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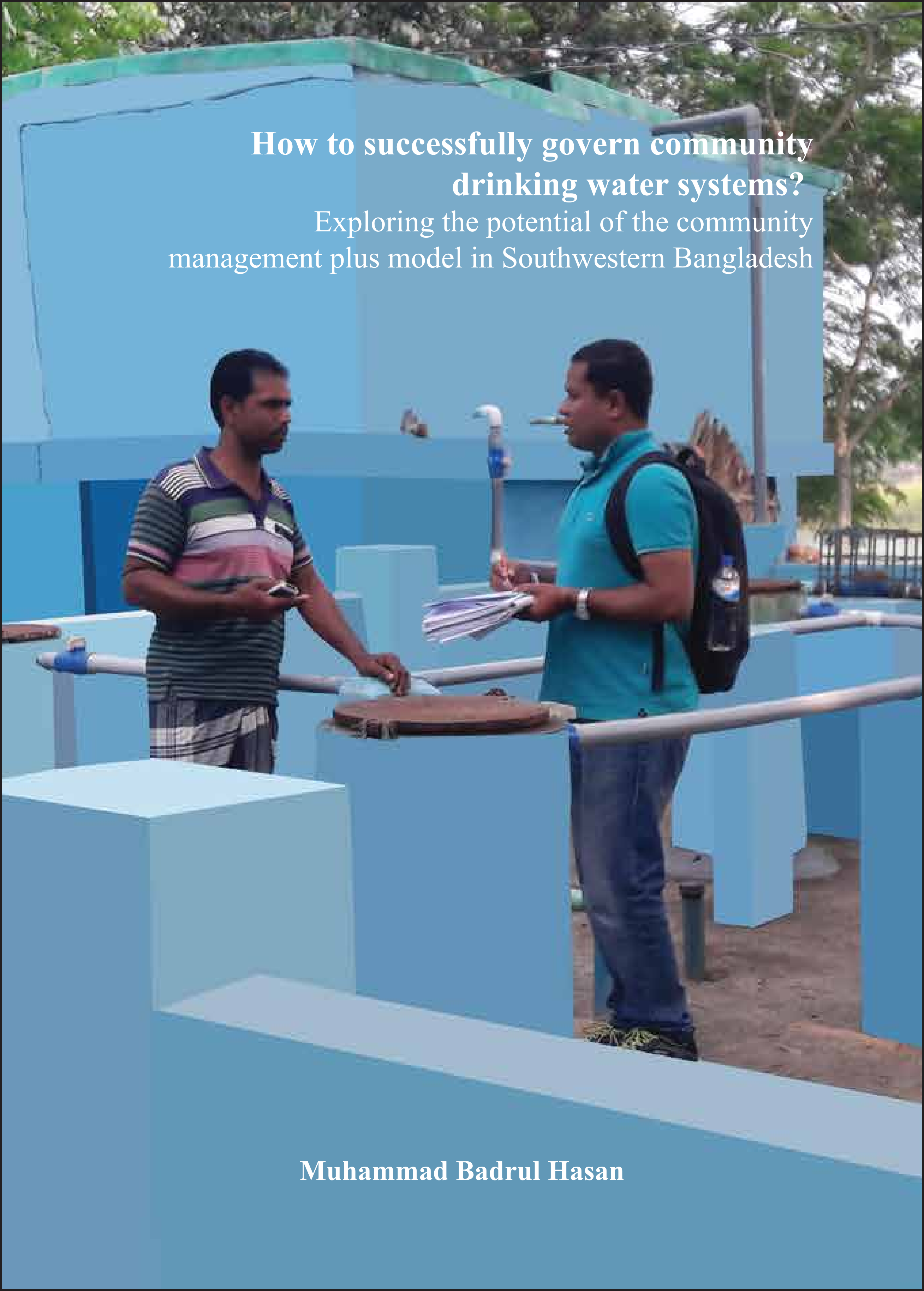

Muhammad Badrul Hasan

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How to successfully govern community drinking water systems?

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Hoe kunnen gemeenschappelijke drinkwatersystemen succesvol worden bestuurd?

Een studie naar het potentieel van het *community management plus* model in het zuidwesten van Bangladesh

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Contents

Tables & Figures

List of Acronyms

AW	Acacia Water
BDT	Bangladesh Taka (local currency)
CE	Choice Experiment
CM	Community Management
CM+	Community Management Plus
DPHE	Department of Public Health Engineering
DU	Dhaka University
DWS	Drinking Water System
HIES	Household Income and Expenditure Survey
IAD	Institutional Analysis and Development
JMP	Joint Monitoring Program
MAR	Managed Aquifer Recharge
MoU	Memorandum of Understanding
NGO	Non-government Organization
PSF	Pond Sand Filter
RANAS	Risk, Attitude, Norm, Ability and Self-esteem
RDWS	Rural Drinking Water System
RO	Reverse Osmosis
RPWS	Rural Pipe Water System
RWSN	Rural Water and Sanitation Network
SDGs	Sustainable Development Goals
SE	Standard Error
NICEF	United Nations Children’s Fund
USD	United States Dollar
WATSAN	Water and Sanitation
WHO	World Health Organization
WTP	Willingness to pay

CHAPTER 1

INTRODUCTION

1

Problem Statement

Despite remarkable progress worldwide, access to improved and safe drinking water for all remains a major concern, especially in developing countries (Moretto et al., 2018). It is estimated that some 2.2 billion people still do not have access to safe drinking water(WHO/UNICEF JMP, 2019). Drinking water scarcity poses a tremendous challenge to public health and, subsequently, socio-economic development (Moretto et al., 2018). Meeting that challenge is therefore recognized as one of the Sustainable Development Goals: SDG 6 aims "*to ensure availability and sustainable management of water and sanitation for all.*"

Climate change impacts are worsening the drinking water scarcity problems (Kiguchi et al., 2014; Schewe et al., 2014). Sea-level rise results in flooding and storm surges, especially in coastal areas. This leads to the damaging of infrastructure and to saline water intruding and contaminating freshwater sources (Sarker & Ahmed, 2015). It is expected that by 2030, almost half of the developing world's population will be living in water-stressed areas, due to, among other things, the impact of climate change (UN Water, 2014).

Broadly speaking, until the end of the previous century, two governance approaches to drinking water delivery—at the two extremes of a spectrum—could be identified in developing countries: those in which the state has a leading role, and those in which the market dominates (Moriarty et al., 2013; Pahl-Wostl, 2009; Smits, 2013). However, both approaches seem to have been plagued by a history of underperformance and drinking water system (DWS) abandonment and/or failure (World Bank, 2017; Moriarty et al., 2013).

A third governance approach to the organization of drinking water delivery has been widely adopted in many developing countries, especially since the *International Drinking Water Supply and Sanitation Decade* (1981–1990): it is one with a leading role for communities (P. Evans, 1992). Under this approach, the end-users act collectively to operate and maintain their community DWS. Commons scholarship presents multiple examples suggesting that under certain conditions, community members can successfully operate and maintain their DWS, and in doing so, even out-perform the market and the state (e.g., Ajeng et al., 2018 for Indonesia; Chitonge, 2011 for Zambia; Fielmua, 2011a for Ghana; Madrigal et al., 2011 for Costa Rica; Wegerich, 2009 for Uzbekistan).

However, this community management (CM) approach has been shown to result in non-optimal performance as well (Harvey & Reed, 2007; Hutchings et al., 2015; Moriarty & Verdemato, 2010). For example, in Asia and Africa, it is reported that around 30–40 % of all DWSs stopped functioning shortly after their installation (Baumann, 2006a; V. R. Ratna Reddy et al., 2011; RWSN, 2009). In response to this, a hybrid approach that some have labeled as *community managementplus* (CM+) has been proposed as a potentially better alternative. Figure 1 presents of broad stroke overview of how thinking about the delivery of drinking water has evolved over time.

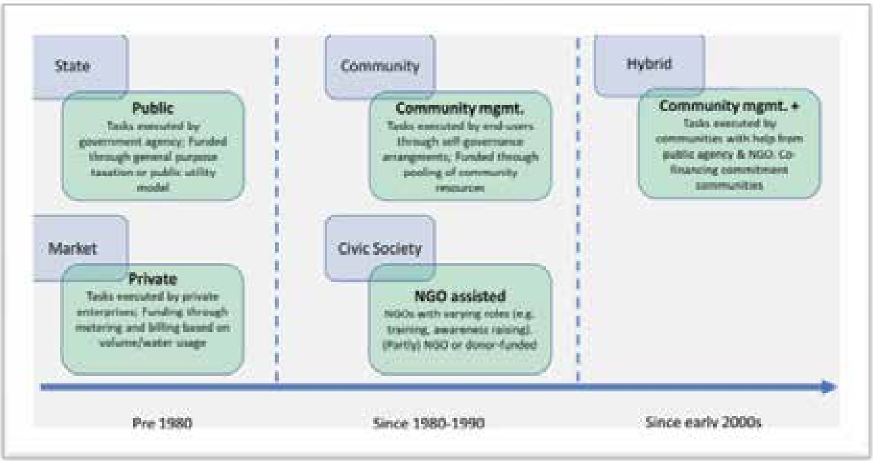

Figure 1: Development in approaches to conceptualizing and organizing drinking water service delivery

CM+ is a governance arrangement where the responsibility for operation and maintenance is shared between communities of DWS users and government agencies or local NGOs (Baumann, 2006a). The general assumption is that CM+ brings together different areas of expertise, helps to build a range of communities' capacities, and benefits from local knowledge about topics ranging from local geographies to cultural norms and sensitivities (Hall et al., 2005). CM+ is therefore thought to have potential to contribute significantly to solving drinking water problems and achieving SDG 6.

Research objective and research question

In this dissertation, I test the validity of this assumption and explore the preconditions for CM+ success. In doing so, I will consider (i) local preferences regarding DWSs, (ii) the psychology of adopting new (drinking water) technologies, (iii) the collective action of DWS users, and collaboration between users and agencies, and (iv) the particular and potential role of NGOs. I consider CM+ a success if (i) the DWS in question aligns with local preferences, (ii) communities are willing to adopt the improved technology, (iii) communities are able to meaningfully engage with each other and with the government agency in the governance of their shared resource, and (iv) NGOs provide effective and relevant forms of support to communities of DWS end-users. These four spheres used for interpreting the success of CM+ coincide with the subsequent chapters of this dissertation, as will be explained below in more detail.

