure negotiations between these two groups of actors to support problem solving.

Future research can be dedicated towards adaptation and further testing of this approach with different kinds of stakeholders based on these insights. The government workshop in Khulna showed that game-based strategy exploration offers an interactive and visual medium to the policy process. Yet, different actors have unique challenges, for which appropriate problem boundaries must be selected while using this approach, in order for this approach to ultimately cater to the capacity building needs of its beneficiaries.

8.3.3 The potential of the APIA beyond Hogladanga village

The purpose of this chapter was to assess how the APIA may be transferred and applied in different contexts, for addressing different kinds of problems and aimed towards different problem owners. Three case-studies, all part of the Shifting Grounds project provided an initial look into this. While the APIA was not implemented in its entirety in all these three case studies, the results are helpful to draw some tentative conclusions about its potential.

First, the case study of Badai (India) showed the variety of institutional problems that exists in different contexts. Using the APIA in Badai to structure local problems has potential, given that this context shares the same multi-actor, institutional, and marginalization characteristics the APIA was designed for. A first attempt with regards to problem identification and institutional analysis supports this conclusion, as it led to a better understanding of industrial water problems. However, the impact on problem solving remains to be seen as this was not pursued in Badai. It is expected that APIA will need to be adapted when applied to different kinds of problems. In Badai, engaging with local industries as well as government departments in the problem solving process is needed. It also highlights the sensitivity of different problems. Being conscious of this sensitivity is needed to predict how APIA based intervention can impact the situation locally.

The case study of Thiuria further highlighted potential implementation challenges with participatory approaches. Here, the key concern for the community was similar to that of Hogladanga. However, capacity building and negotiations proved difficult, given that the problem was deeply rooted in a sensitive political context. Thiuria's bottled water industry was a powerful interest group and there was a deep political divide in the village, which was why problem boundaries were ultimately re-drawn around the issues of arsenic contamination in drinking water supply. Thereafter, engaging the community and local governments proved much easier. This shows that applying a participatory problem solving approach like the APIA requires adapting the approach to suit the socio-political context.

Finally, a third case-study was considered to explore if the APIA may be used with different kinds of problem owners. Here, step 4 of the APIA was conducted with government stakeholders in Khulna to examine drinking water problems through role-playing games. Results showed that government actors had very different capacity building needs than the Hogadanga village community. As a result, the strategy exploration workshop, designed for the Hogladanga village representatives, proved less insightful to government stakeholders. Hence, the APIA (or steps within it) should also be tailored to the interests and needs of different actors. Yet, this case study suggests that government actors find value in game-based methods to discuss and explore problems.

Chapter Nine

Conclusion

Photo courtesy: Author (2019)

9.
CONCLUSION

This chapter builds on the discussion and conclusion sections from the following publications : Gomes et al. (2018); Gomes & Hermans (2018) and Gomes et al (2018).

The preceding chapters of this thesis have investigated ways to support peri-urban communities in addressing problems using an institutional lens. At the outset, a need for an institutional focus to peri-urban problems was highlighted, followed by a discussion of relevant institutional theories to examine peri-urban problems using this lens. Thereafter, a participatory structured approach was developed: the Approach for Participatory Institutional Analysis (APIA). This approach was applied and evaluated in the case study of Hogladanga, a village in peri-urban Khulna. Findings from each step of its application have been presented and discussed in chapters 4 - 7. In order to evaluate the potential of APIA beyond this single case-study, parts of this approach were also been evaluated in other case-studies from Khulna and Kolkata in Chapter 8.

In this final chapter, the research questions, methods, and results are revisited to draw final conclusions. These conclusions summarize the general contributions and insights gained from this research, while also highlighting its limitations and areas for further improvement. Chapter 9 consists of four main sections. The conclusions in section 9.1 start by responding to each sub-questions posed for each preceding chapter that was addressed over the course of this research. Thereafter, a broader reflection is made with regards to the main research in section 9.2. This is followed by limitations of the study in section 9.3 and recommendations for future work in section 9.4.

9.1 Responses to the research questions

This research was undertaken as part of a larger Shifting Grounds project, focusing on peri-urban areas of the Ganges delta. There, observations and previously published research has drawn attention to the emerging groundwater crisis that was developing in these areas as a result of urbanization. The main goal of the Shifting Grounds project was to support institutional change to achieve sustainable, equitable, and pro-poor management of groundwater resources across caste/class and gender. As part of this, the project supported peri-urban communities through knowledge and capacity building (Thissen et al., 2013). This thesis focuses on the institutional context of peri-urban problems in the Ganges delta. It was guided by the following main research question

How can peri-urban communities be supported in addressing institutional aspects of water related problems during urbanisation?

This has since been addressed through the design, implementation, and evaluation of a participatory approach for institutional analysis (known as the APIA). Over the course of four years, this research was guided by the following sub-questions. The next sections discuss the main conclusions for each of these sub-questions.

The relevance of institutions in addressing peri-urban problems stems from the fact that peri-urban areas are affected by unclear roles and responsibilities, defined by fragmented or even overlapping rules. As these institutions serve as guidelines for decision-making and behaviour, it is important that the rules themselves have clarity, be context appropriate, and properly implemented through the governance process. However, as institutions arranged typically around rural and urban administrative boundaries, they often become less effective over time if boundaries, actors, and resource needs are in a state of flux. Reflecting upon the institutional system can help actors explore the solution space afforded by the existing institutional set-up or, if necessary, consider institutional change as an alternate strategy. Therefore, it is important that institutions are meaningfully considered during the problem solving process.

To do this, peri-urban problem owners need a good understanding of the existing rules before they can explore solutions with and without institutional change. Given the challenging institutional environment of peri-urban contexts, efforts are needed to better understand peri-urban problems through an institutional lens.

9.1.1 What is the role of institutions in community problem solving in peri-urban contexts? (RQ 1)

Institutions as sets of rules for social interaction and problem solving

Institutions provide the rules that enable social interactions and that help actors to resolve societal problems and mediate conflicting interests. In this thesis, institutions are defined as formal and informal 'rules' that offers guidelines to actors during decision-making and interactions. In societal problem solving, the role of institutions is described by scholars like (North, 1990, 1991; Ostrom, 2005). They explain that actors respond to a given problem (*or action)* situation by intervening within action 'arenas'. These arenas are structured by different types of rules (eg. position, boundary, information rules etc.) referred to by Ostrom (2005) as structural variables.

This description reflects the relatively stable character of institutions. Despite this, institutions can and do change. Actor interactions, structured by different institutional rules, produce outcomes that in turn positively or negatively impact the situation in question. Actors evaluate these outcomes according to their own objectives, and can accordingly decide whether to stick with the same strategy, select a different strategy, or invest in institutional change as a way of securing their desired outcome. This is the basic mechanism of institutional change. The literature also highlights that institutions (and their corresponding action arenas) exist in a nested structure, which determines the cost as well as the level at which actors need to mobilize resources to bring about institutional change (Ostrom, 2005; Williamson, 2000).

Institutions in the peri-urban context

The peri-urban context has some features that challenge the classic notion and understanding of institutions described in the literature. Three main characteristic features are found to influence the role of institutions in peri-urban problem solving.

First, the dynamic nature of the peri-urban context tests the effectiveness of institutions over time. The credibility thesis (Ho, 2013, 2014) offers a useful conceptualization of institutional change based on their function over time. The dynamic nature of peri-urban areas implies that institutional credibility can shift and potentially weaken over time, as institutions designed for a particular context or point in time become less functional in the long run. This can impede the problem solving process. When this happens, institutional change can be explored as a potential problem solving strategy.

Second, peri-urban areas are socially heterogeneous. This implies that most problems feature multiple actors with conflicting interests and perceptions. Problem solving is thus further constrained by this type of heterogeneity. An institutional perspective can help understand whether the existing institutions help mediate these conflicting interests. If not, alternate institutional arrangements may be explored to satisfy individual or collective interests. Therefore, examining peri-urban problems through an institutional lens requires a consideration of actors involved in the problem, their needs, interests, and influence during problem solving.

Third, and related to this notion of heterogeneity, peri-urban actors vary in their problem solving capacity. Adopting an institutional change strategy requires resources to be mobilized and an ability to effectively navigate within multi-actor arenas. However, not everyone has the required skills or experience in this regard. This holds true for marginalized communities that are typically isolated from decision-making arenas. Their problem understanding and access to resources to successfully intervene in local problems is limited as a result. Here the literature suggests that a more complete mental model leads to informed decision-making, thereby reducing the risk of unintended consequences. Further, theories highlight the presence of both formal and informal mechanisms of institutional change. For actors with limited influence in formal arenas, informal approaches helps counter problem situations in a more feasible way. Supporting marginalized actors during problem solving requires taking into account the feasibility of different strategies.

Institutional change and peri-urban problem solving

Thus, while institutions provide a stable environment for societal problem solving, the institutions themselves can change, and, especially in peri-urban environments, they are likely to change. Examining institutional change therefore is a the final critical element in understanding the role of institutions in community problem solving in peri-urban areas. Three related mechanisms of institutional change are formulated for marginalized communities in the peri-urban context:

a. Institutional function and credibility: Actors respond to system changes via institutional change to get a certain function that is currently not provided by the existing institutional context. This can be an new function, as the changing system produces new needs and requirements, or it can be an existing function for which the 'old' institutions are no longer suitable.

b. Satisficing: The process of responding to system changes occurs through a satisficing process, whereby actors engage in a limited scanning and trial of alternative courses of actions, until they reach a new situation that produces outcomes that are sufficiently satisfactory. This satisficing process is the result of cognitive and resource limitations of actors.

c. Nested structure: Actor's satisficing process is influenced by the nested structure in which institutions exist. This nested structure influences the resources required and available to actors for satisfactory institutional change.

9.1.2 What approach can be used to structure participatory institutional analysis of peri-urban problems? (RQ 2)

Given the need to support problem solving by marginalized peri-urban communities in the Ganges delta, chapter 3 set out to design a participatory approach that facilitates this with local actors. For this, chapter 3 explored existing participatory approaches used in action research, participatory rural appraisals, and operations research. The approach developed in this thesis is based on basic steps outlined in Community Operational Research, while drawing from a broader set of methods and tools commonly featuring in participatory studies.

The Approach for Participatory Institutional Analysis is designed to support communities in addressing their local problems using an institutional perspective. The APIA comprises four key steps, for which the scope, methods, and outputs are specific to each step (Refer Fig. 3.1 in chapter 3). It begins with problem identification in step 1, where the community identifies, and prioritizes their most pressing issues, and defines the boundaries of their selected problem for subsequent analysis. This is the expected output in step 1. For this, stakeholder analysis or causal mapping techniques may be used to facilitate stakeholder meetings and focus group discussions. If step 1 suggests that there is likely to be an important institutional component to the priority problems, the approach continues with step 2.

Step 2 involves mapping the formal and informal institutions underlying the selected problem. This can be structured using the IAD framework developed by Ostrom (2005). The expected output of step 2 is to familiarize problem owners with their institutional set-up. Mapping and analysing the institutions using the IAD framework serves two purposes. First, it allows institutions to be understood in terms of how actors operationalize rules during decision-making, thereby making institutions less abstract for problem owners. Second, it shows how the institutions influence the problem over time, thereby offering problem owners a dynamic view of their problem. This is particularly relevant for applications in the peri-urban areas where such a perspective is necessary given the dynamic nature of this context.

Further analysis of actor level interactions is then conducted in step 3: strategic analysis. Strategic analysis of the selected problem is facilitated with the use of game theory models. For this, the actor interactions occurring within the problem are formalized as a strategic 'game'. The structure of these games is determined by the underlying rules previously identified from step 2. These game theory models are used to examine strategic behaviour occurring within multi-actor arenas around particular collective action problems and their resulting outcomes. The expected output in Step 3 is to translate the selected problem as one or more multi-actor 'game'.

Game theory models from step 3, feed into the fourth and final step of the APIA. In step 4, strategy exploration with problem owners is facilitated through gaming-simulation methods. In step 4 participants explore different problem solving strategies. The simulation-games provides a medium to compare existing strategies with alternate strategies, some of which may only be possible following institutional change. The purpose of the strategy exploration step is to provide community members with a safe, virtual environment to freely explore the solution space prior to engage in real-world negotiations.

9.1.3 How did the APIA help Hogladanga community address their peri-urban problems? (RQ 3)

To evaluate the potential uses of the APIA, Hogladanga village in peri-urban Khulna (Bangladesh) served as a case study for evaluation of this approach in the real world. Chapters 4 - 7 of this thesis presented the methods, results, and insights from each step of this APIA application. The following sections present the conclusions from reach individual step before discussing more general conclusions through this application.

a. How did problem identification help Hogladanga prioritize its most pressing problems for further analysis through the APIA?

Problem identification was the first step in examining peri-urban problems through an institutional lens. The Hogladanga case study shows that problem identification is a highly iterative and non-linear process, as on-going discussions with the community led to revisions of the original problem definitions and boundaries. Results from step 1 highlight the varied experiences regarding peri-urban problems, particularly those concerning water management. As Liebl (2002) explains, contrasting problem statements often stem from specific activities or events over time. In Hogladanga village, problems were linked to larger processes (e.g. urbanisation) that were occurring in the broader context. Moreover, these processes affected residents in different ways based on their use of local resources or livelihood practices. Therefore a broad range of local concerns was described by the community.

Problem definition was also an iterative process. It partly reflects the limitations of community's perceptions of underlying causes of peri-urban problems. For example, their drinking water problem is believed to stem from a lack of public infrastructure. However, one of the reasons why the existing tube-wells are no longer suitable is because the depth at which good quality drinking water has also increased. Thus, not only does the community require more tube-wells, they also need deeper wells. This framing of the drinking water problem also revealed a more systemic nature to the drinking water problem than just negotiating more deep tube-well for the village. These underlying causes were what the subsequent analysis of this problem aimed to provide for this peri-urban community.

Prioritizing local concerns proved essential to help limit the scope of subsequent problem structuring efforts. In Hogladanga, three different problems were selected by the community. Besides access to safe drinking water, canal encroachment and waste management were priority concerns. All three were taken up during the Shifting Grounds project, albeit in different ways. Canal encroachment and waste management problems were addressed directly through the Negotiated Approach process facilitated by JJS, with some additional inputs provided by the researchers. Ultimately, only the access to safe drinking water was further analysed through the APIA. This decision, in retrospect, proved suitable given the time spent implementing the remaining steps of the APIA. Future applications of the APIA can explore how the analysis may be facilitated in a less intensive way with local actors.

The methods used in step 1 can be improved upon. Stakeholder analysis was a useful starting point, although ultimately problem identification requires several rounds of active community discussions. For this, focus group meetings were the primary means of engaging with the community. Although these were useful for deeper-level discussions, Hogladanga residents seemed to benefit significantly in the initial stage from more visual communication tools. The creation of a village map by the community with the help of JJS proved to be an effective way of discussing local problems, both within the community and with government stakeholders (Fig. 9.1). Visualizing the stakeholder mapping of the drinking water problem was also undertaken (Hossain et al., 2018). Future applications should experiment with these and other visual tools to facilitate community discussions in step 1 and throughout the APIA approach.

Figure 9.1. Social map of Hogladanga village used to discuss local problems during NA workshop with government (Photo courtesy Jagrata Juba shangha, 2019)

It can be argued that step 1 is more than just identifying problems of interest in local communities. Initial engagement activities were also helpful and necessary to build relationships and trust with the local community. It helped foster a willingness to readily share very sensitive and conflicting matters later on during the process. Although the local facilitator (JJS), had been active in the Khulna region for many years, it was their first time working in Hogladanga on community empowerment. Therefore, efforts were made during these early stages to communicate project goals and potential benefits to be gained by the local community. Thereafter, interested residents from Hogladanga formed a local negotiation group. It was through this group that the project was able to establish a sustained and meaningful engagement process (Hermans et al., 2019).

b. How did mapping the institutional system of the selected problem improve Hogladanga's understanding of institutions and their impact on the problem over time?

A system's level mapping of Hogadanga's drinking water problems was undertaken using the IAD framework. Through step 2, a broader understanding was reached about the effect of institutions on decision making within formal and informal arenas and their resulting outcomes. Analysing the existing problem situation demonstrated the challenges faced in peri-urban areas in providing safe, reliable drinking water supply.

The analysis revealed insights into the following. First, some of the challenges in peri-urban water supply stemmed from the way formal institutions are implemented in this context. Although local stakeholders repeatedly raised concerns of certain rules not being followed, they actually had limited information about the rules themselves. The institutional mapping highlighted issues with the existing rules with respect to enforcement, clarity and suitability for the changing context. Sharing the results of step 2 during the de-briefing meeting provided insight into some of the factors behind these institutional challenges.

Second, local stakeholders in peri-urban Khulna were knowledgeable about a small part of the problem, based on their perspective, but lacked an understanding of the broader picture. The institutional mapping was a way to bring together different actors' perspectives of the problem at different institutional levels for local stakeholders. Results from step 2 were shared and discussed with peri-urban stakeholders in two ways. The understanding of the broader institutional systems underlying drinking water problems, was conveyed in a multi-stakeholder de-briefing workshop. Bringing together local government, CSO's and the community to the same table allowed different kinds of stakeholders in the drinking water problem to reflect on the analysis and share their own perspectives of the problem. In this way, it served not only as a problem structuring activity but was one of the initial events where peri-urban communities engaged directly with decision-makers.

Third, and relevant especially to the peri-urban context, is that institutional mapping using the IAD framework offered a way to examine peri-urban problems not as static situations but ones that evolve over time in terms of institutions, actors, strategies, and outcomes. The analysis in Hogladanga highlighted key phases in the evolution of water access prompted by institutional changes. It showed how water users increasingly relied on informal institutions in an effort to manage gaps in the formal institutional settings. Future system changes were also identified as being likely given the on-going urban expansion process in Khulna. Eventually, this was likely to impact peri-urban communities like Hogladanga through (formal) institutional changes. Identifying these turning points in the issue was also an important starting point for the strategic analysis that followed.

Given the above mentioned limited institutional understanding of the community, their knowledge regarding specific formal rules for drinking water supply also needed to be improved. For this reason, capacity building efforts during step 2 were facilitated through an institutions brief. The brief presented information about key formal institutions and the directions they provided with regards to water supply. The briefs referred to institutions from the national to the local levels. Reports and follow up discussions with JJS showed there was difficulty in understanding the terminology used in institutional documents. Instead of the formal rules' texts and explanations, materials should make more use of visual aids such as infographics to explain rules (like one included in the brief) next time. Despite this, the brief provided the community with several new insights into what was stated in the formal rules compared to what was actually practiced.

c. How was strategic behaviour of actors involved in the selected problem analysed and what insights did it offer for problem solving?

Results from step 2 provided basic inputs for the construction of game theory models; i.e. players, moves, outcomes, and pay-offs. Preliminary models constructed in step 3 revealed several data gaps that had to be addressed by gathering additional data. Subsequent revisions to these models led to a more informed representation of the drinking water problem, after which a game-theoretic analysis of strategic behaviour was conducted.

The models were expected to offer details about decision heuristics within the action situations, previously structured in step 2. And in this regard, they served their purpose. However, certain assumptions were made, to compensate for data gaps about certain actors that were included in the model but could not be engaged with during the field visits (e.g. members of the WATSAN committee). In this study, strategic analysis was used to enhance problem understanding, rather than guide decision-making. Therefore, decision-making based on the results of step 3 is cautioned against given the risks and uncertainties and lies anyway, outside the scope of the intended use of the approach.

During step 3, doubts whether the situation being modelled was in fact a strategic game were also raised. In some cases, the resource dependency and conflicts between actors was clear, but not always, due to data gaps regarding actor interactions. Moreover, communities themselves are, for many problems they face, a relatively powerless actor. This was one of the reasons why in step 3, the game showed little interdependency. In model 1 about the existing drinking water supply situation, communities were not a real 'player' against the WATSAN committees. This may seem somewhat disappointing, but data gaps for example, are in line with earlier experiences with game theory to support the analysis of local, messy problems (Hermans, Kadigi, Mahoo, & van Halsema, 2006). Moreover, it does not mean that formally structuring behaviour during actor interactions is not important or useful. Despite uncertainties, representing action arenas as game trees, helps sense-making in complex, multi-actor situations. Simplifying decision-making arenas by focusing on the interactions between 3 - 4 of the most important actors can help target strategy formulation.

Structuring the status quo situation as a game tree serves as a benchmark for comparing and contrasting alternative possible strategies. The benchmark it provides for baseline comparison is important for future goal setting as part of the problem structuring and problem solving process (Li, Kilgour, & Hipel, 2004).

The added value of game theory models in this type of intervention was in the exploration of institutional change possibilities. The models developed in step 3 formalized actor behaviour in different institutional settings. Modelling potential outcomes from cooperative strategies for example offered insights on what can be expected in terms of outcomes and payoffs. Similarly, due to urban expansion in Khulna city, institutional change was an eventual possibility. Thus, comparing the future and existing water supply situations can help identify trade-offs between short- and long-term objectives.

Although the methods in step 3 offered insights regarding strategies most suitable for the community, the models itself are not easily understandable for local communities like Hogladanga. It requires some foundational knowledge of game theoretic concepts to interpret the findings of the models. This analytical capacity did not exist in peri-urban communities. Ultimately, strategic insights needed to benefit the community that would take actions to address drinking water problems. Therefore, strategic exploration in step 4 began by translating game theory models into a serious game that could be played by the community.

d. How was strategy exploration facilitated with the community and what effect did it have on problem understanding and problem solving?

The use of gaming-simulation methods to facilitate strategic exploration by peri-urban communities requires a simple game design. It means selecting the appropriate level of detail to include about the problem. In this study, game theory models were used to design games of this nature. Key elements of game theory models such as players, actions, outcomes, and payoffs can be easily translated into a role-play game. However, while simple role-play is recommended to start with, it is recommended that, over time, capacity building activities address more complex aspects of the problem.

The strategy exploration workshop conducted with Hogladanga residents, indicates that gaming-simulation (in this case, a role-playing game) offers a practical and visual medium for peri-urban communities to examine local problems through an institutional lens. The method was well-suited to the context and the abilities of workshop participants. Role-play fostered interactions and active discussions of a complex multi-actor problem. It helped communicate insights about institutions, often an abstract concept, in a way that is easy to understand and apply to strategic problem solving. Furthermore, it revealed the dynamic nature of peri-urban problems as a result of urbanisation. Participants' understanding of problems improved in several ways. Participant learning can be broadly categorized into multi-actor interactions that exist in peri-urban problems, evaluation and comparison of strategies to address local problems, and the benefits and challenges of cooperation (refer section 7.4).

Moreover, local familiarity with gaming-simulation methods is now available and known, allowing the role-playing game to be used again by the community to extend the dialogue and understanding to other residents beyond the workshop participants or from neighbouring communities. For this, support from JJS is needed initially to make game materials and facilitation manuals available to the the community in their local language. Training of local facilitators from the community would also be beneficial. These suggestions were put forward by workshop participants, confirming the added value from role playing games to examine community problems. Overall, step 4 shows that gaming-simulation methods are a suitable and useful medium to support problem solving by peri-urban communities in the global south.

Results from the workshop in Hogladanga provide a basis for improving the game design process and replicating this approach elsewhere. Future uses of gaming-simulation methods for strategic exploration could experiment with more participatory game design processes with the local community. This game-based workshop can also serve as a vehicle for direct interaction, playing it jointly with local community and government representatives. Until now, the workshop was only conducted with members of the community, to prepare them for future negotiations with the government and other actors. In this case, government agencies were responsive and willing to participate. However, it is important to add that creating a level playing field through capacity building of less powerful actors is needed before engaging in dialogues with others.

9.1.4 What is the potential of the APIA beyond Hogladanga when applied to kinds of problems, in different contexts, and to support different problem owners? (RQ 4)

The APIA was applied to water problems in one village in Bangladesh, and it was developed to address the challenges faced by marginalized communities in a peri-urban context. The unique nature of peri-urban areas calls for a problem structuring approach that takes into consideration the dynamic and heterogeneous context in which peri-urban problems exist. However, it is likely that other contexts might also benefit from problem understanding through the APIA. Some of these potential future uses were initially explored in Chapter 8.

Before considering the more specific insights from chapter 8, the following design criteria for APIA may be used to determine if the approach might be an appropriate toolkit to support real-world problem understanding in other cases:

- Complex and dynamic problems: APIA is intended to help unpack and structure key elements of complex, messy problems. These problems are dynamic in that they require consideration of both short and long term strategies to address them.
- Multi-actor situations: APIA targets problems that involve multiple actors that differ in their needs, objectives, and potentially, perspectives.
- Institutional gaps: The APIA is designed to deliver problem understanding through an institutional lens. Therefore, it is applicable for supporting actors with limited understanding of the institutions underlying a particular problem.

Chapter 8 explored applications in three other case studies from the Shifting Grounds project. These provided further insights into what aspects are important to consider when using the APIA. Interventions through the APIA must be context-specific In other words, this approach needs to be tailored to the unique conditions and problem solving needs in a given context. Case studies from India and Bangladesh show that results from Hogladanga cannot be directly used for capacity building even in peri-urban areas facing similar types of drinking water problems. This is because the actors, institutions, and other conditions will vary in different contexts. This was observed in the Kolkata case study, where local politics and the village's geographic location in an arsenic prone area called for a different focus in terms of community capacity building.

Decision support needs are also problem owner specific. Depending on who the APIA is used to support in other contexts, the analytical focus and design of capacity building inputs are also likely to differ. This was demonstrated from the workshop with local government stakeholders in Khulna. Here, knowledge gaps for government actors differed from those of the community, requiring a different kind of simulation game.