The principal objective of this dissertation is to contribute to the optimization of the CM+ approach to governing community drinking water systems, both in general terms and in particular with regard to coastal Bangladesh. The main question of this dissertation is ***how can community drinking water systems be successfully governed?***

First, I assume that the more a DWS aligns with what people prefer and demand, the more likely it will be that a CM+ approach to governing that DWS will be successful. Therefore, it is important to understand what factors feed into households' preferences. Hence, my first sub-question (which is the foundation for chapter 2 of this dissertation) is: *What are the attributes that households consider when determining their overall preference for a DWS, and to what extent do the values assigned to these attributes vary across different types of households?*

My second assumption is that even if a DWS aligns with household preferences, when introduced it will have to compete with existing (presumably less safe) DWSs. CM+ can only succeed if households are willing to adopt the new technology to begin with. The adoption of a new and improved technology is not guaranteed, because a range of socio-psychological factors cause households to hang on to old technologies even when they arguably should not. My second sub-question (which drives chapter 3 of this dissertation) is: *How do socio-psychological factors affect people's willingness to adopt a new and improved DWS?*

Third, CM+ requires collective action by and between the DWS end-users and government support agencies. Typically, provision dilemmas (i.e., arising from private costs vs. shared benefits) and appropriation dilemmas (i.e., arising from private benefits vs. shared costs) render collective action and collaboration difficult. Therefore, the identification of prerequisites for CM+ success requires an understanding of the factors that influence the likelihood of collective action and collaboration by and between DWS end-users and government agencies. Thus, the sub-question underlying my chapter 4 is: *What conditions explain variation in collective action among DWS end-users and collaboration between DWS end-users and government agencies?*

Fourth, CM+ success can be argued to be related to the form and content of support that communities of DWS end-users receive from external non-governmental actors or NGOs. My impression is that we do not have a good overview of what NGOs are doing to support local communities, and that we do not really know what the impact is of what they do. To test this assumption, my last two sub-questions (which are the basis for chapter 5 of this dissertation) are the following: *To what extent does NGO support address the requirements for day-to-day and long-term collective action? To what extent does NGO support have an impact on the requirements for collective action?*

Although Bangladesh is bestowed with a number of perennial rivers, it has long been experiencing severe drinking water scarcity (Murshed & Kaluarachchi, 2018). The WHO estimates that only 39% of the population has access to safely-managed drinking water services (WHO/UNICEF JMP,2015). Apart from increasing population growth, unplanned urbanization, rapid industrialization, and a falling groundwater level, the safe drinking water situation is also exacerbated by climate change impacts (Chowdhury, 2010).

Drinking water scarcity is most acute in the southwestern coastal zone of Bangladesh. The area is frequently exposed to natural hazards with a direct or indirect impact on drinking water provision, such as cyclones, tidal surges, storm surge flooding, waterlogging, and coastal erosion. Climate change is expected to exacerbate the frequency and intensity of many of these hazards. As a result of salinity intrusion and arsenic and pathogenic contamination, aquifers are often unsuitable as a source of drinking water (Afroz et al., 2016; Islam et al., 2019; Rahman & Islam, 2018), and so is surface water (Abedin & Shaw, 2014; Hoque et al., 2019). Using rainwater as an alternative source is challenge because of seasonal variation in precipitation.

In order to address drinking water scarcity, various types of DWSs have been introduced in the area. In 1983, UNICEF and the Department of Public Health Engineering (DPHE) introduced pond sand filters (PSF) in areas without suitable water sources. PSF is a low-cost, low-tech, community-based and community-operated DWS. When arsenic contamination was detected in the 1990s, the government started installing deep tube-wells in affected areas (Fischer et al., 2020). In addition, both the government and NGOs (often supported by international donors) introduced rainwater harvesting, piped water, and reverse osmosis systems. Recently, managed aquifer recharge (MAR) systems have been added to the family of solutions to drinking water problems in the southwestern coastal areas of Bangladesh.

National drinking water policies in Bangladesh very explicitly accommodate drinking service delivery based on what could be labeled as CM+. The National Policy for Safe Water Supply and Sanitation (1998) recognizes four actors that are involved in the provision of safe drinking water in rural areas: (1) the DPHE; (2) local government institutes (i.e., Upazila Parishad and Union Parishad); (3) NGOs; and (4) local communities. The DPHE is the lead public agency that is responsible for installing drinking water infrastructure in most of the country. To that end, the central government allocates budget to the DPHE via local governments (Hoque, 2009). The Upazila Parishad and the Union Parishad, the second and third tiers of local government in Bangladesh, cooperate with the DPHE in the implementation process of DWS by approving the list of DWS sites proposed at the Upazila water and sanitation (WATSAN) committee's monthly meeting. Community members are supposed to operate and maintain their DWS themselves. To that end, they appoint a paid caretaker and form a maintenance committee comprising 5–7 members from the community.

The study area is characterized by a history of relatively high levels of DWS failure (Hoque et al., 2004; Shafiquzzaman et al., 2009; Hossain et al., 2015). Hossain et al. (2015) found that in their sample, 87% of the PSFs, 60% of rainwater harvesting systems, and 7% of the tube-wells were non-functional due to maintenance issues, costs, and lack of user friendliness. Similarly, regarding MAR, the latest statistics suggest that by now nearly one-third of the MAR systems have become dysfunctional. Therefore, this case offered a unique chance to explore the prerequisites for CM+ to succeed as a drinking water service delivery model.

Research Design

Theoretical foundation:

The first research sub-question entails investigating the factors that determine households' preferences regarding DWS. To establish household preferences with regard to DWS, I employ a choice experiment (CE) model. CE is based among other things on consumer goods theory (Lancaster, 1966), which holds that consumers derive utility from characteristics of the goods (rather than from the good itself), and on random utility theory (Marschak, 1960), which sees utility as dormant and hence impossible for the researcher to observe directly. In my analysis, I differentiate between attributes of the household (e.g., size, location, income, and education) and attributes of the DWS (e.g., disaster resilience and reliability of the DWS, and the price, taste, and quality of the water it produces).

The second research sub-question entails identifying the social and psychological factors that affect peoples' adoption and continued use of water from a new and improved DWS. To do so, I use a combination of the psychological factors proposed by the so-called RANAS model (Mosler, 2012) and a number of contextual factors. In broad strokes, RANAS—an acronym— recognizes **r**isk, **a**ttitude,

norms, **a**bility, and **s**elf-regulation as factors that affect people's willingness to consider converting to a new and more safe drinking water option. The RANAS model is rooted partly in protection motivation theory (Floyd et. al., 2000) and partly in health action process theory, from which it borrows ideas about the role of risk. The theory of planned behavior (Ajzen, 1991) contributes factors related to attitude, norms, and ability. I also consider contextual factors in my research, such as the presence of other drinking water options that the new and improved option has to compete with.

The third research sub-question entails investigating the conditions under which DWS end-users are likely to engage in collective action among themselves, and of collaboration with external support entities (e.g., DPHE). DWSs under a CM+ regime can be perceived of as a shared resource or a commons. This means that social dilemmas (i.e., dilemmas of appropriation and provision) must be solved in order to avoid failure (Madrigal et al., 2011; Naiga et al., 2015; Ostrom, 1990). In the literature, a number of so-called enabling conditions are suggested that are thought to increase the likelihood that users invest sufficiently in provision and adhere to an optimal rate of withdrawal or appropriation (Madrigal et al., 2011a; Naiga et al., 2015).For my study of collective action among DWS users, I developed a set of enabling conditions for the particular context of DWS governance, drawing insights from commons literature in particular (e.g., Agrawal, 2001; Baland & Platteau, 1996; Cox et al., 2010; Ostrom, 1990). The set comprises 20 indicators related to (i) resource characteristics, (ii) the relation between resource system characteristics, (iii) user group characteristics, (iv) institutional arrangement, and (v) the state. For studying collaboration between DWS users and public agencies, I propose a theoretical framework that comprises 16 indicators clustered into four major blocks: (i) user group characteristics; (ii) public agency characteristics; (iii) the relationship between user group and public agency; and (iv) institutional arrangement.

The fourth research sub-question entails the assessment of the forms and impacts of NGO support on the organization of collective action among the end-users of the DWS system. To do so, I draw on commons and collective action literatures in general and on the work of Barnes & Laerhoven (2013, 2016, 2014) to develop a theoretical framework. Factors that I expect to be important for day-to-day collective action comprise (i) regular meetings, (ii) rules-in-use and (iii) rules enforcement. For durable, long-term collective action, I expect that the following are important (i) understanding of relevant policies, (ii) participation of users in decision-making, (iii) the management capacity of resource users, (iv) fair allocation of benefits, (v) the ability of users to pay, (vi) the willingness of users to pay, (vii) awareness among users, (viii) dynamic leadership and (ix) a supportive external environment. I study whether NGOs take these requirements into account in their support activities, and, if so, whether their support significantly affects any of these requirements.

The dissertation aims to contribute to scientific advancement and to solving societal problems. It is expected to contribute to the academic debate around the governance of community DWSs. Historically, that debate has considered public delivery models on the one hand, and community service delivery models on the other. In this dissertation, I explore the potential of approaches to drinking water service delivery that are based on responsibility being shared by both the government or local NGOs and the community. The exploration of such models urges me to draw from and build on (i) economic theory on consumer preferences (chapter 2); (ii) theories from psychology and sociology on the adoption of innovations (chapter 3); (iii) theories from economics and political science on collective action and collaboration in a context of the governance of commons (chapter 4), and (iv) institutional and development theories on NGO support (chapter 5). The dissertation also has societal relevance. Over the years, both the government and NGOs, often financed by international donors, have introduced multiple DWSs in the coastal zone of Bangladesh in order to mitigate drinking water scarcity. However, many of these DWSs have failed (Hoque et al., 2004; Shafiquzzaman et al., 2009; Hossain et al., 2015). With this dissertation I hope to contribute to the understanding of failure and success of DWSs in regions of drinking water scarcity in Bangladesh and beyond.

Site selection and description

I selected three districts located in the southwestern coastal zone: Khulna, Bagerhat, and Satkhira. The geographical and socio-economic conditions of the population in the study areas are summarized in Table 1. These districts were chosen as they experience severe scarcity of drinking water due to salinity intrusion, arsenic contamination, and a high frequency of natural hazards induced by climate change, such as cyclones, storm surges, and flooding (Abedin & Shaw, 2014). Additionally, they vary greatly from each other in terms of the functionality of community-run DWSs (Hossain et al., 2015). The population of the study area is predominantly rural, with nearly 80% living in rural areas. The poverty rate of the area varies from 19% to 31% (Shameem et al., 2014). People engage in a diverse set of economic activities; however, the primary occupations include agriculture (55%) and shrimp farming (25 %). The average literacy rate of the people of the study area is around 50%, which is lower than the national rate (73%) in Bangladesh (Bangladesh Bureau of Statistics, 2020). Within each district, the empirical cases selected for the study vary, as they were chosen considering the objective of each respective chapter.

Table 1: Geographical and socio-economic conditions of the population in the study area

District name	# Sub-districts	# Unions	# Villages	Area (km²)	Population		Literacy rate (%)	Poverty rate (%)
					Urban	Rural		
Khulna	9	71	1106	4389.11	1,284,208	1,094,763	57.81	30.8
Bagerhat	9	75	1031	3959.11	206,554	1,342,477	58.71	31.0
Satkhira	7	79	1436	3858.33	171,614	1,693,090	45.52	18.6
Total	25	225	3573	12206.55	1,662,376	4,130,330		

Source: Bangladesh Population Census 2011, Bangladesh Bureau of Statistics 2018, and Household Income and Expenditure Survey 2016.

For empirical chapters 2 and 3, a survey approach was employed to assess households' preferences for and adoption of a new DWS. In these chapters, households form the unit of analysis. In total, 882 households (chapter 2) and 780 households (chapter 3) from across the 16 (chapter 2) and 15 (chapter 3) MAR sites from those three districts were selected, using random route sampling to ensure their representative character (Hoffmeyer-Zlotnik, 2003). The MAR communities vary in terms of DWS performance, socio-psychological, and contextual factors. Both chapters explore (each from a different theoretical and methodological angle), if, how, and to what extent socio-psychological and contextual factors affect households' preferences for and actual adoption of a new DWS.

In chapters 4 and 5, the entire DWS sites (i.e., the infrastructure, the stakeholders, and the institutional arrangements, combined) represent the unit of analysis. A comparative case study approach was used, in which respectively 30 cases (chapter 4) and 11 cases (chapter 5) were selected using purposive sampling. AdoptingPoteete et al.'s definition of a case "as a relatively well-bounded phenomenon or class of events" (2010:33), in these chapters, each community at the time of study forms a case. In both chapters, I use a comparative case study design because these chapters are exploratory and aim to elucidate the relations between variables in a data-poor context. In such a context, comparison among a small number of cases is suitable as it allows for the study to be sufficiently deep to explain the causal relations in complex settings (Gerring, 2006). In both chapters, the case selection controls as much as possible for factors which are hypothesized to influence the outcome variable. Both chapters explore (each from a somewhat different theoretical and methodological angle), if, how, and to what extent a range of factors affect collective action and collaboration in the context of DWS governance.

Selected drinking water systems

For my research, I selected two particular types of DWSs, namely MAR and PSF systems. The governance of both types of DWS aligns with the definition of CM+: Both MAR and PSF are primarily community-operated, while public agencies, local governments and local NGOs are involved by providing support to the communities.

Managed aquifer recharge (MAR)

MAR as used in the research area is a groundwater management tool where the aquifer is artificially replenished through injection wells (Dillon et al., 2009). In MAR systems, water is first collected from ponds or rooftop rainwater during the monsoon season. After passing through a sand filter, it is passed through 4 to 6 infiltration wells around an abstraction well into the aquifer, where it is temporarily stored as a freshwater bubble. During the dry season, the freshwater can be abstracted through a hand pump. After having experimented with first four and later an additional 20 pilot sites, UNICEF Bangladesh, together with Dhaka University Geology Department, DPHE, and Acacia Water (a Dutch consultancy firm), financed by the Dutch Embassy, rolled out another 79 pilot sites between 2014–2015. The ambition is to scale up the technology considerably, so it can play an important role in solving drinking water problems in the region and beyond.

During the pilot period, sites were selected by the Dhaka University Geology Department together with some local NGOs. DPHE constructed the sites and local NGOs provided necessary support to the communities. After installation, the MAR systems were handed over to the local communities who were supposed to operate and maintain those systems themselves. To do so, the community formed a user committee comprising 5–7 members from among themselves and appointed and needed to pay a caretaker.

Pond sand filters (PSF)

PSF is considered a suitable drinking water option in areas where groundwater sources are compromised by arsenic or salinization. DPHE and UNICEF started introducing PSF with the construction of 12 test sites in the Khulna district in 1984 (Harun & Kabir, 2012). Ever since, both government and NGOs (often financed by international donors) have been installing PSF systems in coastal areas of Bangladesh. In PSF systems, (pond) water is first pumped (manually) into a raised filter chamber consisting of a layered, sand filter bed through which the water then trickles down. This removes the turbidity, coliform bacteria and other impurities in a manner identical to slow sand filtration (Yokota et al., 2001).

In accordance with national guidelines, DPHE installs the PSF sites, the Upazila Parishad coordinates the implementation process, and the Union Parishad selects the PSF sites. The local community operates and maintains the PSF system by appointing and paying a caretaker from among themselves. The DPHE and Union Parishad are to provide support to the community in case of major repair requirements.

Data collection

The study collected data in three rounds. Multiple methods were used to collect the data needed to answer the research questions. Each chapter in the dissertation explains the methods in detail. Because of the nature of the study, mixed methods of data collection were employed, i.e., both qualitative and quantitative. Mixed methods increase the validity and reliability of the data by triangulating data from different sources (Creswell & Creswell, 2017; Djamba & Neuman, 2002).

The qualitative methods used in this thesis include focus group discussions with the end-users and key informant interviews with the elected representatives of the local government institutes (Union Parishad and Upazila Parishad), officials of public agency (DPHE), and local NGOs. Data collected through household surveys (e.g., with the household members responsible for water collection and management decisions) were used for quantitative descriptions and analyses. A summary of the details of data collection methods for the respective chapters is presented in Table 2.

In addition to these methods, I used observations to assess the performance of DWS and the behavior of end-users. I engaged government officials, local government representatives, local NGO officials, and community members (including local elites) by means of informal discussions, in order to gain a more in-depth understanding of the contexts. Also, a workshop was organized to triangulate the data collected through qualitative and quantitative methods. Furthermore, I collected data from secondary sources such as books, journals, research papers, government policy documents, technical documents, and annual reports.

Table 2: Data collection methods

Chapter	Sub-question	Details of data collection methods used
2	What are the attributes that households consider when determining their overall preference for a DWS, and to what extent do the values assigned to these attributes vary across different types of households?	▪ 882 questionnaires at the household level in 16 MAR communities ▪ 16 semi-structured interviews with members of MAR communities (one per community)
3	How do socio-psychological factors affect people's willingness to adopt a new and improved DWS?	• 780 questionnaires at the household level in 15 MAR communities • 30 semi-structured interviews with 15 MAR communities (2 per community)
4	What conditions explain variation in collective action among DWS end-users and collaboration between DWS end-users and government agencies?	▪ 30 structured group interviews with local DWS (PSF) users (each comprising 8–12 end-users and including PSF user committee members) ▪ 6 in-depth interviews with officials of the public agency involved (i.e., DPHE).
5	To what extent does NGO support address the requirements for day-to-day and long-term collective action? To what extent does NGO	▪ 11 focus group discussions with local DWS (MAR) end-users including user committee members (10 participants/session) ▪ 11 in-depth semi-structured interviews with the chairperson of the

Chapter	Sub-question	Details of data collection methods used
	support have an impact on the requirements for collective action?	user committee ▪ 15 semi-structured interviews with NGO staff members ▪ 4 semi-structured interviews with Dhaka University MAR officials ▪ 11 semi-structured interviews with Union Parishad (the lowest tier of local government) elected representatives

Outline of the dissertation

The dissertation is composed of six chapters. Apart from the introduction and the concluding chapters, it includes four empirical chapters that are divided into two parts. The first part deals with identifying the factors that determine households' preferences and willingness to adopt a new and improved DWS, while the other part explores the conditions required for organizing collective action among the DWS users and the promotion of collaboration between the DWS users and the external support entities. Chapter 2 focuses on mapping what people prefer regarding DWS by measuring the variation in their willingness to pay for it in the three southwestern coastal districts of Bangladesh. Chapter 3 discusses the social and psychological factors influencing people to adopt and continue to use water from the MAR system, switching from their existing DWS. Chapter 4 provides an analysis of the enabling conditions that are presumably required to achieve collective action among the end-users and effective collaboration between the end-users and public agency. Chapter 5 moves on to assess the forms and the impacts of NGO support on the requirements of both day-to-day and long-term collective action among the end-users of DWSs. The integration of the subsequent empirical chapters in this dissertation is illustrated in Figure 1.

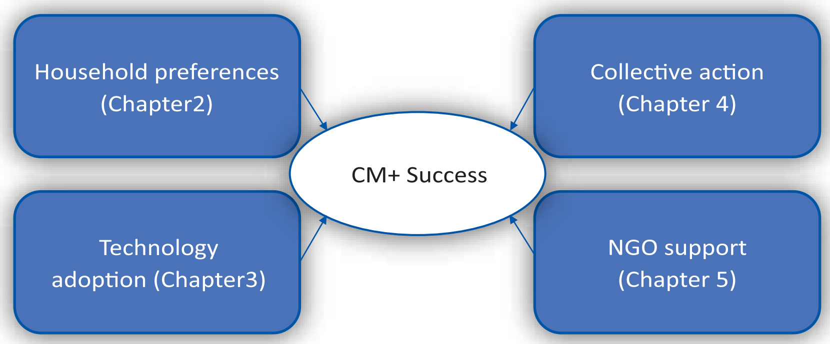

Figure 2: Schematic outline of the research presented in the dissertation

In the synthesis chapter 6, the findings of all empirical chapters are summarized and evaluated in relation to the potential of CM+ as a viable service delivery approach in the specific context of a shared drinking water system. In addition, the theoretical and practical implications of the findings for both southwestern coastal Bangladesh and other delta regions with similar contexts are discussed. Lastly, the dissertation offers some recommendations for policymakers and for future research.

References

Abedin, A., & Shaw, R. (2014). Safe Water Adaptability for Salinity , Arsenic and Drought Risks in Southwest of Bangladesh. *Risk, Hazards {&} Crisis in Public Policy*, *4*(2), 62–82. https://doi.org/10.1002/rhc3.12033

Afroz, S., Cramb, R., & Grunbuhel, C. (2016). Collective Management of Water Resources in Coastal Bangladesh: Formal and Substantive Approaches. *Human Ecology*, *44*(1), 17–31. https://doi.org/10.1007/s10745-016-9809-x

Agrawal, A. (2001). Common Property Institution and Sustainable Governance of Resources. *World Development*, *29*(10), 1649–1672. https://doi.org/https://doi.org/10.1016/S0305-750X(01)00063-8

Ajeng, R., Roekmi, K., Baskaran, K., & Chua, L. H. C. (2018). Community-based water supplies in Cikarang , Indonesia : are they sustainable ? *Natural Resources Forum*, *42*(2), 108–122. https://doi.org/10.1111/1477-8947.12146

Ajzen, I. (1991). The theory of planned behavior. *Organizational Behavior and Human Decision Processes*, *50*(2), 179–211. https://doi.org/https://doi.org/10.1016/0749-5978(91)90020-T

Baland, J., & Platteau, J. (1996). *Halting degradation of natural resources: Is there a Role for Rural Communities?* . Oxford:Clarendon Press.