Establishing a strong working relationship with local problem owners is essential. This must be invested in early on in the project. Application of the APIA in Hogladanga proved to be an intensive and iterative process. Significant time and other resources was needed to cultivate trust and rapport with the project beneficiaries, given the duration over which local problems were analysed through this approach. It is recommended that future projects using the APIA make available the resources necessary to support a continuous engagement with problem owners.

The role of local partners in managing capacity building efforts cannot be taken for granted. Finding partners to lead activities on the ground is essential in projects led by organizations based outside the study region. In the Shifting Grounds project, efforts by JJS were instrumental for results achieved in Hogladanga and the simulation workshop with government stakeholders. Their networks, local knowledge, resources (e.g. personnel, time) played a big role in adapting the approach to the local context. Similarly in peri-urban Kolkata, the local partner helped navigate the challenging political context. An important criterion for selecting local partners is their ability to engage with stakeholders at different levels. Therefore, prior experience working in project areas and local connections are useful assets to APIA based interventions.

Attention to political conditions is important. Discussing and intervening in institutional problems can sometimes be sensitive. This can be especially true for marginalized communities, that anyway have limited influence in decision-making. Depending on the context, and issue taken up, different hurdles can be faced during the implementation process. Failing to recognize and acknowledge local politics can have consequences for the intervention and its beneficiaries. Similar experiences were seen in peri-urban Kolkata (India) where issues such as industrial pollution and bottling water companies are politically sensitive. In Thiuria, it required re-adjusting the focus and method of engaging with local actors.

9.2 Limitations

Like all research, this research also has its own limitations. These can be categorized into limitations in the overall APIA approach, methods, process, and results presented from this study.

9.2.1 Study Limitations

The APIA was designed to support peri-urban communities understand the water management issues they faced through an institutional lens as a starting point for exploring solutions to them. The study has demonstrated the potential of the APIA in this regard. However, institutions are one part of a larger system. Even in peri-urban contexts, where institutions are especially problematic and therefore, relevant to consider during problem solving, other physical, social, and economic conditions also shape local situations. In this way, there are limitations in the scope of the APIA.

Steps 1 and 2 of the APIA considered other aspects of the peri-urban system to some extent, although in far less detail than the institutional context. Interventions should consider how to integrate other kinds of analyses into the capacity building process. The Shifting Grounds project attempted to achieve this through groundwater modelling and socio-economic analyses. However, delays and data gaps made it difficult to align the results from different research trajectories with the capacity building process. Further research is needed to explore how this can be achieved.

At the same time, choices were made in the selection of problem boundaries. Despite the important role that groundwater plays in Hogladanga, peri-urban problems permeate all water sources. Therefore, initial focus on groundwater resources was later revised to include secondary sources also. The potential source of water depends on its use. Water use in this context varies significantly. Areas with access to surface water use it for livelihood activities (e.g. fish farming) or for drinking purposes (in urban areas, following treatment). Rain water plays a major albeit seasonal role in rice farming whereas groundwater is used for drinking, domestic, and livelihood purposes. Ultimately, it was Hogladanga's drinking water problem that was taken up for further analyses using the APIA. The scope of the problem diagnosis was iteratively decided after deliberations between the community and the research team. Although problem owners are able to identify their most pressing issues, preliminary research can help define the boundaries best suited for further analyses. Even then, there are limitations in what can be taken up meaningfully in the analysis.

The case study application in Hogladanga offers a limited basis for more general conclusions about the APIA and its potential to support problem solving efforts. Ultimately, this was a pilot study of a new approach to examine local problems with real-world actors. The decision to focus on one village was, in retrospect, a smart choice, given the time needed to design, implement, and then evaluate this approach in a single case study. Lessons from this pilot study are still very much useful in further improving the APIA. The importance of pilot studies in social science research is attributed to insights gained about the research protocols, methods, and potential problems (e.g. politics) that could lead to a failure of the research project (Van Teijlingen & Hundley, 2001). Nevertheless, additional research is needed to establish its true potential and improve it further.

Chapter 8 reflected on the transferability of the APIA through smaller scale applications from peri-urban Khulna and Kolkata. They revealed important considerations to be made while applying the APIA with different problem owners or to examine different peri-urban problems or for capacity building in different contexts. These serve as a starting point for generalizations beyond Hogladanga. Nevertheless, the examples in chapter 8 that have made use of the APIA in one way or another are all from a peri-urban context in South Asia. The kinds of problems for which this approach is relevant is, however, not confined to peri-urban areas only. In fact, the types of societal problems that might require actors to understand their institutional context or the multi-actor arenas are numerous. The study is limited in this regard and should be explored in the future. Ultimately, further applications are needed to draw more substantial conclusions about the APIA in general.

9.2.2 Methodological Limitations

Certain limitations were also recognized in some of the methods of the APIA. For example in step 3, game theory modelling was used to structure and examine decision heuristics within the action situation. And in this regard, the developed models offered a lot of information about the actors involved in Hogladanga's drinking water problem, and their motivations. However, assumptions had to be made to compensate for data gaps about actors who could not be engaged with during the field visits. Insufficient data also influenced the payoff estimations in the models. Conventional utility estimation typically begins by ranking outcomes based on actor values (Cunningham et al., 2014). These values may instead be inferred using the evaluative criteria. Discussions thus far did not focus explicitly on the relative importance of these criteria during decision making. Future applications of the APIA can consider how to incorporate this into capacity building activities.

Data limitations are not uncommon in the use of modelling tools to analyse system behaviour. This study used data inputs from the agents themselves. Numerous model iterations helped analyse the sensitivity to different payoff valuations and game structures. Furthermore, the strategy exploration workshops also intended to serve as a source of validation. As noted in section 9.1, these and other uncertainties are likely to remain as a consequence of using game theory to structure strategic interactions. This does not make their use meaningless. Formal models, such as game theory models, provide a systematic structure to help with sense-making in complex, multi-actor situations and can help target strategy formulation.

Game theory models were the starting point for game design in step 4. This method had its limitations in the number of players that can be structured and analysed. This influenced the role-playing game also. It necessitated simplifying the game's design and the level of detail about the problem. Therefore, it was not surprising that workshop participants highlighted missing details. It can be argued that the problem boundaries used to design this game were appropriate for this stage of problem solving. At the same time, it was clear that a game theoretic analysis, and use of a game to communicate its results, likely produces a different experience for participants compared to a game designed more for entertainment for example.

As with the entire approach, the role-playing game in step 4 focused primarily on the institutional context. As mentioned earlier, the peri-urban system is far more complex. In other words, the 'wicked' nature of the drinking water problem was only partially captured in step 4. However, strategy exploration that also considered other factors would have led to a more complex game that run the risk of not being playable or easily understandable by the community. It also relates to the idea of balancing reality, meaning, and play in game design (Harteveld, 2011). Striking the right balance here, therefore, remains an issue for further deliberation.

9.2.3 Process-related Limitations

One of the design requirements for this approach was that it should enable beneficiaries (in this case, peri-urban communities) to analyse their own problems. The case study in Hogladanga shows how marginalized communities were involved in institutional examination of drinking water problems. In this case study, methods were new for researchers, local facilitators, and local residents alike. This made it difficult to allow communities to take the lead in applying the steps of the APIA as it was still being developed. For this reason, the process as applied in this first case was still driven more by the project team than by the local communities. Still, particular efforts were made to ensure that the research-driven process did address the problems that communities were facing, and that the communities became co-owners of the analysis. For this purpose, frequent community meetings were needed to facilitate knowledge sharing about local problems and their underlying institutional context. This was valuable to the implementation process. However, there is scope to build community ownership over the use of the APIA. For example, a semi-structured game could offer communities an opportunity to add more details into the game in terms of actions or resources. Other examples of how this can be achieved during the game design process are discussed in Gomes et al. (2018). Future efforts should explore ways of directly engaging problem owners with the tools and methods used in the APIA.

A risk in using the APIA is that a poor representation and inclusion of local community members may reinforce marginalization and inequity, rather than reduce it. This risk is present with other participatory approaches and community OR interventions as well, and so the APIA approach is no exception. In Hogladanga, a conscious and continuous effort was made to involve community members beyond the local elites and the well-educated. This was helped by the knowledge and skills of the local NGO partner in Khulna. Nevertheless, particular groups may still be missed or underrepresented unintentionally. Also, work in one particular community, may have inadvertently put other peri-urban village communities in the region at a further distance. Hence, it is incorrect to pretend that a conscious analysis of institutional aspects is a guarantee for reducing power imbalances or creating more equitable outcomes. Not including such an analysis, however, is even more likely to reinforce existing practices of marginalization and vulnerability.

This study also offered lessons with regards to how the APIA helped improve the policy process. Arnstein (1969) highlights eight levels of citizen participation. This ladder of participation was designed to identify different roles for citizens in policymaking. In peri-urban Khulna, we see that residents reside at the level of 'informing'. One of the roadblocks highlighted by Arnstein (1969) for marginalized groups (or 'have-nots') is knowledge. The APIA in this regard aims to create a more level playing field in terms of negotiations and decision-making by building the necessary knowledge and skills of those less powerful. In this study, capacity building and analytical insights were developed in parallel, which was highly valuable to the problem structuring process. Active participation of local communities was also important to build local consensus and knowledge about the problem.

However, scaling up problem solving efforts is also encouraged over time to support dialogue and negotiations during solution finding efforts. The APIA is limited in this regard and further work is needed to extend the approach's benefits from capacity building towards a more long-term problem solving objective. This too is likely to be intensive and lengthy engagement process, involving researchers and local actors working together to find promising pathways towards institutional designs that are fit for future challenges.

Another area for improvement is measuring the impact from the APIA. This research has made a valuable contribution within a larger stream of work and activities in the Shifting Grounds project. However, It is not possible to claim that the results in Hogladanga (and for that matter, in all four case studies) could be achieved without the other project activities occurring in parallel. This makes it challenging to measure results and evaluate outcomes from the APIA. In such types of projects, it is important to distinguish between the impact of the APIA from other activities.

These differentiations were hard to disentangle. Residents' problem understanding was also partly fed by earlier interactions with local facilitators and with different project researchers. The evaluation framework used in this study (section 3.4 in chapter 3) can be improved upon in this regard. For example, isolating the achievements attributable to the APIA, can benefit from Mayne's (2012) contribution analysis. It adopts a theory of change approach to substantiate causality claims. This is appropriate for evaluating the approach within an on-going problem solving process or as part of a larger project, where research and capacity building activities are conducted simultaneously.

Part of the challenge in evaluating the APIA stems from its focus on institutions. The purpose behind structuring problems using an institutions lens was to help problem owners understand the solution possibilities afforded by the existing institutions as well as their limitations. Theory states that actors may use institutional change as a way of changing outcomes in societal problems (Ostrom, 2005). Yet the duration over which institutional change occurs extends beyond traditional project timelines. Therefore, expecting results in terms of institutional change is futile. APIA practitioners should target and limit the scope of their interventions to problem understanding. This allows for measuring results from the existing baseline of problem understanding and problem solving capacity. Even then, it would be helpful to monitor any long-term actions taken as a result of this intervention in contexts where the APIA is applied.

9.3 Recommendations for APIA as a capacity development tool

This study developed and investigated an Approach for Participatory Institutional Analysis, or the APIA, as a way to navigate institutional problems with local actors in a structured way. Overall, the approach seems promising, but clearly more experience and evidence is needed for its further development. The following three recommendations will help improve the APIA for further use.

Supporting problem solving through the APIA requires intensive and sustained engagement efforts on the ground. These are only possible with the help of a local partner. Their local networks, stakeholder relations, and expertise is ultimately what makes this a participatory approach. Further work is needed to encourage more directly, the involvement of project beneficiaries in the application of APIA methods and tools. This requires designing capacity building activities as interactive workshops such that they produce the outputs in each step of the approach. This is not to say that researchers and facilitators will not have a role to play. Supplementing information gaps about the problem is an important function of project researchers. Similarly, local facilitators are needed at these workshops to lead participants through the different steps. Training of local facilitators is therefore essential. Preparing an APIA implementation manual is another way to guide practitioners through future APIA applications.

Improving the monitoring and evaluation protocols for the APIA is also essential. This is not only needed for reporting results to funding partners but also needed for scientifically analysing the strengths and weaknesses of this approach. This study highlights the challenges of isolating results of the APIA toolkit from other project outcomes. It is recommended that other relevant evaluation frameworks (eg. Mayne, 2012) be considered in future applications. It is important to not only monitor and record formal capacity building activities, but also consider informal interactions with local actors that occur throughout the project during the evaluation.

Related to the above mentioned point, it is recommended that projects be modest about the expected results from capacity building studies like this in their proposal. This is particularly relevant for research programs aimed at policy interventions. Short-term impacts aimed at capacity building are needed but this is often not emphasized enough in program funding. Moreover, institutional change is generally a slow moving process requiring policy windows during which actors can intervene. Therefore, expecting results in the policy context is often not possible in a typical four year project timeframe depending on the projects focus and policy windows that happen to exist at the time. Instead, research should focus on tangible ways of measuring and reporting capacity building results.