Bangladesh Bureau of Statistics. (2020). *Statistics and Informatics Division (SID), Ministry of Planning, Bangladesh*.

Barnes, C, & Laerhoven, F. Van. (2013). Helping to Self-Help? External Interventions to Stimulate Local Collective Action in Joint Forest Management, Maharashtra, India: *International Forestry Review*, *15*(1), 1–17. https://doi.org/10.1505/146554813805927246

Barnes, Clare, & van Laerhoven, F. (2014). Making it last? Analysing the role of NGO interventions in the development of institutions for durable collective action in Indian community forestry. *Environmental Science and Policy*, *53*, 192–205. https://doi.org/10.1016/j.envsci.2014.06.008

Barnes, Clare, van Laerhoven, F., & Driessen, P. P. J. (2016). Advocating for Change? How a Civil Society-led Coalition Influences the Implementation of the Forest Rights Act in India. *World Development*, *84*, 162–175. https://doi.org/10.1016/j.worlddev.2016.03.013

Baumann, E. (2006). Do operation and maintenance pay? *Waterlines*, *25*(1), 10–12. https://doi.org/10.3362/0262-8104.2006.033

Chitonge, H. (2011). A decade of implementing water services reform in Zambia: Review of outcomes, challenges and opportunities. *Water Alternatives*, *4*(3), 279–300.

Chowdhury, N. T. (2010). Water management in Bangladesh: An analytical review. *Water Policy*, *12*(1), 32–51. https://doi.org/10.2166/wp.2009.112

Cox, M., Arnold, G., & Villamayor, S. (2010). A Review of Design

Principles for Community-based Natural Resource Management. *Ecology and Society*, *15*(4), 28. https://doi.org/38

Creswell, J. W., & Creswell, J. D. (2017). *Research design: Qualitative, quantitative, and mixed methods approaches* (5th ed.). Sage publications.

Dillon, P. J., Pavelic, P., Page, D., Beringen, H., & Ward, J. (2009). Managed aquifer recharge: An introduction. *Waterlines Report Series*, *13*, 1–64.

Djamba, Y. K., (2002). Social Research Methods: Qualitative and Quantitative Approaches. *Teaching Sociology*, 30(3) , 380. . https://doi.org/10.2307/3211488

Evans, P. (1992). *Community management of improved water supply systems : a preliminary review*. *706191*. http://www.ircwash.org/sites/default/files/205.1-92CO-10003.pdf

Fielmua, N. (2011). The Role of the Community Management Model towards Improved and Sustainable Access to Potable Water in Ghana (A Case of Nadowli District). *Journal of Sustainable Development*, *4*(3), 174–184. https://doi.org/10.5539/jsd.v4n3p174

Fischer, A., Hope, R., Manandhar, A., Hoque, S., Foster, T., Hakim, A., Islam, M. S., & Bradley, D. (2020). Risky responsibilities for rural drinking water institutions: The case of unregulated self-supply in Bangladesh. *Global Environmental Change*, *65, 102152*. https://doi.org/10.1016/j.gloenvcha.2020.102152

Floyd, D. L., Prentice-Dunn, S., & Rogers, R. W. (2000). A meta-analysis of research on protection motivation theory. *Journal of Applied Social Psychology*, *30*(2), 407–429. https://doi.org/10.1111/j.1559-1816.2000.tb02323.x

Gerring, J. (2006). *Case Study Research: Principles and Practices*. Cambridge University Press.

Hall, D., Lethbridge, J., & Lobina, E. (2005). Public–Public Partnerships in Health and Essential Services. *MSP Occational Paper No. 9*, *July*. http://gala.gre.ac.uk/3639/

Harun, M. A. , & Kabir, G. M. M. (2013). Evaluating pond sand filter as sustainable drinking water supplier in the Southwest coastal region of Bangladesh. *Applied Water Science*, *3*(1), 161–166. https://doi.org/10.1007/s13201-012-0069-7

Harvey, P. A., & Reed, R. A. (2007). Community-managed water supplies in Africa: Sustainable or dispensable? *Community Development Journal*, *42*(3), 365–378. https://doi.org/10.1093/cdj/bsl001

Hoffmeyer-Zlotnik, J. H. P. (2003). New sampling designs and the quality of data. *Developments in Applied Statistics*, *19*, 205–217. http://mrvar.fdv.uni-lj.si/pub/mz/mz19/abst/hoff.htm

Hoque, B. A., Hoque, M. M., Ahmed, T., Islam, S., Azad, A. K., Ali, N., Hossain, M., & Hossain, M. S. (2004). Demand-based water options for arsenic mitigation: An experience from rural Bangladesh. *Public Health*, *118*(1), 70–77. https://doi.org/10.1016/S0033-3506(03)00135-5

Hoque, M.R. (2009). *Access to Safe Drinking Water in Rural Bangladesh: Water Governance by DPHE*. BRAC University, Dhaka, Bangladesh.

Hoque, S. F., Hope, R., Arif, S. T., Akhter, T., Naz, M., & Salehin, M. (2019). A social-ecological analysis of drinking water risks in coastal Bangladesh. *Science of the Total Environment*, *679*, 23–34. https://doi.org/10.1016/j.scitotenv.2019.04.359

Hossain, M., Rahman, S. N., Bhattacharya, P., Jacks, G., Saha, R., & Rahman, M. (2015). Sustainability of arsenic mitigation interventions-an evaluation of different alternative safe drinking water options provided in Matlab, an arsenic hot spot in Bangladesh. *Frontiers in Environmental Science*, *3, 30*, 1–15. https://doi.org/10.3389/fenvs.2015.00030

Hutchings, P., Chan, M. Y., Cuadrado, L., Ezbakhe, F., Mesa, B., Tamekawa, C., & Franceys, R. (2015). *A systematic review of success factors in the community management of rural water supplies over the past 30 years*. *17*, 963–983. https://doi.org/10.2166/wp.2015.128

Islam, M., Ali Akber, M., & Atikul Islam, M. (2019). Willingness to pay for improved drinking water in Southwest coastal Bangladesh. *Water Science and Technology: Water Supply*, *19*(1), 1–10. https://doi.org/10.2166/ws.2018.047

Kiguchi, M., Shen, Y., Kanae, S., & Oki, T. (2014). Re-evaluation of future water stress due to socio-economic and climate factors under a warming climate. *Hydrological Sciences Journal*, *60*(1), 14–29. https://doi.org/10.1080/02626667.2014.888067

Lancaster, K. J. . (1966). A New Approach to Consumer Theory. *The Journal of Political Economy*, *74*(2), 132–157.

Madrigal, R., Alpízar, F., & Schlüter, A. (2011). Determinants of Performance of Community-Based Drinking Water Organizations. *World Development*, *39*(9), 1663–1675. https://doi.org/10.1016/j.worlddev.2011.02.011

Marschak, J. (1960). Binary choice constraints on random utility indications. In Arrow K (Ed.), *Stanford Symposium on Mathematical Methods in the Social Sciences*. Stanford University Press.

Moretto, L., Faldi, G., Ranzato, M., Rosati, F. N., Ilito Boozi, J. P., & Teller, J. (2018). Challenges of water and sanitation service co-production in the global South. *Environment and Urbanization*, *30*(2), 425–443. https://doi.org/10.1177/0956247818790652

Moriarty, P., Smits, S., Butterworth, J., & Franceys, R. (2013). Trend in rural water supply: Towards a service delivery approach. *Water Alternatives*, *6*(3), 329–349.

Moriarty, P., & Verdemato, T. (2010). Providing Sustainable Water Services at Scale . *Report of the International Symposium on Rural Water Services*, 1–37. papers2://publication/uuid/8C9349A7-3CBA-44B2-95B5-DCD6342A7E09

Mosler, H. J. (2012). A systematic approach to behavior change interventions for the water and sanitation sector in developing countries: A conceptual model, a review, and a guideline. *International Journal of Environmental Health Research*, *22*(5), 431–449. https://doi.org/10.1080/09603123.2011.650156

Murshed, S. B., & Kaluarachchi, J. J. (2018). Scarcity of fresh water resources in the Ganges Delta of Bangladesh. *Water Security*, *4–5*(May), 8–18. https://doi.org/10.1016/j.wasec.2018.11.002

Naiga, R., Penker, M., & Hogl, K. (2015). Challenging pathways to safe water access in rural Uganda: From supply to demand-driven water governance. *International Journal of the Commons*, *9*(1), 237–260.http://doi.org/10.18352/ijc.480

Ostrom, E. (1990). *Governing the Commons: The Evolution of Institutions for Collective Action* (Ist editio). Cambridge University Press. https://doi.org/10.1017/CBO9780511807763

Pahl-Wostl, C. (2009). A conceptual framework for analysing adaptive capacity and multi-level learning processes in resource governance regimes. *Global Environmental Change*, *19*(3), 354–365. https://doi.org/10.1016/j.gloenvcha.2009.06.001

Rahman, M. M., Alam, K., Karim, R., & Islam, M. K. (2017). Willingness to Pay for Improved Water Supply : A Policy Implications for Future Water Security. *American Journal of Environmental and Resource Economics*, *2*(4), 116–122. https://doi.org/10.11648/j.ajere.20170204.11

Reddy, V. R. (1999). Pricing of rural drinking water: a study of willingness and ability to pay in Western India. *Journal of Social and Economic Development,2*(1), 101–122.

RWSN. (2009). Handpump Data, Selected Countries in Sub-Saharan Africa. RWSN, St Gallen, Switzerland, . http://www.rural-water-supply.net/_ressources/documents/default/203.pdf

Sarker, M. H., & Ahmed, F. (2015). *Climate Change Vulnerability of Drinking Water Supply Infrastructure in Coastal Areas of Bangladesh*. IUCN, International Union for Conservation of Nature, Dhaka, Bangladesh.