The strengths and weaknesses of the APIA have been demonstrated in Hogladanga and other areas in the urbanizing Ganges delta. However, it remains to be seen whether this approach offers some value in other contexts. Applying the APIA to problems not associated with a peri-urban context lies outside the scope of this research. Further work is needed to examine this potential.

9.4 Future work on peri-urban policy analysis

One of the motivations behind this thesis was to understand how urbanization processes in the global south can be improved. Focusing research on peri-urban areas is needed given that they are the cities of tomorrow. Therefore, understanding the challenges of managing rural to urban transitions is relevant for shaping a more sustainable urban trajectory.

This research highlights the important role that institutions play in peri-urban water resource management. The existing institutional set-up in peri-urban areas from India and Bangladesh fail to satisfy the changing needs of peri-urban resource users, nor do they support the sustainable utilization of peri-urban resources. From a policy perspective, peri-urban areas in the global south requires a different approach.

This study attempts to intervene in the policy process through capacity building of marginalized peri-urban communities. Supporting communities is required in order for peri-urban policies to better reflect the needs and concerns of local actors, who are directly affected by the outcomes of these policies. Capacity building is a first step in helping communities influence the policy process. It is known that actors vary in their socio-political influence. Part of this stems from gaps in knowledge about the problems and the arenas in which they are addressed in. The APIA approach offers a way to support peri-urban communities through capacity building, serving as a stimulus for longer-term action or even institutional change.

However, problem understanding is only the starting point in policy interventions. While this approach offers peri-urban communities a way of better negotiating solutions to their problems, it is unlikely to lead to significant changes in peri-urban policymaking at a broader scale. Instead, policy interventions are also needed at a government level. Here too, institutional constraints exists which limit the scale and direction of change. Policymakers need to move beyond the existing cycles of failure. For this, other decision support tools can be explored to support capacity building. Ultimately, the path towards policy improvements in the real-world is a long and challenging one. However, this should not deter researchers from intervening through research and capacity building.

Many societal problems are in need of governance and institutional interventions. It is here that approaches like the APIA are of use, as actors struggle to make sense of the complex and messy problems they face. The APIA is one way to structure and make sense of problems using an institutional lens with problem owners. It is only through a better understanding of problems that solutions to address them become more visible.


Photo courtesy Jagrata Juba Shangha (2016)

Appendices

Appendices

Appendix for Chapter 4

1. Stakeholder analysis

Preparations for the pre-scoping visit to Khulna in 2015 included a preliminary stakeholder analysis to identify key actors and relations between them together concerning the problem in question. The stakeholder analysis outlines several steps, however, at this stage the following steps were performed given that its goal was to aid in identifying the key stakeholders to be interviewed during the visit:

a. Problem Formulation

What is known at the outset of this research is that the city of Khulna is experiencing rapid urbanization. Urban development has created challenges in the management of finite resources within these peri-urban areas, specifically ensuring groundwater availability to a growing population and different user groups. The project's initial proposal highlights that this challenge has translated into issues of scarcity, groundwater contamination by arsenic and salinity. It also pointed to the incidence of conflict between these user groups over this resource (Thissen et al., 2013). For example, a well-publicized conflict between the peri-urban communities and KWASA over their plans to source peri-urban water for the Khulna City Corporation residents. This conflict resulted ultimately in a court order restriction against the KCC project despite initial pipelines and investments already underway (Roy, 2013). For this reason, the problem can be broadly defined as groundwater management in peri-urban Khulna. The pre-scoping visit is to understand the breath of groundwater issues faced by the communities, user groups and managers of groundwater in peri-urban Khulna and how they relate to the institutional context. The problem owner in this case is the peri-urban communities that are dependent on groundwater resources but who's water needs are threatened by urbanization and deteriorating groundwater resources.

b. Actor Inventory

An initial actor inventory was built using a combination of secondary resources and key informant discussions which at this stage involved the local project team. Mitroff (1983) (cited in (Enserink et al., 2010) identifies the position and reputation approach as two ways of identifying the actors involved . Thus, the broad roles of each actor in the context of the defined problem is also listed below. Moreover, the identification of 'actors' as opposed to 'stakeholders' offers not just those interested in a particular issue but also their ability to influence decision making outcomes and include both individuals and social groups or organizations (Enserink et al., 2010). The following actor list is based on a multi-level analysis. At the local upazilla and village level are those actors directly involved/ affected by groundwater management outcomes. However, these decisions, based on existing institutional theory exist within a larger context and thus include actors at higher levels of governance. For this reason, actors from the national level are also included to map out the institutional system operating in Bangladesh. The inventory of actors identified are summarized in the table below.

Actors involved in groundwater management in peri-urban areas		Role
National Govt	Ministry of Local Government, Rural Development and Cooperatives (LGRD&C)	Strengthen capacity of local government units & support local project implementation
	Department of Public Health Engineering (DPHE)	Provision of water supply in rural (and some urban areas of Bangladesh not under WASA)
	Local Government Engineering Department (LGED)	Coordinate infrastructure development works of newly formed upazilas
	Ministry of Water Resources	Water development & management in Bangladesh apex body
	Bangladesh Water Development Board (BWDB)	Implementing Arm of MOWR (Projects under National water Mgmt plan)
	Water Resources Planning Organization (WARPO)	National level water resource planning and management
	Institute of Water Modelling (IWM)	Offers modelling services to govt and internal agencies
	Institute of Water and Flood Management (IWFM)	BUET's research & advisory arm water related issues
	Ministry of Agriculture	Develop and support implementation of agricultural policies, plans
	Bangladesh Agricultural Development Corporation (BADC)	Provision of irrigation facilities to farmers
	Urban Development Directorate	Create urban development plans
	Center for Environmental and Geographic Information services (CEGIS)	Integrated environmental analysis research (Under MOWR)
Local Govt	Khulna Water Supply and Sewerage Authority (KWASA)	Water service provider to Khulna city
	Khulna City Corporation (KCC)	Khulna city administration
	Department of Public Health Engineering (DPHE)	Water services to peri-urban areas
	Khulna Development Authority	Urban development of Khulna block
	Union Parishad	Local Administration
	Prodhan	Village level administration
	Upazila Nirbhai Officers	Upazila level administration
Community	Peri-urban residents	Groundwater/surface water users
	Farmers	Irrigation uses of water resources
	Local industries	Commercial users of water
	Prawn Cultivators	Aquaculture use of water
Civil Society Org.	BRAC	Bangladesh development agency
	Phultola Pani Andolan Committee	Advocacy body involved in KCC- Phultola conflict
	Sushilan	Local livelihood security through agriculture based programs
	Bangladesh Environmental Lawyers Association	Campaign, advocacy, advisory services to local communities

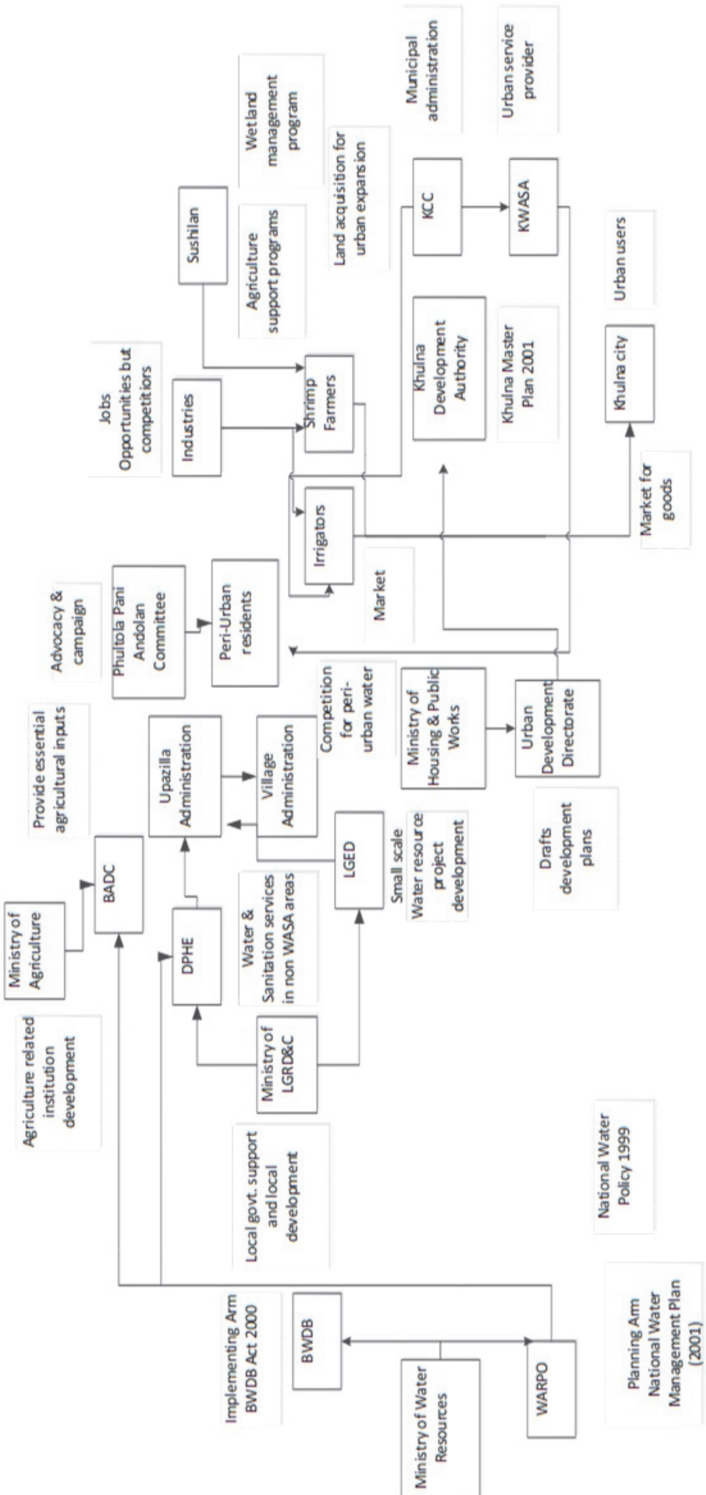
Actor	Interests	Desired situation/ objectives	Existing situation and gap	Causes	Possible solutions
DPHE	Peri-urban Khulna water supplier historically through tube well	Meet water supply demands of peri-urban Khulna	Demand gap, alternate options available but still in testing stage	Mobilizing local bodies and resources to implement	Greater resource and sanctioning power
LGRD&C	Strengthen capacity of local administrative units	Local government capable of managing water resource demands with urbanization	Urbanization not planned in an integrated manner	Lack of coordination	Integrated planning training and institutions that facilitate coordination of activities
LGED	infrastructure project in new upazillas	stakeholder participation in planning and implementation of rural infrastructure projects	Unplanned urban expansion, peri-urban areas with limited infrastructure services	Projects dependent on funding from development agencies	Unknown
KWASA	Water supplier (Surface and GW) in Khulna	100% coverage	Demand gap, issues with securing sources (eg Phultala conflict)	Lack of reliable groundwater resources & local opposition against abstraction	Policies that permit resource abstraction from outside city.
BADC	Irrigation and seed supply to local farmers	support local agricultural sector and achieve food security	Lack of reliable water resources for farmers	competition from other users and resource deterioration	Advocate ministry of agriculture & MoWR to address water scarcity issues facing farmers or explore alternate farming practices.