Schewe, J., Heinke, J., Gerten, D., Haddeland, I., Arnell, N. W., Clark, D. B., Dankers, R., Eisner, S., Fekete, B. M., Colón-González, F. J., Gosling, S. N., Kim, H., Liu, X., Masaki, Y., Portmann, F. T., Satoh, Y., Stacke, T., Tang, Q., Wada, Y., … Kabat, P. (2014). Multimodel assessment of water scarcity under climate change. *Proceedings of the National Academy of Sciences*, *111*(9), 3245–3250. https://doi.org/10.1073/pnas.1222460110

Shafiquzzaman, M., Azam, M. S., Moshima, I., & Nakajima, J. (2009). Technical and Social evaluation of arsenic mitigation in rural bangladesh. *Journal of Health, Population and Nutrition*, *27*(5), 674–683. https://doi.org/10.3329/jhpn.v27i5.3779

Shameem, M. I. M., Momtaz, S., & Rauscher, R. (2014). Vulnerability of rural livelihoods to multiple stressors: A case study from the southwest coastal region of Bangladesh. *Ocean and Coastal Management*, *102*, 79–87.

https://doi.org/10.1016/j.ocecoaman.2014.09.002

Smits, S. (2013). *Service delivery models*. IRC International Water and Sanitation Centre. https://www.ircwash.org/news/service-delivery-models

UN, W. (2014). *International Decade for Action "Water for Life" 2005-2015, UNDESA.* https://www.un.org/waterforlifedecade/scarcity.shtml#

Wegerich, K. (2009). The hidden urban tail-enders - Drinking water supply as a common pool resource problem in Khorezm, Uzbekistan. *International Journal of Sustainable Society*, *1*(3), 240–254. https://doi.org/10.1504/IJSSOC.2009.027622

World Bank. (2017). *Sustainability Assessment of Rural Water Service Delivery Models : Findings of a Multi-Country Review, World Bank.*WHO/UNICEF JMP. (2015). *WHO/UNICEF Joint Monitoring Programme (JMP) for Water Supply and Sanitation, Bangladesh.*

WHO/UNICEF JMP. (2019). *Progress on household drinking water, sanitation and hygiene 2000-2017: special focus on inequalities. World Health Organization*.

Yokota, H., Tanabe, K., Sezaki, M., Akiyoshi, Y., Miyata, T., Kawahara, K., Tsushima, S., Hironaka, H., Takafuji, H., Rahman, M., Ahmad, S. A., Sayed, M. H. S. U., & Faruquee, M. H. (2001). Arsenic contamination of ground and pond water and water purification system using pond water in Bangladesh. *Engineering Geology*, *60*(1–4), 323–331. https://doi.org/10.1016/S0013-7952(00)00112-5

CHAPTER 2

ELUCIDATING HOUSEHOLDS' PREFERENCES FOR DRINKING WATER SUPPLY SYSTEMS IN BANGLADESH: A CHOICE EXPERIMENT

This chapter has been submitted to Water International as: Hasan, MB., van Rijnsoever, Driessen, P.P., Zoomers, A., and van Laerhoven (2021) Elucidating households' preferences for drinking water supply systems in Bangladesh: A choice experiment (under review).

Abstract

For drinking water supply systems to continue working, the alignment between supply and demand is crucial. However, a well-working market for drinking water delivery solutions is often absent in countries in the so-called global south. Therefore, government agencies and/or donors need to come up with alternative ways to elucidate household preferences, instead. In this study, we explore how households characterized by different attributes differ in how they value a bundle of different drinking water system attributes when ultimately establishing their overall preference. We conduct a choice experiment in southwestern Bangladesh that included 882 households. We show that rather than simply preferring one drinking water system over the other, households determine what they prefer based on how they value a range of different attributes of such a system. Also, households with different attributes are found to value different drinking water system attributes, differently. Our contribution to theory regards the unpacking of household preferences for drinking water supply systems. Our contribution to the development of methods regards the use of choice experiments for doing that. In practical terms, we hope to show that government agencies and donors shouldn't take their attempts to offer households what they want, lightly.

Keywords:

Drinking water systems, choice experiment, preference, willingness to pay, Bangladesh

Introduction

Despite remarkable improvements, lack of access to safe drinking water sources remains a major concern in many developing countries (Vásquez, Franceschi, & Van Hecken, 2012). In Bangladesh, it is estimated that 45% of the population do not have access to safe drinking water sources (WHO/UNICEF JMP, 2020). The use of unsafe sources leads to public health issues, which in turn thwarts socio-economic development (Veldkamp et al., 2015) .

Drinking water scarcity is more acute in the southwestern coastal region of the country (Afroz et al., 2016), which is prone to frequent flooding and cyclones that often destroy local drinking water systems (Abedin et al., 2014). Here too, sea-level rise and a reduction in inflowing freshwater have resulted in salinity intrusion that affects the quality of drinking water (Rahman Talukder et al., 2015; Rahman et al., 2017). Furthermore, surface water is easily contaminated by pathogens and chemical agents, and naturally occurring arsenic is mobilized when water is abstracted from aquifers.

Initiatives to improve the drinking water situation in developing countries have often failed to deliver (Madajewicz et al., 2017; Starkl et al., 2013; Whittington et al., 1998). Bangladesh is no exception. It is estimated that around 30-40% of the drinking water projects in countries in Asia and Africa fail within six months to a year after their installation (RWSN, 2009; Reddy et al., 2011). In

Bangladesh, Hossain et al. (2015) found that 87% of the pond sand filters, 60% of the rainwater harvesting systems, and 7% of the tube-wells were dysfunctional.

Failure has been attributed to the non-optimal alignment of newly introduced drinking water solutions with local preferences (Hubbard et al., 2011; Whittington et al., 2009). Understanding the factors that constitute households' preferences is therefore important, but not many studies have looked into this specifically in relation to rural drinking water systems. Those that have (e.g., Burt et al., 2017; Vásquez & Espaillat, 2016; Wendimu & Bekele, 2015) estimate households' preferences for DWS in aggregated terms only, and do not unpack these preferences into the attributes that are responsible for them. More importantly, aggregated studies do not enable types of households to be differentiated in terms of which attributes they value and to what extent when they are allowed to choose their preferred DWS.

This study therefore primarily aims to identify and weigh the attributes that households consider when determining their overall preference for a DWS. Secondly, it is our objective to establish to what extent the values attributed to these attributes vary across households. To do so, we used a choice experiment. The study was conducted in the coastal area of Southwest Bangladesh. With our study we hope to contribute to better alignment between supply and demand, and subsequently to the successful implementation of drinking water solutions in water-scarce areas in Bangladesh and elsewhere.

Theory

The extent to which households start and continue to use new drinking water systems depends, among other things, on their preferences (Evans et al., 2014). The literature indicates that household preferences are composed of several attributes (Sajjadi et al., 2016).

Drinking water system attributes

The first attribute a household is likely to consider when establishing its overall preference for a DWS is disaster resilience, which in our study we took to mean the ability of the system to withstand cyclones and flooding. The study area is susceptible to a variety of natural disasters, especially frequent flooding and cyclones that destroy sources of fresh drinking water (Abedin et al., 2014).

Another DWS attribute that we hypothesize may affect a household's overall preference is the DWS's ability to supply potable drinking water. Not surprisingly, the literature (e.g. Park, 2015; Brouwer et al., 2015; Dauda et al. 2015) indicates that people prefer DWSs that supply water that does not make them sick. In this study, we define systems that pose no health risk as DWSs with the capacity to produce water that does not pose a risk to public or personal health.

The reliable availability of water is another attribute that we hypothesized may affect people's preference for DWSs (Vásquez & Espaillat, 2016; Wendimu & Bekele, 2015). As drinking water is scarce in the study areas, especially during the dry season (April–September), we assume that the reliable, year-round availability of water is likely to influence households' preferences and, subsequently, their willingness to pay for the installment and operation of a DWS.

A fourth attribute we proposed to look into as a possible influence on the overall household preference for DWSs, is the taste of the water it supplies (see also Wendimu & Bekele 2015; Whittington et al., 1990). In the southwestern coastal areas, salinity, turbidity, and odor of drinking water are major concerns. Therefore, we define taste in terms of water that is free from salinity, turbidity, and bad odor.

We also expected the price of water to influence a household's preference for DWS (Ahmad et al., 2006; Hasan et al. 2019; Islam et al., 2014). As most people in the study areas are not particularly well off, we suspected that they would probably prefer a DWS that can supply cheap rather than more expensive drinking water.

Household preferences

We expected that households' preferences that are based on attributes of the DWS will vary according to attributes associated with the household itself (Evans& Mara, 2011). This expectation is based on the literature, in which aspects mentioned to have a potential influence on households' preferences for DWSs include the income, size, and location of the household. Drawing insights from the existing literature and field experience, we offer an approach to evaluate the preferences of households in southwestern coastal Bangladesh for different types of DWSs with varying characteristics (see Table 1).

The existing literature indicates that *location* of the households influences households' preferences for DWSs. Comparing willingness to pay for the improved drinking service in rural and urban areas of Kenya, the study of Brouwer et al. (2015) showed that rural households are more price sensitive that urban households.

Anecdotal evidence also suggests that households' *income* has a positive impact on their willingness to pay for drinking water system (Echenique & Seshagiri, 2009; Harahap & Hartono, 2007; Wendimu & Bekele, 2015; Whittington et al., 1990). Households with more income are likely to be willing to pay more for the DWS than households with less income (e.g., Harahap & Hartono, 2007).

Household *size* is also thought to influence willingness to pay for DWSs in developing countries (Echenique & Seshagiri, 2009; Harahap & Hartono, 2007; Wendimu & Bekele, 2015). Wendimu & Bekele (2015) found that in Ethiopia, household size negatively affects the willingness to pay for good quality drinking water.

We assume that *water scarcity level* is likely to influence households' willingness to pay for DWSs in developing countries. We expect that households that have experienced more water stress are more likely to be willing to pay more than households with less experience of drinking water stress.

Table 1: Theoretical framework

Variables	**Definition of attributes**	**Sources**
Household attributes		
Household location	Nature of residence (i.e., rural or urban)	Brouwer & Crescent (2015)
Household size	Number of household members who share the same meals	Echenique & Seshagiri (2009); Wendimu & Bekele (2015)
Household income	Total income of all members in a household	Echenique & Seshagiri (2009); Wendimu & Bekele (2015); Whittington et al. (1990)
Water scarcity level	Extent to which households are living with drinking water scarcity	Present authors
Drinking Water System attributes		
A1: Disaster resilience	Ability of a DWS to withstand disasters, particularly cyclones and flooding	Present authors

A2: No risk to health	Capacity of a DWS to produce water that poses no risks to public health	Ahmad et al. (2006); Islam et al. (2014); Park (2015); Brouwer et al. (2015); Dauda et al. (2015)
A3: Reliability	Ability of a DWS to supply water year-round	Vásquez & Espaillat (2016); Wendimu & Bekele (2015)
A4: Taste	Ability of a DWS to supply palatable water, i.e., not saline, turbid, or with a bad odor	Hasan et al. (2019); Wendimu & Bekele (2015); Whittington et al. (1990)
A5: Price	Price of water per unit	Ahmad et al. (2006); Hasan et al. (2019); Islam et al. (2014)

Materials and methods

Study areas

The study was carried out in the three southwestern coastal districts of Bangladesh, namely Khulna, Bagerhat, and Satkhira. We selected them the following grounds. First, drinking water scarcity is acute in these districts, due to salinity intrusion, arsenic contamination, and frequent natural disasters (Afroz et al., 2016). Second, the DWS projects in this area have had varied success (Hasan et al., 2020).