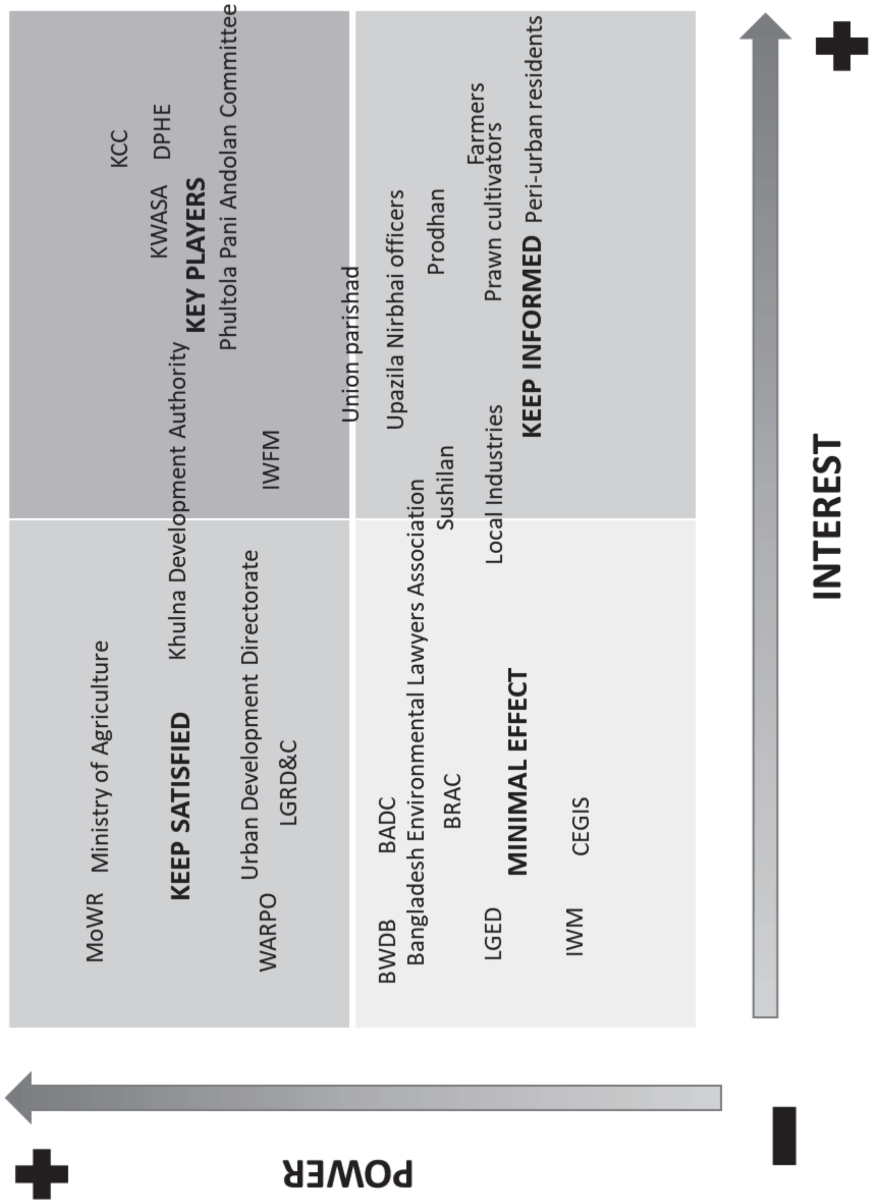
c. Problem formulation of actors

Actor	Interests	Desired situation/ objectives	Existing situation and gap	Causes	Possible solutions
Khulna Development Authority	Sustainable urban development of Khulna division	Implement Khulna master plan in an integrated manner	Unknown	Poor coordination	Unknown
Peri-urban residents	Daily household water supply from tube-well	Secure reliable, easily available water resource supply of good quality	Seasonal scarcity, contamination issues	Farming activties and groundwater decline. Also threat of local resources being supplied to KCC	Invest in alternate resource options eg surface water supply. Have government protect peri-urban water sources from further deterioration & allocation to other areas
Farmers	Livelihood dependency of groundwater	Secure low cost round the year water supply for cropping cycles	Groundwater decline makes pumping costs higher, alternate surface water projects not reached their location	Overpumping	Irrigation subsidies or small scale irrigation projects for local farmers to address demand gap
Industries	Production uses of water resources	Piped water supply	Unknown	Unknown	Unknown
Local administration	Address resource needs of their constituents and prevent conflicts between user groups	Have multiple reliables sources of water and infrastructure for peri-urban water supply	Groundwater still the main source in peri-urban areas, issues of scarcity and limited alternate options for users	Overpumping, population demand, lack of water supply infrastructure	Advocate ministries and state government to secure funds for water supply projects in peri-urban areas

c. Problem formulation of actors (contd.)

d. Actor relations map





e. **Power versus interest grid**

Appendix for Chapters 4 & 5

2. Summary of meetings conducted during the 2015 field visit

Date	Interviewee	Stakeholder Type	Location
24-5-2015	Representative from WARPO	Government	Dhaka city
25-5-2015	Representative from DPHE (national level)	Government	Dhaka city
25-5-2015	Representative from DoE (national level)	Government	Dhaka city
26-5-2015	FGD with members of the Phultola Paani Andolan Committee	CSO	Phultala
27-5-2015	Representative from DPHE (sub-district level)	Government	Khulna city
27-5-2015	Representative from KWASA	Government	Khulna city
28-5-2015	Representative from DPHE (su-district level)	Government	Khulna city
28-5-2015	FGD with Matumdanga residents	Community	Matumdanga
28-5-2015	Representatives from Development of Mohila Society (DMS) & Tarongo Social Welfare Organization	CSO	Matumdanga
31-5-2015	FGD with Hogladanga residents	Community	Hogladanga
31-5-2015	Representative from Jalma Union	Government	Bhotiaghata
1-6-2015	Representative from BWDB (district level)	Government	Khulna city
1-6-2015	Representative from KDA	Government	Khulna city
2-6-2015	Representative from KCC	Government	Khulna city
7-6-2015	Professor, BUET (Institute of Water & flood Management)	Research	Dhaka city
7-6-2015	Representatives from BADC (national level)	Government (agriculture)	Dhaka city
8-6-2015	Professor, University of Dhaka	Research	Dhaka city
8-6-2015	Representative from Local Government Engineering Department (LGED) (national level)	Government (Engineering)	Dhaka city

3. Interview design for pre-scoping visit to peri-urban Khulna in 2015

i. Introduction (common for all interviews and FGD's)

Start by outlining the purpose of the research:

1. Understand the key issues concerning GW management in peri-urban Khulna. Particularly, in the context of formal and informal rules for GW management
2. Decision making processes and outcomes from these rules

Describe the background of the Shifting Grounds project:

- 4 year project to improve peri-urban groundwater management. Analysis of existing groundwater institutions. Develop a series of stakeholder workshops to address key challenges.
  *Consent to use information/ respondent's name in project related reports
  *Consent to recording meeting to review discussions/ information later on

A. Community stakeholders and users of groundwater (incl. industrial)

ii. Interviewee background
- Name, Contact Info
- Describe yourself in terms of family size, land ownership, livelihoods, educational, religious or case background?
- How long have you resided/operated in this area?
- What are your main livelihood activities and where are these practiced?
- How has the community you live in changed over time (last 10-20 years) (eg economic activities, social groups and land use)
- What effect has urbanization had on your life/ economic activities?

iii. Relevance of GW to stakeholder
- Describe the role of groundwater to your daily life (importance)
- Describe the changes in groundwater and surface water availability in the last 10-20 years?
- For what purpose/ activities do you use groundwater and in what periods (eg seasonal irrigation)

iv. Local water resources
- How do you access groundwater resources for your needs? (who, individual or shared access)
- What are the rules for using groundwater? (costs, informal rules, licensing, capacity rules)

v. Concerns
- Is there a concern over groundwater or water resources in general and what are the most pressing issues faced by you/ community?
- How does it affect you/ your community?
- What causes this problem according to you? (eg overdraft) (eg rules that caused this problem)
- Has this created any tension/ conflicts within the community or with outside stakeholders?

vi. Groundwater issues and solutions

- How has this issue evolved over time? (costs and benefits of the outcomes it created)
- Describe the mechanism for addressing groundwater concerns? (platforms meetings etc, rules for participating, who can take part, what is your role in such a process)
- What challenges do you face in addressing your concerns regarding this issue?
- What is your preferred outcome to resolve this issue?
- Who should be responsible and what can you do to address it?
- What are your alternate options if these concerns do not get addressed?

B. Government stakeholders

ii. Interviewee background

- Name, Contact Info, Name of Organization, Position

iii. Role in Groundwater management/ peri urban development

- What is your organization/ agency's main responsibilities and objectives?
- Describe the activities undertaken to achieve these objectives
- What are the challenges in achieving these objectives

iv. Rules & regulations

- Describe the rules/regulations/policies regarding your organization's activities
- What national or state level policies influence the local situation/working of this organization
- How are these rules implemented
- Describe the process of amending existing rules and what prompts such a change

v. Changes in the region

- Describe the expansion of Khulna in the last twenty years? (economic activities, population or land use)
- Describe how urban expansion affected the activities of your organization/ agency?
- What are the costs and benefits of urbanization in the area?
- How has changes in groundwater/ surface water availability impacted the activities of your organization?

vi. Key concerns regarding groundwater

- Is there a concern over groundwater or water resources in general and what are the most pressing issues ?
- What are the impacts? And who is affected most?
- What causes this problem according to you? (eg overdraft) (eg rules that caused this problem)
- Has this created any tension/ conflicts within the community?
- How has this issue evolved over time and what has been the outcome?
- What causes this problem according to you? (eg overdraft) (eg rules that caused this problem)
- What is the preferred outcome to resolve this issue and who should be responsible?

- What is the role of our organization in this?
- What are the alternate options if this issue does not get resolved?

vii. Coordination mechanisms

- Is there any coordination mechanism in place to address this issue? Is this mandated in any policy etc?
- Describe the mechanisms (who is involved, rules for engagement)
- What are the challenges of engaging in such a coordination ?
- Is there any participatory mechanisms to engage with non-governmental organizations and communities?

C. Civil society groups

ii. Interviewee background

- Name, Contact Info
- Name of Organization, Position
- Areas of operation, type of role (advocacy, program delivery)

iii. Role in society and problem solving

- What local social or environmental challenges are addressed by your organization?
- Why are these programs needed (in relation to existing government programs)
- Tell me about the programs, services to help local communities deal with these issues
- What outcomes are you hoping to achieve through this work? (including long term vision, how do you see the roles of CSOs, local communities, government and private sector in the long term)
- How do you implement these programs and how effective were these programs in addressing the challenges?
- Describe the platforms for coordinating with other actors to address local issues
- What are the benefits and costs of sharing info/ coordinating with other agencies/ actors
- What have been the outcomes from engaging with other actors (describe your experience)

iv. Community characteristics

- Describe how these communities have changed in the last 10-20 years
- Is groundwater a concern in the areas you work in? (or water resources in general)
- Has this created any tension/ conflicts within the community or with other groups?
- What in your opinion is responsible for current situations
- Which groups are most affected by this issue ?
- what are the options to address this and describe the mechanism ?

Appendix for Chapter 6

4. Summary of meetings conducted during the 2017 field visit

Date	Interviewee	Stakeholder Type	Location
10-2-2017	FGD with Holadanga residents	Community	Hogldanga
11-02-2017	Guided tour by Hogladanga resident	Community	Hogldanga
11-02-2017	Marginalized household #3	Community	Hogldanga
11-02-2017	Marginalized household #4	Community	Hogldanga
11-02-2017	Drinking water user #5	Community	Hogldanga
11-02-2017	Migrant resident #6	Community	Hogldanga
11-02-2017	Tube well owner #7	Community	Hogldanga
11-02-2017	Migrant resident #8	Community	Hogldanga
11-02-2017	Tube well owner #9	Community	Hogldanga
11-02-2017	Local Farmer & Fisherman	Community	Hogldanga
12-02-2017	Union council representative	Government	Batiaghata
12-02-2017	Representative from the Department of Agricultural Extension (DAE)	Government	Batiaghata
12-02-2017	Sub-district representative	Government	Batiaghata
13-02-2017	Piped water user #1, Khulna City	Community	Khulna City
13-02-2017	Private tube well user #2 and landlord	Community	Khulna City
13-02-2017	Representative from KCC	Government	Khulna City
13-02-2017	Representative from KWASA	Government	Khulna City
14-02-2017	Representative from KDA	Government	Khulna City
14-02-2017	Manager, Bottled water company	Business	Khulna City
15-02-2017	Representative from Department of Environment (DOE) divisional office	Government	Khulna City
15-02-2017	Professor, Khulna University	Research	Khulna

5. Interview design for field visit (2017) to peri-urban Khulna

Topic	Question
Objectives	Given your role as ____ in water supply, what is your primary objective? OR What is it that you seek as a ___________?
Actions	What are the available means to help you reach this objective OR What actions can you take to reach this objective? OR What types of water resources are available to you and what actions do you take using these resources to reach your objective?
Criteria	In your objective of _____ what is important to you? OR Why is this option your preference? OR How do you select between these different water resource options?
Weightage for different criteria	Rank these criteria in order of importance
Actor dependenties	Who else is involved in helping you reach this objective? OR What resources/ role/ position do these actors have?
O&M	Describe the treastment mechanism for this type of resource?
Preferred solution	Is this option problematic in any way? Why? OR What would be your preferred solution? Why?
Changing the game	What would need to happen for an alternate/ preferred solution to be provided?
Management	Is there a role you have to play in managing such an option?
Problem scenarios	How would the game change if it becomes part of Khulna city/ Economic Zone/ your current option is no longer available?