The communities in the three districts are heterogeneous in terms of their socio-economic and demographic characteristics (see Table 2). Their main sources of drinking water are surface water from open ponds, pond sand filters (PSF), and rainwater harvesting systems (RWHSs). Often, neither shallow nor deep tube-well pumps are feasible, due to a lack of suitable aquifers at reasonable depths (Hoque et al., 2004; Islam et al., 2013).

Sampling

We purposively chose 16 communities from three southwestern coastal districts. Communities vary in terms of availability of different types of drinking water systems (Figure 1). Since a complete list of all households was unavailable, we used a random route method (Hoffmeyer-Zlotnik, 2003) to select a representative sample. We selected 882 households from the16 communities, i.e., approximately 50 households from each community (for details, see Table 2).

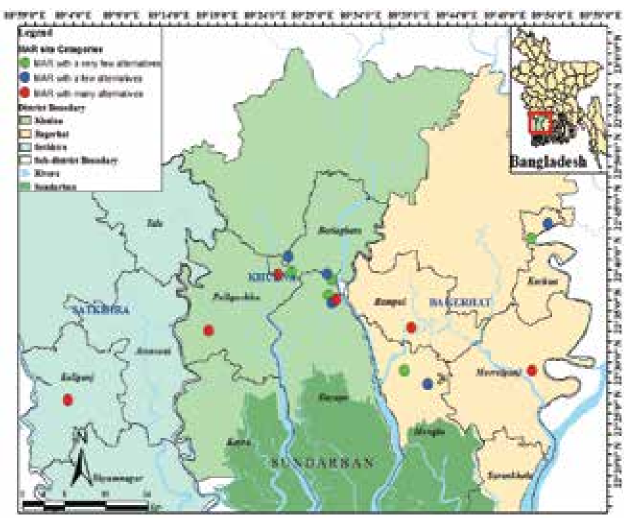

Figure 1: Study area

Table 2: Sample description

Community name	Union	Sub-district	District	Respondents (survey)	Households (per community) *	Travel time to the nearest urban center (minutes) **	Availability of different types of drinking water systems***
Barunpara	Gongarampur	Batiaghata	Khulna	45	486	40	Shallow tube-well (STW), rainwater harvesting system (RWHS), managed aquifer recharge (MAR)
Bhogobotipur	Surkhali	Batiaghata	Khulna	67	276	45	RWHS, vendors, MAR
Chalna	Chalna Pourasava	Dacope	Khulna	58	326	20	RWHS, vendors, MAR
South Chadpai	Chadpai	Mongla	Bagerhat	62	426	30	Pond, MAR

Community name	Union	Sub-district	District	Respondents (survey)	Households (per community) *	Travel time to the nearest urban center (minutes) **	Availability of different types of drinking water systems***
Boyer singaguccho gram	Dhopakhali	Kochua	Bager hat	50	72	40	Pond, RWHS, MAR
Kayemkhula	Gongarampur	Botiagh-ata	Khulna	46	170	45	Rural piped water system (RPWS), RWHS, MAR
Kollansree	Surkhali	Botiagh-ata	Khulna	47	360	60	Pond, RWHS, MAR
Duarijara	Sundarban	Mongla	Bager-hat	56	152	50	Pond, reverse osmosis (RO), RWHS, MAR
Achbua	ChalnaPouras-ava	Dacop	Khulna	62	667	60	STW, RWHS, RO, MAR
Gazalia	Gazalia	Kachua	Bager-hat	56	365	40	Pond sand filter (PSF), RWHS, vendor, and MAR
Laxmikhula	Laskar	Paikgac-ha	Khulna	56	220	60	Pond, PSF, RWHS, RO, and MAR

Community name	Union	Sub-district	District	Respondents (survey)	Households (per community) *	Travel time to the nearest urban center (minutes) **	Availability of different types of drinking water systems***
Kalikabari	Boloibunia	Morrelg-onj	Bager-hat	57	407	30	RO, RPWS, PSF, pond, RWHS, vendor, and MAR
Chalna bazar	Chalna	Dacop	Khulna	47	278	15	RWHS, RO, PSF, vendor, and MAR
Bigordana	Deluti	Paikgac - ha	Khulna	61	203	45	Pond, PSF, STW, RWHS, vendor and MAR
Thekra Rah-impur	Kusholia	Kaligonj	Satkhi - ra	63	421	40	Pond, PSF, RO, RWHS and MAR
Jhonjonia	RampalSadar	Rampal	Bager - hat	49	455	10	PSF, RO, vendor, MAR, and RWHS
Total = 16	**13**	**8**	**3**	**882**	**5284**		

* Data obtained from the respective local administrations; ** Data obtained from local key respondents. Numbers are based on the form of transportation most commonly used in the respective communities. *** **Data obtained from local NGOs.**

Choice experiment design

A choice experiment (CE) is a suitable method to investigate households' preferences for improved public services in developing countries (Bennett & Birol, 2010). We used the CE method since this method not only helped us to measure the variation in the households' willingness to pay (WTP) for different drinking water delivery systems but also allowed us to determine the economic valuation of attributes of that delivery system (Christie et al., 2007).

In the CE method, respondents are presented with two or more options that represent different service levels, each associated with a price. Respondents are asked to indicate their most preferred option from a set (Louviere et al., 2000). Different service levels and prices are mentioned in several experiments, to provide the variation required for the estimation of marginal utilities of each attribute. A series of experiments is presented to each respondent, with the experiments varying across respondents. Statistical analysis of the responses using the choices yields an estimate of the respondents' WTP.

Determination of attributes and their level

The first step of the study was to select the appropriate DWS attributes. Drawing on the insights from the existing literature and field experiences, we selected four non-monetary attributes that households might plausibly consider when establishing their overall preference for a DWS: disaster resilience, no risk to health, reliable availability, and taste. All our selected attributes were measured in terms of three levels, representing minimum, medium, and maximum values. In addition, there was a financial attribute that included eight different price levels, ranging from 0 to 1.75 BDT per liter (local currency). Attributes and levels are described in Table 3.

Table 3: Attributes, definitions, and their levels

Variables	Definition	Level and description		
		Level 1	**Level 2**	**Level 3**
A1: Disaster resilience	The ability of a DWS to withstand disasters (cyclones and flooding)	1: No disaster resilience When a cyclone and/or flood hits, you are sure to lose all/most of your stored water	2: Somewhat disaster-resilient When a cyclone and/or flood hits, there is a chance that you will lose some of your stored water	3: Totally disaster-resilient When a cyclone and/or flood occurs, all stored water is safe
A2: No risk to health	The capacity of a DWS to produce water that poses no risk to public health	1: Not free from health risk When drinking from this source during the dry season, the children in your household will suffer from diarrhea 4 times per year (per child)	2: Somewhat free from health risk When drinking from this source during the dry season, the children in your household will suffer from diarrhea 1 time per year (per child)	3: Totally free from health risk When drinking from this source during the dry season, none of your household members will get sick
A3: Reliable availability	The ability of a DWS to produce water year- round	1: Unreliable availability The water stored in this system is certainly insufficient to cover	2: Somewhat reliable availability There is a chance that the water stored in this system will not be	3: Totally reliable availability You are guaranteed to

Variables	Definition	Level and description							
		your drinking water needs during the whole dry season			sufficient for the whole dry season			be able to collect all the drinking water you need during the dry season	
A4: Taste	The ability of a DWS to produce water free from salinity and odor	1: Bad taste The water produced by this source tastes bad—turbidity, bad odor, and/or salinity are major issues			2: Medium taste The water from this source tastes reasonably good—there are minor issues with turbidity, bad odor, and/or salinity			3: Perfect taste The water produced by this source tastes exactly how you would like your drinking water to taste	
A5: Price	Price of water per liter	Level 1 BDT 0.00*	Level 2 BDT 0.25	Level 3 BDT0.50	Level 4 BDT0.75	Level 5 BDT1.00	Level 6 BDT1.25	Level 7 BDT1.50	Level 8 BDT1.75

* 1 BDT = USD 0.012

Design of the choice cards

The hypothetical DWS scenarios on the choice cards were generated using an orthogonal full factorial design with the NGENE program, which allowed for the estimation of both the main effects and interaction effects (Mangham et al., 2009). In this design, all levels of the attributes in the choice profiles are varied systematically. Eighteen sets of six choice cards were generated by this design. Each respondent was randomly presented with one set of six choice cards, each consisting of two options, A and B. Respondents were asked to choose one of those two alternatives from each card. Each option consisted of several attributes with randomly assigned values; one of the attributes' values related to the price of the option in question. Respondents selected their preferred option (A or B) based on the combination of attribute values, including price. Respondents did this six times—i.e., the set that they were confronted with consisted of six choice cards/tasks. An example of a choice set with six choice cards is presented in Table 4.

Table 4: An example of a choice set with six choice cards

Attribut-es	Choice card 1		Choice card 2		Choice card 3		Choice card 4		Choice card 5		Choice card 6	
	Option A	**Option B**	**Option A**	**Option B**	**Option A**	**Option B**	**Option A**	**Option B**	**Option A**	**Option B**	**Option A**	**Option B**
Disaster resilient	No disaster resilien ce	Total disaster resilienc e	Some disaster resilienc e:	Total disaster resilienc e	No disaster resilienc e	Some disaster resilien ce	No disaster resilienc e	Total disaster resilienc e	Some disaster resilienc e	Total disaster resilien ce	No disaster resilien ce	No disaster resilienc e
No risk to health	Some risk to health	Not free from health risk	Not free from health risk	No risk to health	Some risk to health	Not free from health risk	Some risk to health	Some risk to health	No risk to health	Not free from health risk	No risk to health	No risk to health
Reliable availabil ity	Totally reliable	Unrelia ble	Somew hat reliable	Unrelia ble	Somew hat reliable	Totally reliable	Unrelia ble	Somew hat reliable	Somew hat reliable	Totally reliable	Totally reliable	Unrelia ble

Attribut-es	Choice card 1		Choice card 2		Choice card 3		Choice card 4		Choice card 5		Choice card 6	
Taste	Tolerable taste	Bad taste	Perfect taste	Bad taste	Perfect taste	Perfect taste	Medium taste	Perfect taste	Bad taste	Medium taste	Bad taste	Medium taste
Price in BDT/liter	1.75	0.50	1.50	0.00	1.00	0.75	0.25	1.25	1.00	0.75	1.50	1.25
Choice (forced)*												
Choice (actual) **												

*Choice (forced) implies the situation in which the respondent had to choose between two options (A and B) on a choice card even though neither choice was liked.

**Choice (actual) implies the situation in which the respondent could either forcedly choose the option or opt out if this option was not liked.