6. Input tables for Model 1: Existing drinking water supply situation

a. Game Specification table

Players	Actions	Description
Residents	Apply for public tube-well	Submits application for public tube-well at WATSAN committee via union parishad
	Invest in private tube-well	Hires mechanic to install private tube-well
WATSAN chairman	Issue license to Hogladanga	At least one tube well license is allocated to Hogladanga village
	Issue license to another village	All tube well licenses are allocated to other areas of the upazilla
DPHE	Assess aquifer condition	Tube-well installations is based on data of local GW level and quality parameters
	No aquifer assessment	Tube-well installations conducted without the use of local aquifer data
Nature	Viable aquifer	Selected TW location is viable in terms of groundwater availability, depth and quality
	Non-viable aquifer	Selected TW location is in a non-viable aquifer
Mechanic	Install tube-well	Accepts contract to install TW
	Refuse installation contract	Does not accept TW installation contract

Number	Outcome	Action combinations	Rationale
1	Safe, affordable, drinking water supply for Hogladanga via public tube well	[Apply for public tube-well] + [Issue license to Hogladanga] + [Assess aquifer condition] + [Viable aquifer] + [Install tube-well]	This is the best case outcome in the game for the community. Their application for public TW licence is approved, after which installation procedures are careful in considering the local aquifer situation. It leads to an functional, safe DW infrastructure for this village.
2	Public tube well installation in Hogladanga is halted as location is not viable in groundwater volume or quality	[Apply for public tube-well] + [Issue license to Hogladanga] + [Assess aquifer condition] + [Non-viable aquifer]	This outcome is a return to status quo for the village as despite approval of TW licence, installation cannot proceed as the site is in a non-viable aquifer. PHE can decide to re-try in another location, causing some delays for the village and once again, uncertain outcome.
3	Public tube well with safe, affordable water supply is available in Hogladanga despite lack of data	[Apply for public tube-well] + [Issue license to Hogladanga] + [No aquifer assessment]+ [Install tube-well] + [Viable aquifer]	This outcome despite being risky for both DPHE and Mechanic is positive as the tube-well site is discovered to be in a viable aquifer after installation.
4	Failed public tube well in Hogladanga and selected site is discovered as non-viable following installation	[Apply for public tube-well] + [Issue license to Hogladanga] + [No aquifer assessment] + [Install TW] + [Non-Viable aquifer]	This outcome is sometimes experienced by the village. The process of installing public TW without prior assessments produces a non-functional tube well results in a loss for mechanic. For the village, it is a return to status quo for the time-being.
5	Approved public tube well is not installed in Hogladanga due to unavailability of contractor	[Apply for public tube-well] + [Issue license to Hogladanga] + [No aquifer assessment] + [Refuse installation contract]	This outcome is a return to status quo due to issues between the engineers and mechanics over the payment rules for installing public tube wells without assessment. Evidence of this can be found in peri-urban areas already.

b. Outcome Description table

Number	Outcome	Action combinations	Rationale
6	No funding for public tube-well infrastructure approved for Hogladanga village	[Apply for public tube-well] + [Issue license to another village]	This outcome is often seen in this village as tube well applications are not approved by the village. The assumption is that licences are allocated elsewhere instead. DPHE and Mechanics are still involved in installation in other areas. As it is uncertain whether installations in other areas, make use of aquifer data, this model makes the assumption that
7	Risk pays off as private tube well provides safe drinking water supply to tube well owner (and other local residents)	[Invest in private tube-well]+ [Install tube-well] + [Viable aquifer]	This outcome despite being costly and risky for the village, results in a successful private tube well. WATSAN and DPHE are able to use the quotas to install public tube-wells elsewhere as applications are still received from other areas.
8	Private tube well investor incurs a loss as groundwater is not available or is of poor quality	[Invest in private tube-well]+ [Install tube-well] + [Non-viable aquifer]	This outcome is costly and risky investment as the outcome is a failed private tube-well installation . Village has to return to status quo or try again in another location. WATSAN and DPHE are able to use the quotas to install public tube-wells elsewhere as applications are still received from other areas.
9	Private tube-well is halted in Hogladanga due to unavailability of contractors	[Invest in private tube-well] + [Refuse installation contract]	This outcome is unlikely as mechanics are guaranteed payments by private TW owners. If it does occur, it means a return to status quo for the village. WATSAN and DPHE are able to use the quotas to install public tube-wells elsewhere as applications are still received from other areas.

b. Outcome Description table (contd.)

c. Game Tags

Tag Name	Description
Drinking water quality	Source of drinking water meets drinking water standards (safe to drink)
Convenience (distance/ time/ effort)	Measure of effort (in terms of distance/ time/effort) spent in daily household water collection
Affordable	Cost of drinking water supply in relation to household income
Alternatives	Access to more than one option for meeting drinking water needs
Reliable	Quality drinking water supply reliable over time
Jurisdiction needs	Responsibility to manage drinking water needs within territorial / administrative boundaries
Maintain good relationships	Satisfy voter base and manage political relationships while in office
Follow rules	Implement policies, rules and guidelines for the provision of drinking water supply
Resource data	Water supply decisions based on data on local groundwater conditions
Mandate	Fulfil mandate to supply safe drinking water supply in all areas outside WASA's
Business opportunity	Accept business opportunities to increase profits
Risk	Avoid risky contracts where payment is not guaranteed for services provided

Player	Weightage	Values	Rationale
Residents (R)	3	Drinking water quality	Based on the frequency in which quality and convenience were discussed during the field visits, NA meetings. Reliability is the next most important criteria given they experiences with previously installed tube-wells that over time have not been reliable. Affordability as a criteria varies from household to household based on their income. But in general if there are more tube-wells privately installed by a few people, tube-well owners are willing to share them will economically disadvantaged and neighbouring households. Alternatives are important only if the existing DW options are unavailable or fail to satisfy the other criteria.
	3	Convenience	
	1	Affordable	
	2	Reliable	
	1	Alternatives	
WATSAN (W)	4	Jurisdiction needs	Politics is believed to play a big role in the committee's decision making process. This is because most WATSAN members are elected representatives from the upazilla and union level administration. Therefore maintaining good relationships and satisfying drinking water needs of their constituencies is valued most. Meeting jurisdiction' s DW needs is the 2nd most important value for the committee based on their role in drinking water supply within the upazilla.
	6	Satisfy constituencies	
DPHE (E)	5	Follow rules	Based on interviews, rule following strongly drives the operations of the DPHE (eg. installation only after WATSAN approval, installation based on funding available etc). Therefore this is the most valued criteria. Next, given their role as rural service provide, they actions are driven by their mandate to meet drinking water needs in all rural areas (esp underserved areas). Their operations involve monitoring tube-wells and collecting data for decision making purposes. However, interviews reveal a data gap at least at the upazilla level. Therefore, resource data is ranked third.
	2	Resource data	
	3	Mandate	
Mechanic (M)	4	Business opportunity	These values are estimated based on the discussions with JJS. We assume that contractors prefer low risk job contracts given the issues with DPHE over this. Therefore risk is valued highest , followed by profits that drive their business as a contractor for tube-well installations. In this case risk can fall on a continuum from low or high. In this model low risk is awarded a score of 6 whereas high risk contracts receives a score of 2 (instead of 0 to account for contractors/ residents experience during installation process)
	6	Risk aversion	

d. Player values/ criteria for decision making

R	W	E	M	Outcome	Tags
8				1	Good quality, convenience (more tube wells to share reduces waiting time), reliable supply, affordable
	6				Jurisdiction needs, satisfy small voter base
		10			Fulfil mandate, follow rules, resource data available
			10		Profit, Low risk
1				2	Alternatives used
	5				Jurisdiction needs (partially recognized by issuing license), Maintain good relationships (small voter base unsatisfied despite license being issued)
		7			Follow rules, Resource data
			6		Risk aversion (low risk)
6				3	Good quality & reliable supply(guaranteed only at installation), affordable, convenient (more tube wells to share reduces waiting time)
	6				Jurisdiction needs, satisfy small voter base
		7			Fulfil mandate , follow rules (except for installations using GW data)
			6		Profit, high risk
3,5				4	poor quality, unreality, alternatives, affordable
	5				Jurisdiction needs (partially recognized by issuing license), Maintain good relationships (small voter base unsatisfied despite license being issued)
		4			Follow rules (except for installations using GW data)
			2		High risk and no payment
1				5	Alternatives needed
	5				Jurisdiction needs (recognized by issuing license), Maintain good relationships (satisfy voter base by favouring them for licenses)
		4			Follow rules (except for installations using GW data)
			6		Low risk

e. Payoff calculation table

R	W	E	M	Outcome	Tags
1				6[a]	Alternatives needed
	10				Maintain good relationships (in larger voter base), jurisdiction needs (elsewhere)
		7			Follow rules (except for installation using GW data and priority to underserved areas), Mandate
			4		Business opportunity (uncertain profit), high risk
6,5				7[b]	Good quality, at time of installation), reliable (at time of installation), less affordable, convenient
	10				Satisfy constituencies (allocate licenses to applications from other areas), Jurisdiction needs (elsewhere)
		7			Follow rules (except for installation using GW data and priority to underserved areas), Mandate
			10		Profit, low risk
2,5				8[b]	poor quality, unreality, alternatives, investment losses (so 0 affordability)
	10				Satisfy constituencies (allocate licenses to applications from other areas), Jurisdiction needs (elsewhere)
		7			Follow rules (except for installation using GW data and priority to underserved areas), Mandate
			10		Profit, low risk
1				9[b]	Alternatives needed
	10				Satisfy constituencies (allocate licenses to applications from other areas), Jurisdiction needs (elsewhere)
		7			Follow rules (except for installation using GW data and priority to underserved areas), Mandate
			0		Missed business opportunity

e. Payoff calculation table (contd.)

d. Payoff calculation table (contd.)

Rationale for partial scoring of payoffs in table 12e

- Poor drinking water quality or quality guaranteed only at the time of installation receives a score of 2 (3-1)
- Less convenient outcomes (eg. shared public tube wells are less convenience than private tube wells) receives a score of 2 (3-1)
- Less affordable drinking water sources (eg private) receives a score of 0.5 (1-0.5)
- Less reliable sources(eg. low volume groundwater either at the time of installation or over time) receives a score of 1 (2-1)
- Jurisdiction needs is only partially fulfilled (when licence has been issued but tube well is not installed) receives a score of 3 (4-1)
- Satisfying smaller constituencies (i.e smaller voter groups) received a score of 2(6-4)
- Failure to follow certain rules (using groundwater data to install, priority to underserved areas) receives a score of 4 (5-1)
- Missed business opportunities receive a score of 0
- Low risk contracts received a full score of 6 while high risk receives only 2 points (6-4). Mechanic's skills and past knowledge can be used even when groundwater data is not used which is why they still receive 2 points.

Notes:

[a] DPHE, and Mechanics receive payoffs as they are in charge of installing public tube wells in other areas of the upazilla also. The model assumes that the installation practices followed in hogladanga (no aquifer assessment) is also applied in other parts of the upazilla.

[b] WATSAN and DPHE receive payoffs in these outcomes as this model assumes that they are still allocating licenses and installing wells elsewhere in the upazilla

f. Hick's optimum and pareto optimal solutions

	Outcome								
Player	**1**	**2**	**3**	**4**	**5**	**6**	**7**	**8**	**9**
Residents	8	1	6	3,5	1	1	6,5	2,5	1
WATSAN	6	5	6	5	5	10	10	10	10
DPHE	10	7	7	4	4	7	7	7	7
Mechanic	10	6	6	2	6	4	10	10	0
Total utility	34	13	26	12	16	10	16,5	10	3

Hicks optimal

Pareto optimal

7. Input tables for Model 2: Future drinking water supply situation

a. Game Specification table

Sequence	Players	Actions
1	Residents	Apply for piped connection
		Apply for public tube well
		Invest in private tube well
		Purchase bottled water
2	Urban water authority	Extend piped network
		Do no extend piped network
		License private tube well
		Do not license private tube well
		Install public well
		Do not install public well
3	Nature	Viable aquifer
		Non-viable aquifer
2	Mechanic	Install
		Do not install
2	Bottling Company	Sell
		Do Not Sell

Number	Outcome	Action combinations	Rationale
1	Safe, drinking water supply for residents in the form of packaged water	Purchase packaged water + Sell	This is a costly, but convenient option for the urban resident as the cost of packaged water supply . Residents may be able to justify this cost if the quality is better than the other available options. How drinking water quality depends on if the supplier follows water quality standards. Although not all bottle water companies follow testing protocols or have licenses, the model assumes the company conducts routine quality control testing as per Bangladesh standards to ensure safe water quality. It is not clear whether the new licencing rules will affect these commercial companies in the future. In this model we assume this to not be an issue. Bottle companies agree to supply to new urban areas as it brings in more business.
2	No access to safe drinking water supply due to unavailable bottled water supply. Residents return to status quo.	Purchase packaged water + Do not sell	This is an unlikely option as packaged water companies are always looking to increase their profits. But their refusal to clients in Khulna city might be due to high distribution costs or lack of proper road network to distribute to newly urban areas or resource scarcity or stricter regulation of bottle water companies.
3	Private tube well provides safe, water supply to residents as site is in a viable aquifer	Invest in private TW + Install tube well + Viable aquifer	Private tube wells require high upfront installation costs and in the future licence fees (KWASA has issued a notice to begin regulating private TW's again). We assume that the tube well location is based on continence for the household resulting in a 50% probability that the location is situated in a viable aquifer (depth and quality), although the tube well owner is not aware of the GW conditions. Mechanics will always accept a contract to install a TW licence as they will get paid irrespective of the outcome. Moreover, there will also be on-going O&M costs for the tube well owner.
4	No access to drinking water supply as private tube-well installation in unsuccessfully as the installation site is located in a non-viable aquifer. Residents return to status quo	Invest in private TW + Install tube well + Non-viable aquifer	Private tube wells require high upfront installation costs and in the future licence fees (KWASA has issued a notice to begin regulating private TW's again). We assume that the tube well location is based on convenience for the household resulting in a 50% probability that the location is situated in a non-viable aquifer (depth and quality). Tube well owner will either decide to continue drinking poor quality TW (not likely) or use the existing options (status quo) or select a different strategy. This outcome is a wasted investment for the residents. Mechanics will always accept a contract to install a TW licence as they will get paid irrespective of the outcome.
5	No installation of private tube well possible unavailability of mechanics to undertake installation. Residents return to status quo	Invest in private TW + Refuse TW contract	This is a rare outcome as mechanics get paid irrespective of whether installation is a success. Moreover, it is a missed opportunity for the mechanic to refuse a TW contract as they will always get paid to install irrespective of the outcome

b. Outcome description table

Number	Outcome	Action combinations	Rationale
6	Access to safe drinking water supply within the house from new piped water supply project	Apply for piped supply + Extend piped supply	New surface water project is expected to private better quality drinking water supply with the help of a new treatment plant and piped network. But the cost of water supply is costly given KWASA's ambitions of recovering production costs by raising tariffs and metering supply.
7	Urban provider is unable to extend pipeline coverage to new residents who apply for piped water supply. Residents return to status quo.	Apply for piped supply + Do not extend piped supply	KWASA's new project is designed to meet supply needs of existing KCC residents so it is unlikely that the network will be extended to Khulna's new residents in the future. Moreover, their ability to provide piped connections to new urban residents depends on whether they have road connections etc.
8	Public tube well provides safe, affordable drinking water supply to residents as site is in a viable aquifer	Apply for public tube well+ Install public TW + viable aquifer	KWASA may continue to provide tube well connections given that surface water projects are not expected to cover the entire KCC areas. GW quality is tested only at the time of TW installation and occasionally during random TW sampling.
9	Public tube well installation unsuccessful as site is non-viable for safe, reliable groundwater access. Residents return to status quo	Apply for public tube well + Install public TW + non-viable aquifer	Private tube wells require high upfront installation costs . We assume that the tube well location is based on household preferences resulting in a 50% probability that the location is situated in a non-viable aquifer (depth and quality). Residents need to decide if they will continue drinking poor quality TW (not likely) or look for other options.
10	Residents return to status quo as urban provider is no longer providing public tube wells in order to reduce the pressure on groundwater resources	Apply for public TW + Do not install public TW	KWASA would like to reduce the dependency on groundwater resources which is why this option , although unlikely, is a possibility

b. Outcome description table (contd.)

c. Game Tags

Tag Name	Description
Drinking water quality	Source of drinking water meets drinking water standards (safe to drink)
Convenience (distance/ time/ effort)	Measure of effort (in terms of distance/ time/effort) spent in daily household water collection
Affordable	Cost of drinking water supply in relation to household income
Alternatives	Access to more than one option for meeting drinking water needs
Reliable	Quality drinking water supply reliable over time
Rule based DW supply	Provide drinking water supply only within municipal administrative boundaries and if other infrastructure services already exist (e.g roads)
Meet urban drinking water demand	Close the drinking water supply gap in Khulna city
Safe drinking water quality	Drinking water quality should meet the standards outlined by national and WASA policies
Financial sustainability	Recover cost of drinking water supply services
Sustainable water mgmt	Reduce groundwater depletion by augmenting alternate sources of drinking water
Business opportunity	Grow profits fro bottle water distribution business by growing customer base
Meet demand	Use bottle water business to close the gap in drinking water supply
Cost effectiveness	Cost of bottled water needs to compensate for distribution costs. Location determines the cost for distributing bottled water.
Business opportunity	Accept business opportunities to increase profits
Risk	Avoid risky contracts where payment is not guaranteed for services provided

Player	Weightage	Values	Rationale
Residents (R)	3	Quality	Based on the number of times these values were mentioned by interviewees during the field visits/ NA meetings. Reliability refers to the volume of drinking water supply available over time. Convenience refers to the distance/ time and effort spent collecting drinking water.
	3	Reliability	
	2	Affordability	
	1	Convenience	
	1	Availability of alternative	
Urban water authority (W)	3	Rule based DW supply	Jurisdictions relate to the supply of drinking water only within KCC boundaries. But is also related to the supply areas targeted in water supply projects. Currently, piped supply projects target existing urban wards, before extending to newly acquired areas. Water quality is third as KWASA is aware of poor quality of drinking water in piped network which is why they have investing in new projects to replace the piped network. Financial sustainability is the ability to recover costs of water supply. This value is evident in KWASA's attempts to increase tariffs. KWASA has re-started regulating tube well licences, metering deep tube -wells, and is investing in piped supply project. This shows their interest in reducing over-exploitation of GW resources.
	2,5	Meet urban drinking water demand	
	2,5	Safe drinking water quality	
	1	Financial sustainability	
	1	Sustainable water mgmt	
Bottled water company (B)	6	Business opportunity	Business opportunity refers to increasing customer base to grow profits. Meet demand for quality drinking water was mentioned by the bottle company we interviewed and demonstrated in the steps taken to monitor water quality on-site. Cost effectiveness is also included as the coverage area extends to nearby areas in Khulna city to keep production and distribution costs low. We assume that supplying further away increases the distribution costs.
	2	Meet demand	
	2	Cost effectiveness	
Mechanic (M)	6	Business opportunity	These values were estimated based on the discussions with JJS. We assume that mechanics prefer low risk job contracts with a guaranteed profit while evaluating business opportunities. We assume the peri-urban mechanics have the same values are mechanics in urban areas.
	4	Low risk	

d. Player values

R	W	B	M	Outcome	Tags
7,5				1	Convenience, Quality , Reliability, Affordability (0.5)
	1				Sustainable water mgmt (assuming tube-well licence is taken and is metered)
		8			Business opportunity, Meet demand
			0		No business opportunity
1				2	Alternatives needed
	1				Sustainable water mgmt (assuming tube-well licence is taken and is metered)
		2			Cost effectiveness
			1		Potential business opportunity
7,5				3	Convenience (0.5), quality, reliability, Affordability (1)
	2				Rule based (regulation) (1), Sustainable water mgmt (through licencing)
		0			
			10		Business opportunity, low risk
3				4	Alternatives needed, Poor quality (1) or unreliable supply (1)
	2				Rule based (regulation) (1), (Sustainable water mgmt (through licencing)
		1			Potential business opportunity (1)
			10		Profit, low risk
1				5	Alternatives needed
	2				Rules based (regulation) (1), Sustainable water mgmt (licensing)
		1			Potential business opportunity (1)
			0		Missed opportunity

e. Payoff table

R	W	B	M	Outcome	Tags
8				6	Quality, Reliability, Convenience, Affordability (1)
	10				Quality stds, Meet urban water needs, Rules (jurisdiction),Financial sustainability (tariffs), sustainable management of water resources
		0			No business opportunity
			0		No business opportunity
1				7	Alternatives needed
	3				Rules (jurisdiction, water supply project contracts)
		1			Potential business opportunity (1)
			1		Potential business opportunity (1)
8,5				8	Quality (checked at time of installation), Reliability, Convenience (0,5), Affordability
	7,5				Meet urban water needs, Quality stds (1), Financial sustainability (metering/tariff), Rules
		0			No business opportunity
			0		No business opportunity
3				9	Alternatives needed, Poor quality (1),reliability (1)
	3				Rules (jurisdiction, licence, water quality stds)
		1			Potential business opportunity (1)
			1		Potential business opportunity (1)
1				10	Alternatives needed
	1				Sustainable water mgmt (through licensing)
		1			Potential business opportunity (1)
			1		Potential business opportunity (1)

e. Payoff table (contd.)

e. Payoff table (contd.)

Rationale for partial scoring of payoffs in table 13e

- Poor drinking water quality receives a score of 1 (3-2)
- Less reliable sources(eg. low volume groundwater either at the time of installation or over time) receives a score of 1 (3-2)
- Affordability can vary depending on the source between 0.5 and 2
- Less convenient outcomes (eg. tube wells are less convenience than piped supply) and receives a score of 0.5 (1-0.5)
- Partial fulfilment of rules for drinking water supply receives a score of 1 (3-2)
- Potential business opportunity receives a score of 1 (6-5)

f. Hick's optimum and pareto optimal solutions

	Outcome									
Player	**1**	**2**	**3**	**4**	**5**	**6**	**7**	**8**	**9**	**10**
Residents	7,5	1	7,5	3	1	8	1	8,5	3	1
KWASA	1	1	2	2	2	10	3	7,5	3	1
Bottle	8	2	0	1	1	0	1	0	1	1
Mechanic	0	1	10	10	0	0	1	0	1	1
Total utility	16,5	5	19,5	16	4	18	6	16	8	4

(light grey)	Hicks optimal
(dark grey)	Pareto optimal

8. Input tables for Model 3 (cooperative model) : Water quality

Player	Actors	Objective	Role	Resources	Constraints
Groundwater monitoring agencies (M)	BWDB, BADC, DOE, KWASA	For the purpose of fulfilling the actor's mission, undertake groundwater monitoring activities	BWDB: coordination on water management (that involves groundwater monitoring in some capacity)	GW monitoring stations (BWDB, DOE, BWDB)	Personnel for Gw monitoring (DOE)
			BADC: Quality agricultural inputs and efficient irrigation management (that involved GW monitoring)	Historical GW data (~1977)- quality & quantity (BWDB), Bi-monthly GW level data (BADC), GW zoning maps (BADC), Minor irrigation survey (BADC), Water quality data (BADC, DOE)	Coverage of TW depth monitoring (DOE)
			DOE: Industrial regulation and monitoring for pollution control in order to conserve the environment (recent institutional capacity expanded to groundwater monitoring)	Standards/ guidelines for GW data collection (BWDB), Monthly qualit tests via random sampling of urban tube wells & quality tests of all public tube wells at time of installation (KWASA)	Institutional capacity (DOE)
				Water quality testing kits (BADC)	
				Technical expertise (BWDB, DOE, KWASA, BADC)	
			KWASA: Potable water supply to all urban citizens including slums (this involves water quality testing)	Testing facilities in Khulna division (BADC, DOE)	Testing facilities (KWASA)
				Water quality map of urban area (KWASA)	

a. Actor Specification table

Player	Actors	Objective	Role	Resources
DPHE (E)	Drinking water supply to all areas outside WASA	Groundwater level/ quality monitoring (installation & on a case by case basis)	Aquifer database on groundwater quality and quantity(central level)	No estimates of groundwater availability
			Some groundwater quality data (public wells installed)	Testing facilities (only 1 lab at Mohakali + district lab)
		Water quality monitoring (installation)	Some GW level data (annual)	Coordination mechanisms (sector dev plan + BWA)
		Lobby for coordination to improve water assessment	Technical expertise on tube wells to access GW	
Residents (R)	Ensure availability of safe drinking water supply	Drinking water user	Groundwater usage for drinking, domestic, agricultural purposes	Access to government agencies
		Knowledge of local aquifer conditions	Data on private tube-well installations	Resources to conduct their own groundwater testing
			Knowledge of water level with good quality water	Technical expertise
			Communication platform (Ward *shobas*)	
			Seasonal/long-term aquifer changes	

a. Actor Specification table (contd.)

b. Game specifications

Outcome No.	Player 1	Player 2	Player 3	Outcome
1	-	-	-	Null coalition
2	M	-	-	Individual monitoring
3	-	E	-	Individual monitoring
4	-	-	R	Individual monitoring
5	M	E	-	Bilateral coalition
6	-	E	R	Bilateral coalition
7	M	-	R	Bilateral coalition
8	M	E	R	Grand coalition

c. Game Tags

Tag Name	Description
Aquifer conditions	Monitoring the condition of groundwater resources is an essential part of fulfilling the agency's objectives.
Institutional capacity	Improve institutional capacity to effectively monitor groundwater resources and support decision-making.
Rule following	Groundwater monitoring activities follow institutional procedures created by higher levels of the govt. agency
Drinking water quality	Ensure that public drinking water supply meets national water quality standards
Aquifer data	Availability of reliable and sufficient data on local aquifer conditions for decision-making
Coordination	Coordination with other government agencies is need to manage groundwater resources
Local water quality	Selection of safe drinking water infrastructure for household use requires keep track of water quality in different sources in the village
Groundwater availability	Meeting household drinking water needs requires tracking local tube-wells that reliably supply groundwater