Survey design and implementation

The household survey was conducted with a structured questionnaire that consisted of two components. The first part contained questions on a range of household attributes. These included (i) household location, age, gender, level of education, household size, water scarcity level, and household income; and (ii) the respondent's household daily consumption of water for drinking.

The second part of the questionnaire involved the choice cards. Each choice card contained two hypothetical alternative options of DWS with varying levels of attributes. Respondents were presented with each card, one by one, and asked to indicate which of the two presented alternatives with varying attribute levels they preferred. After choosing their preferred option (A or B), respondents were asked whether they would choose their selected option in real life (rather than in the hypothetical setting of the CE). To arrive at an overall real choice, we multiplied the forced and the real choice. We first pre-tested the questionnaire in three communities—one in each of the three districts covered in the study. The questionnaire was revised after pre-testing and then administered from December 2018 to January 2019.

Data collection

Data was collected through household surveys (N=882). A research team comprising seven graduate students from a local university assisted us in carrying out the surveys. They were provided with necessary information about the research aim and design and were trained in social skills and interviewing techniques (e.g., how to ask questions and tick the accurate answer category). Walking along a street in the target community, we selected every second household. We conducted surveys with the person responsible for choices related to drinking water in their household. We aimed to include around 50 households from each community. Before starting the interview, respondents were informed in detail about the study's objectives and were asked to give their (verbal) consent. Each interview lasted 30–40 minutes on average. The response rate was 85%.

Data analysis

Data analysis was carried out in two steps. First, we ran a conditional logit regression model to determine the influence of the attributes on households' preferences for DWS, which we then used as input to calculate WTP. The choice for options A and B was the dependent variable and the DWS attributes were the independent variables. The WTP was calculated by dividing the regression coefficient of non-monetary attributes by the regression coefficient of the monetary attribute (Nieboer et al., 2010). The following formula was used to calculate the WTP for the attributes of the DWS:

$$WTPa = -\left(\frac{\beta a}{\beta priceofwater}\right)$$

Where a and β indicate attribute and regression coefficient respectively, WTPa indicates willingness to pay for an attribute and βa is the regression coefficient of an attribute.

In model 2, we calculated the average WTP of subgroups we created based on household attributes. We ran a regression model with the main effects, and based on the regression coefficient, we calculated and compared the WTP between the subgroups. Based on the differences of WTP between two subgroups, we examined the significance of household attributes on the WTP.

Results

Description of the household attributes

Table 5: Socio-economic characteristics of respondents/ households

Socio-economic characteristics	**Frequency and percentage (%)**
Household location	Rural: 603 (68.4%) Urban: 279 (31.6%)
Household size	4.66 (mean) ≤4 household members: 478 (54.2%) >4 household members: 404 (45.8%)
Household income (annual)	Poor*: 396 (44.9%) Better-off: 486 (55.1%)
Mean daily household water consumption (L)	22.90

* Poor and better-off households were defined based on HIES (2016).

Regression analysis

Regression model 1: willingness to pay for DWS attributes

Table 6: Regression analysis and willingness to pay, for the total study sample

	β	SE	Sig.	WTP
Household attributes				
Household location	.036	.050	.471	
Household size	.120	.045	.008***	
Household income	.209	.047	.000***	
Household's drinking water scarcity level	.245	.048	.000***	
DWS attributes				
Disaster resilience			.000***	
Disaster resilience (1)	-1.181	.164	.000***	0.02
Disaster resilience (2)	-.826	.134	.000***	0.01
No risk to health			.000***	
No risk to health (1)	-2.371	.170	.000***	0.4
No risk to health (2)	-1.433	.151	.000***	0.02

	β	SE	Sig.	WTP
Reliability			.000***	
Reliability (1)	.007	.156	.965	-0.00
Reliability (2)	-1.058	.150	.000***	0.02
Taste			.000***	
Taste (1)	-1.018	.150	.000***	0.02
Taste (2)	.374	.150	.012***	-0.00
Cost (in USD)	-65.621	10.105	.000***	

Note: ***, **, and * and indicate the statistical significance at 1%, 5% , and 10 % respectively. Here, total number of observations (N)=105845, -2 Log Likelihood= 17393.229 and Pseudo R^2= 0.041

The regression analysis presented in Table 6 reveals that the influence of all the DWS attributes considered in the study is statistically significant at the 1% level, indicating that all these attributes are influence the respondents' decision-making about adopting the DWS. The attribute that seems to matter most for determining DWS preference is no risk to health. We found that households are willing to pay the maximum amount of money for water that does not pose a health risk (around 4 cents/ per liter). For the remaining attributes (i.e., disaster resilience, reliability, and taste), respondents are willing to pay around 2 cents per liter of water. The findings also show that three of the four household attributes significantly influence households' willingness to pay for the drinking water system ($P<0.05$): household size, household income, and household's water scarcity level.

Regression model 2: Marginal effect of household attributes on willingness to pay

In model 2, we calculated the marginal effects of certain household attributes by conducting a regression analysis for each subgroup created based on varying household attributes, separately.

The regression analysis presented in Table 7 (see Appendix) reveals *household income* as the strong determinant of households' WTP. We found that the better-off households were willing to pay 0.03 cents for a liter of water from a disaster-resilient DWS, 0.05 cents for a liter of water with no health risk, 0.02 cents for a liter of water from a reliable DWS, and 0.02 cents per liter water from a system able to provide tasty water; the comparable prices poor families were willing to pay per liter are 0.01, 0.02, 0.01, and 0.01 cents.

As expected, *water scarcity levels* are significant in affecting households' WTP for a DWS ($P<0.03$). Households experiencing extreme scarcity of drinking water are willing to pay more for an improvement of all DWS attributes than households experiencing moderate drinking water scarcity. Households experiencing extreme drinking water scarcity are willing to pay 0.02 cents for a liter of water from a disaster-resilient DWS, 0.04 cents for a liter of water with no health risk, 0.02 cents for a liter of water from a reliable DWS, and 0.02 cents per liter water from a system able to provide tasty water; the comparable prices poor families from areas with moderate drinking water scarcity were willing to pay per liter are 0.01, 0.03, 0.01, and 0.01 cents, respectively.

Similarly, our analysis shows the *household size* has a significant ($P<0.05$) influence on a household's willingness to pay for drinking water system. We found that households with more than four members are willing to pay more than households with four or fewer members for DWSs that are disaster-resilient and offer a reliable supply of water free from health risk. Our results show that households with more than four members are willing to pay 0.02 cents for a liter of water from a disaster-resilient DWS, 0.04 cents for a liter of water free from health risk, and 0.02 cents for a liter of water from a reliable DWS; the comparable prices households with four or fewer members are willing to pay per liter of water are 0.01, 0.03, 0.01, and 0.01 cents, respectively. However, households with fewer than four members are willing to pay more for a liter of water from a DWS capable of providing tasty water (0.02 cents) than are households with more than four members (0.01 cents).

Whereas *household location* did not appear to be significant in the regression analysis, it did appear to be significant in our marginal effect results. Households in urban areas are willing to pay more than households living in rural areas for water from a DWS capable of providing water that has no health risk and is tasty. Urban households are willing to pay 0.05 cents per liter for water that poses no risk to health, and 0.02 cents per liter for tasty water; the comparable prices households residing in rural areas are prepared to pay are 0.03 cents and 0.01 cents, respectively.

Discussion

The major objective of the study was to identify the attributes that influence households' overall preference for DWSs and establish the extent to which the values attributed to these attributes vary across households. We used a CE to elicit variation in households' WTP. We determined households' preferences by measuring the variation in the WTP for DWS with varying attribute levels.

We found that the extent to which a household perceives they are susceptible to contracting a disease from drinking water strongly affects the household's WTP for a DWS; people are willing to pay more for water from a DWS that is capable of providing safe drinking water. This expected finding is consistent with observations of earlier studies (e.g., Hasan et al., 2019; Islam et al., 2014; Brouwer et al., 2015; Dauda et al., 2015). Also as expected, people are willing to pay more for water from a DWS that is capable of withstanding natural disasters. This is probably because people in the study areas are used to experiencing various natural disasters, especially the frequent floods and cyclones that severely affect their drinking water sources. People are also willing to pay more for water from a DWS that is reliable, that is, is guaranteed to produce water year-round. This expected finding is in line with earlier studies (e.g.,Vásquez & Espaillat, 2016; Wendimu & Bekele, 2015). Furthermore, we found that people appreciate taste to an extent that they are willing to pay more for water from a DWS that is capable of providing tasty water. Yet again, this finding agrees with previous studies (Wendimu & Bekele, 2015; Whittington et al., 1990).

Regarding household attributes, the higher the household income, the more willing a household is to pay for water from a DWS that scores high on all the DWS attributes included in our study. This expected result is congruent with the findings of earlier studies (e.g., Echenique & Seshagiri, 2009; Wendimu & Bekele, 2015; Whittington et al., 1990). Furthermore, households that experience drinking water scarcity are willing to pay more for water from a DWS that scores high on all the attributes. One possible explanation is that people in the study areas are used to facing drinking water problems related to salinity intrusion, and arsenic and pathogenic contamination. Awareness of and experience with specific drinking water problems may increase the willingness to avoid such problems. Larger households are willing to pay more for DWSs, possibly because in absolute terms they need more water for drinking and other purposes. In addition, households in urban areas are willing to pay more than rural households. This finding may be related to greater awareness of risks, the absence of alternatives, or the fact that urbanites are more accustomed to paying for services. Our result is consistent with the observations of previous studies (e.g., Brouwer et al., 2015).

There are some limitations to this study. Firstly, the factors found to influence households' preferences in our study seem largely contextual and therefore extrapolating our results to regions elsewhere may not be reliable. Secondly, for data collection, we targeted the household members responsible for water management. However, we did not always succeed in surveying these individuals if they were busy elsewhere for their work. In such cases, we collected data from the senior member of the household, who might not have truly represented their household's view on the matters that interested us. Future research could address these broader issues to ensure the generalizability of findings.

Our research findings have both scientific and social implications. Our study has scientific implications in the sense that we assessed household preferences for DWS in disaggregated terms, employing a CE in the specific context of rural areas. The study has social implications as our findings can help policy makers, public agencies, and NGOs to optimize strategies for the successful design and implementation of drinking water systems in Bangladesh and developing countries elsewhere.

Conclusion and recommendations

DWSs often fail in low- and middle-income countries like Bangladesh as very often they do not consider people's preferences. Our study was therefore conducted to identify the DWS attributes that constitute the overall households' preference for DWS and to establish the extent to which the values attributed to these attributes vary across households with varying attributes. We determined households' preferences by measuring variation in WTP for DWS with varying attributes. For this, we employed a CE. We found that households prefer DWSs that are disaster-resilient and reliably produce water that poses no risk to health and is tasty. We also found that income, size, location, and water scarcity levels explain variation in households' willingness to pay for water from a DWS with varying attribute levels.