Player	Weightage	Tags	Rationale
M	3	Aquifer conditions [c]	All actors grouped as player (M) value groundwater conditions (esp quality) in order to fulfil their own agency's goal. Each actor is motivated by this value in different ways. Interviews (eg DOE), reports (eg BADC report) and online databases (eg BWDB) show gaps in satisfying this player's value which is why it receives a lower weightage compared to 'Rule following'.
	2	Institutional capacity [c]	In interviews, 3 out of the 4 actors who make up player (M) mentioned the need for better institutional capacity or are actively pursuing it.
	5	Rule following [c]	Agency operations are based on rules sanctioned by higher levels. (e.g the the district office of the DOE is unable to change monitoring locations, without approval from higher level. Therefore, rule following receives the highest weightage.
E	5	Drinking water quality [c]	DPHE needs to ensure safe drinking water quality as per department guidelines and national water policies. For this, the department conducts testing of public tube wells at the time of installation or whenever a complaint is received from the user.
	2	Aquifer data [c]	Valuing aquifer data is based on interviews and the existence of an online aquifer database at the national level. Data is required for the provision of drinking water services. The weightage is based on DPHE's issues with data availability and its use in decision-making at the local level.
	3	Coordination	Based on key informant interviews with DPHE, this actor values the need for coordination between agencies.
R	5	Safe drinking water quality [c]	Based on the community's negotiation strategy
	5	Groundwater availability [c]	Based on the community interviews and negotiation strategy. Interviews reveal how the community keeps track of which tube-wells provide sufficient groundwater volume over time. Experiences with public/ private tube well installations which have failed over time also means that volume of groundwater is important for local needs.

d. Player values

Number	Outcome	Payoff	Tags	Resources shared
1	∅	0	no monitoring of groundwater conducted in this area. And so all actors fail to meet their objective (even partially)	N/A
2	M	5	limited data regarding aquifer conditions (gaps in groundwater use across sectors and in local areas where monitoring is not conducted) (1), Institutional capacity limited as departments are constrained by resources, orders from higher level (1), rule following constrained by resource availability at the local level (3)	None
3	E	3.5	Partial success in fulfilling agency mission: safe drinking water standards only guaranteed in public wells at time of installation (2.5), aquifer data is limited spatially-temporally (1), coordination (0)	None
4	R	5	Partial fulfilment of actor's objective: Informal recording of tube wells with better quality (based on taste, smell, colour parameters only) (2.5), Informal records of which tube wells supply good volume of groundwater (2.5)	None
5	ME	16	Improved institutional capacity (through bilateral coordination between government agencies) (2), rule following improved due availability of data and monitoring resources(3), better knowledge of cross-sectoral aquifer condition but gaps in areas where neither agency operates (2.5) / Water quality standards can be checked over time as departments share sampling responsibilities (4), More aquifer data available for decision making (1,5), Coordination (3),	GW level data, GW quality data, Joint mapping, Testing facilities
6	ER	14	Drinking water standards ensured in all local tube wells (including private wells) over time but only in a fixed geographic region (3.5), Improved aquifer data for decision making but onyl in a small geographic area (2), coordination with community requires training and use of department resources(1.5)/ Reliable data on local drinking water quality depending on what resources DPHE can provide (3), share expertise on local aquifer conditions during tube well installations (4)	Testing facilities, Technical expertise, Test kits, Sector wise- GW use, GW data, Communication platform
7	MR	10.5	More local data on aquifer conditions available but only from a confined geographic region (1.5), No significant improvements in institutional capacity as community is very small and requires training and other kinds of monitoring support (1), rule following helped by local data but again as the community is small, improvements are marginal(2)/ reliable data on safe drinking water sites(3), technical support to assess local aquifer conditions (eg water levels)(3)	Technical expertise, GW data (shared), Communication platform, Sector-wise GW use
8	MER	30	Efficient groundwater mgmt. achievable within a specific geographic region (3), improved institutional capacity that utilizes resources available by other actors (2), rules for coordination followed by all parties (5)/ drinking water standards can be checked over time through coordination of monitoring efforts and sharing of data (5), aquifer data used in decision making (2), coordination (3)/ safe drinking water monitored over time (5), GW availability monitored over time (5)	All resources

e. Payoff calculations

e. Payoff calculations (contd.)

Rationale for partial scoring of payoffs in table f

- Aquifer conditions: Limited knowledge of local aquifer conditions can be assigned a partial score between 1 and 3
- Institutional capacity: Monitoring constrained due to institutional capacity receives a score of 1 (2-1)
- Rule following: The costs of changing, creating new rules, or failing to apply existing rules results in a lower score of 3 (5-2)
- Drinking water quality: Testing drinking water only once at the time of installation reduces the department's guarantee to provide safe water supply and receives a score of 2.5 (5-2.5)
- Aquifer data: Scoring of insufficient or unreliable aquifer data can vary between 1-2
- Safe drinking water quality: Informal methods of checking drinking water quality (taste, colour, odour, health effects) is less reliable and receives a score of 2.5 (5-2.5)
- Groundwater availability: Tracking GW availability (based on pumping over time) informally from existing tube-wells may not be a reliable estimate of groundwater conditions elsewhere in the area due to fragmented aquifer conditions. This can affect the success of new tube-well installations and receives a score of 2.5 (5-2.5)

f. Input file for cooperative game in R

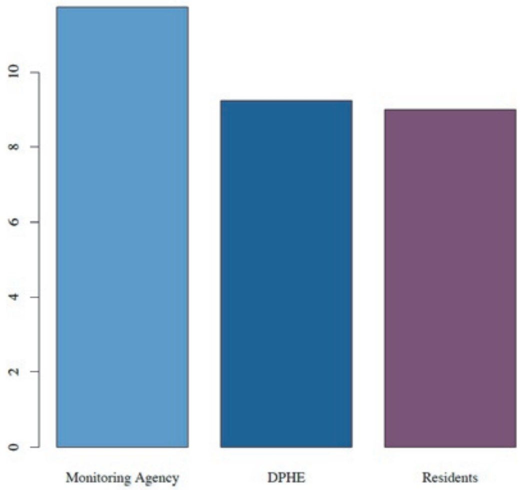
```
library(GameTheory)
library(ggplot2)
library(ggtern)
values <- c(5,3.5,5,16,14,10.5,30)
Monitoring <- DefineGame(3,values)
names <- c("Monitoring Agency","DPHE","Residents")
summary(Monitoring,names)
Monitoringnucleolus <- Nucleolus(Monitoring)
summary(Monitoringnucleolus)
Monitoringshapley <- ShapleyValue(Monitoring,names)
summary(Monitoringshapley)
```

g. Nucleolus output from R

```
Nucleolus of a Gains Game for the given coalitions
  v(S) x(S)   Ei
1  5.0 12.5 -4.5
2  3.5  8.0 -4.5
3   5.0  9.5 -4.5
```

h. Shapley value output from R

```
                    Shapley Value
Monitoring Agency     11.75
DPHE                  9.25
Residents             9.00
```



Appendix for Chapter 7

9. List of experts consulted during the game design process

Name	Organisation	Area of expertise
Abby Onencan	TU Delft	Nile basin game developer
Shalini Kurapati	TU Delft	Game developer & expert on situational awareness
Leon Hermans	TU Delft, Shifting Grounds	Principal Investigator
Umme Kulsum	BUET	Expert on local context
Remi Kempers	Both ENDS	Expert on NA process
ATM Zakir Hossain	JJS	Expert on local NA activities and context
Femke Bekius	TU Delft	Design of workshops using game theory models
Wil Thissen	TU Delft	Shifting Grounds project lead & promoter
Els van Daalen	TU Delft	Game design expert

Appendix for Chapter 8

10. Summary of meetings held during the 2014 field visit to peri-urban Kolkata

Date	Interviewee	Location
19-10-2014	Sundarband Unnayan Parishad representative	Sonarpur block
20-10-2014	Central Groundwater Board representative	Kolkata city
21-10-2014	State Water Investigation Directorate representatives	Kolkata city
22-10-2014	Center for Groundwater Studies representative	Kolkata city
22-10-2014	Sonarpur Block Development Officer	Sonarpur block
22-10-2014	West Bengal Wasteland Development Corporation representative	Kolkata city
27-10-2014	Central Groundwater Board representative	Kolkata city
27-10-2014	Representative from Barrackpore II Block Development Office	Barackpore
27-10-2014	Block level representative	Barrackpore
28-10-2014	Representative from Block Development Office	Sonarpur
28-10-2014	Representative from Sonarpur Industrial Development Office	Sonarpur
29-10-2014	Representative from south 24 parangas	Kolkata
30-10-2014	Shop owner and resident from Bilkanda I	Iswaripure
30-10-2014	Farmer and local businessman from Bandipur	Iswaripure
30-10-2014	Panchayat representative	Bandipur

11. Summary of meetings held during the 2014 field visit to peri-urban Kolkata

Date	Interviewee	Location
15-11-2016	Expert on East Kolkata Wetlands	Kolkata city
15-11-2016	West Bengal Pollution Control Board representative	Kolkata city
16-11-2016	State Water Investigation Directorate representative	Kolkata city
17-11-2016	District level representative	Kolkata city
17-11-2016	District level SWID representative	Kolkata city
18-11-2016	Irrigation Department representative	Kolkata city
18-11-2016	District level PHE representative	Kolkata city
19-11-2016	Panchyat representative	Badai
19-11-2016	Farmer from Badai	Badai
19-11-2016 22-11-2016 23-11-2016	Farmer and former tube well operator	Badai
22-11-2016	District level representative	Kolkata city
22-11-2016	Industry Association representative	Badai
23-11-2016	Block level representative	Barrackpore II
23-11-2016	Factory representative	Badai
24-11-2016	Local farmer and fisherman	Thiuria
24-11-2016	Local women	Thiuria
25-11-2016	District level representative	Kolkata city
25-11-2016	Block level representative	Thiuria
25-11-2016	Agricultural Department representative	Sonarpur
25-11-2016	Block level PHE representative	Sonarpur
25-11-2016	Block level representative	Sonarpur

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- Gomes, S., Hermans, L., Islam, K., Huda, S., Hossain, A., & Thissen, W. (2018). Capacity Building for Water Management in Peri-Urban Communities, Bangladesh: A Simulation-Gaming Approach. *Water*, *10*(11), 1704. https://doi.org/10.3390/w10111704

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About the Author

Sharlene Gomes was born in Mumbai, India on April 17th, 1984. She graduated with a Bachelor of Science in 2004 from the University in Mumbai, majoring in Zology and a minor in Biochemistry. She also received an Honours in Zology from St. Xavier's College, Mumbai. Shortly after she immigrated to Toronto, Canada with her family.

After moving to Canada, Sharlene worked at an analytical laboratory called Maxxam Analytics for over three years coordinating regulatory testing protocols for water, food, and envionrmental companies in Canada. In 2008, Sharlene went on to further her undergraduate studies in Environmental Science at the University of Guelph. This was followed by an internship in Corporate Sustainability at Mahindra & Mahindra (Mumbai).

In 2011, Sharlene moved to Oxford (U.K.) for her Masters studies in Water science, policy, and Management at the University of Oxford. Her thesis titled ' Metering Mumbai: Potential of Smart Meter Technology to Improve Water Governance' received a distinction and was published in the annual report of the Municipal Corporation of Greater Mumbai. She has since worked on policy related issues at Global Policy Forum (New York) and WASH Canada (Toronto). Prior to her PhD, she was posted in Manila (Philippines) as an policy analyst intern with the Canadian International Development Agency.

Sharlene moved to Delft in 2014 to pursue a PhD at Delft University of Technology in the 'Shifting Grounds' project. In November 2018, she accepted a post-doc researcher position in the 'H2O-T2S in Urban Fringe Areas' project at the Faculty of Technology, Policy, Management. She continues her work on water issues in peri-urban areas of Pune, Hyderabad, and Kolkata cities (India). In the T2S project, Sharlene is exploring the potential of adaptation pathways to improve decision-making during urban transitions. The approach developed during her PhD will also be applied later this year in Bangladesh as part of a UDW funded project 'Capacity for Interactive Participatory Institutional Analysis' between TU Delft, Deltares, and Jagrata Juba Shangha.

Water resources in the Ganges delta are undergoing drastic change as a result of urbanisation. Increasing demand for water due to urban expansion around cities like Kolkata (India) and Khulna (Bangladesh) is affecting groundwater access in nearby peri-urban communities. Peri-urban areas lie outside the formal purview of urban institutions, while their prevailing rural institutions are not equipped to deal with the changing urbanization context. To support problem solving efforts by peri-urban communities, this thesis offers the 'Approach for Participatory Institutional Analysis' or APIA. This participatory and structured approach explores problems using an institutional lens. It offers communities insight into the underlying institutions or rules in their most-pressing problems, the actors involved, and strategies to address them. This book outlines the need for such an approach, particularly in peri-urban areas and tells the story of how the APIA helped peri-urban communities examine their groundwater-based drinking water problems. Case-study applications in Bangladesh and India provide insights into APIA's potential as a capacity building tool and ways to further improve its design and use with stakeholders in different contexts.