Based on the findings mentioned above, we offer a set of recommendations for policy makers, public agencies, and NGOs involved in the design and implementation of DWS in low- and middle-income countries. Firstly, before introducing a new DWS, the community's preferences and expectations regarding the DWS should be assessed. Secondly, when formulating planning and implementation strategies for the DWS, the household attributes and DWS attributes should be considered separately. Thirdly, since communities value drinking water systems that are disaster-resilientand provide safe, tasty water reliably, they should be

2

guaranteed that in terms of technology and governance, the system being promoted performs optimally on all those attributes. Fourthly, as the values attached to the attributes of DWS vary across households based on income, size, location and water scarcity levels, these attributes should be considered when planning new DWSs and formulating strategies for implementing them. Finally, when persuading households to adopt the new system, the focus should be on raising people’s awareness based on an explicit narrative that stresses the system’s performance with specific regard to these attributes.

References

Abedin, A., & Shaw, R. (2014). Safe Water Adaptability for Salinity , Arsenic and Drought Risks in Southwest of Bangladesh. *Risk, Hazards {&} Crisis in Public Policy*, *4*(2), 62–82. https://doi.org/10.1002/rhc3.12033

Afroz, S., Cramb, R., & Grunbuhel, C. (2016). Collective Management of Water Resources in Coastal Bangladesh: Formal and Substantive Approaches. *Human Ecology*, *44*(1), 17–31. https://doi.org/10.1007/s10745-016-9809-x

Ahmad, J., Goldar, B., & Misra, S. (2006). *Rural communities ' preferences for arsenic mitigation options in Bangladesh*. Journal of Water and Health, 4(4), 463–477. https://doi.org/10.2166/wh.2006.027

Bennett, J., & Birol, E. (2010). Introduction: The roles and significance of choice experiments in developing country contexts, Chapters , 1–14. https://doi.org/10.4337/9781781000649.00007

Brouwer, R., & Crescent, F. (2015). Comparing Willingness to Pay for Improved Drinking-Water Quality Using Stated Preference Methods in Rural and Urban. *Applied Health Economics and Health Policy*, 15(1). 81–94. https://doi.org/10.1007/s40258-014-0137-2

Burt, Z., Njee, R. M., Mbatia, Y., Msimbe, V., Brown, J., Clasen, T. F., Malebo, H. M., & Ray, I. (2017). User preferences and willingness to pay for safe drinking water : Experimental

2

evidence from rural Tanzania. *Social Science & Medicine*, *173*, 63–71. https://doi.org/10.1016/j.socscimed.2016.11.031

Christie, M., Hanley, N., & Hynes, S. (2007). Valuing enhancements to forest recreation using choice experiment and contingent behaviour methods. *Journal of Forest Economics*, *13*(2–3), 75–102. https://doi.org/10.1016/j.jfe.2007.02.005

Dauda, S. A., Yacob, M. R., & Radam, A. (2015). Household ' s willingness to pay for heterogeneous attributes of drinking water quality and services improvement : an application of choice experiment. *Applied Water Science*, *5*(3), 253–259. https://doi.org/10.1007/s13201-014-0186-6

Echenique, M., & Seshagiri, R. (2009). Attribute-based willingness to pay for improved water services: A developing country application. *Environment and Planning B: Planning and Design*, *36*(3), 384–397. https://doi.org/10.1068/b33126

Evans, B., & Mara, D. (2011). *Sanitation & Water Supply in Low-income Countries*. Bookboon.

Evans, W. D., Ph, D., Pattanayak, S. K., Young, S., Buszin, J., Rai, S., & Bihm, J. W. (2014). Social Marketing of Water and Sanitation Products: A Systematic Review of Peer-reviewed Literature. *Social Science & Medicine*, *110*, 18–25. https://doi.org/10.1016/j.socscimed.2014.03.011

Harahap, B. N., & Hartono, D. (2007). Analysis of Willingness to Pay and Determinant of Drinking Water and Sanitation Availability in Indonesia Using Hedonic Price Model Approach and Logistic Model, *Center for Economics and Development Studies, Padjadjaran University, Jakarta, Indonesia*

Hasan, M. B., Driessen, P. P. J., Majumder, S., Zoomers, A., & van Laerhoven, F. (2019). Factors Affecting Consumption of Water from a Newly Introduced Safe Drinking Water System: The Case of Managed Aquifer Recharge (MAR) Systems in Bangladesh. *Water*, *11*(12), 2459. https://doi.org/10.3390/w11122459

Hasan, M. B., Driessen, P. P. J., Majumder, S., Zoomers, A., & van Laerhoven, F. (2020). A community management plus model for the governance of rural drinking water systems: A comparative case study of pond sand filter systems in Bangladesh. *International Journal of the Commons*, *14*(1), 662–679. https://doi.org/10.5334/ijc.1006

Hoffmeyer-Zlotnik, J. H. P. (2003). New sampling designs and the quality of data. *Developments in Applied Statistics*, *19*, 205–217. http://mrvar.fdv.uni-lj.si/pub/mz/mz19/abst/hoff.htm

Hoque, B. A., Hoque, M. M., Ahmed, T., Islam, S., Azad, A. K., Ali, N., Hossain, M., & Hossain, M. S. (2004). Demand-based water options for arsenic mitigation: An experience from rural Bangladesh. *Public Health*, *118*(1), 70–77. https://doi.org/10.1016/S0033-3506(03)00135-5

Hossain, M., Rahman, S. N., Bhattacharya, P., Jacks, G., Saha, R., & Rahman, M. (2015). Sustainability of arsenic mitigation interventionsâ€"an evaluation of different alternative safe drinking water options provided in Matlab, an arsenic hot spot in Bangladesh. *Frontiers in Environmental Science*, *3, 30.* https://doi.org/10.3389/fenvs.2015.00030

Hubbard, B., Sarisky, J., Gelting, R., Baffigo, V., Seminario, R., & Centurion, C. (2011). A community demand-driven approach toward sustainable water and sanitation infrastructure development. *International Journal of Hygiene and Environmental Health*, *214*(4), 326–334. https://doi.org/10.1016/j.ijheh.2011.05.005

Islam, N., Brouwer, R., & Yang, H. (2014). Household ' s willingness to pay for arsenic safe drinking water in Bangladesh. *Journal of Environmental Management*, *143*, 151–161. https://doi.org/10.1016/j.jenvman.2014.04.018

Islam, A., Sakakibara, H., Sekine, M., & Md. Karim, R. (2013). Potable water scarcity: Options and issues in the coastal areas of Bangladesh. *Journal of Water and Health*, *11*(3), 532–542. https://doi.org/10.2166/wh.2013.215

Louviere, J. J., Hensher, D. A., & Swait, J. D. (2000). *Stated choice methods: analysis and applications*. Cambridge university press.

Madajewicz, M., Tompsett, A., & Habib, A. (2017). Community Participation in Decision-Making Evidence from an experiment in safe drinking water provision in Bangladesh. *Working Paper*, 1–76.

Mangham, L. J., Hanson, K., & Mcpake, B. (2009). How to do (or not to do) . . . Designing a discrete choice experiment for application in a low-income country. *Health Policy and Planning*, *24*(2), 151–158. https://doi.org/10.1093/heapol/czn047

Nieboer, A. P., Koolman, X., & Stolk, E. A. (2010). Preferences for long-term care services: Willingness to pay estimates derived from a discrete choice experiment. *Social Science & Medicine*, *70*(9), 1317–1325. https://doi.org/10.1016/j.socscimed.2009.12.027

Park, K. (2015). *Park's textbook of preventive and social medicine,* 23rd, Jabalpur. Banarsidas Bhanot Publishers.

Rahman, M. M., Alam, K., Karim, R., & Islam, M. K. (2017). Willingness to Pay for Improved Water Supply : A Policy Implications for Future Water Security. *American Journal of Environmental and Resource Economics*, *2*(4), 116–122. https://doi.org/10.11648/j.ajere.20170204.11

Rahman Talukder, M. R., Rutherford, S., & Chu, C. (2015). Salinization of Drinking Water in the Context of Climate Change and Sea Level Rise: A Public Health Priority for Coastal Bangladesh. *International Journal of Climate Change: Impacts & Responses*, *8*.

Ratna Reddy, V. R., Rammohan Rao, M. S., & Venkataswamy, M. (2011). 'Slippage': The Bane of Rural Drinking Water Sector (A Study of Extent and Causes in Andhra Pradesh). *Journal of Social and Economic Development*, *13*(2), 163–188.

RWSN. (2009). Handpump Data, Selected Countries in Sub-Saharan Africa, RWSN, St Gallen, Switzerland.. http://www.rural-water-supply.net/_ressources/documents/default/203.pdf

Sajjadi, S., Alipour, V., & Matlabi, M. (2016). Consumer Perception and Preference of Drinking Water Sources. *Electronic Physician*, *8*(11), 3228–3233. https://doi.org/10.19082/3228

Starkl, M., Brunner, N., & Stenstro, T. (2013). Why Do Water and Sanitation Systems for the Poor Still Fail ? Policy Analysis in Economically Advanced Developing Countries. *Environmental Science & Technology*, *47*(12), 6102–6110.https://doi.org/10.1021/es3048416

Vásquez, W. F., & Espaillat, R. (2016). Willingness to pay for reliable supplies of safe drinking water in Guatemala : A referendum contingent valuation study. *Urban Water Journal*, 13(3), 284-292. , 1–9. https://doi.org/10.1080/1573062X.2014.991741

Vásquez, W. F., Franceschi, D., & Hecken, G. T. Van. (2012). Household preferences for municipal water services in Nicaragua Household preferences for municipal water services in Nicaragua. *Environment and Development Economics*, *17*(01), 105–126. https://doi.org/10.1017/S1355770X11000234

Veldkamp, T. I. E., Wada, Y., de Moel, H., Kummu, M., Eisner, S., Aerts, J. C. J. H., & Ward, P. J. (2015). Changing mechanism of global water scarcity events: Impacts of socioeconomic changes and inter-annual hydro-climatic variability. *Global*

Environmental Change, *32*, 18–29. https://doi.org/10.1016/j.gloenvcha.2015.02.011

Wendimu, S., & Bekele, W. (2015). Determinants of individual willingness to pay for quality water supply : The case of Wonji Shoa Sugar Estate , Ethiopia. *Journal of Ecology and the Natural Environment*, *3*(15), 474–480. https://doi.org/10.5897/JENE11.089

Whittington, D., Davis, J., & McClelland, E. (1998). Implementing a demand-driven approach to community water supply planning: A case study of Lugazi, Uganda. *Water International*, *23*(3), 134–145.https://doi.org/10.1080/02508069808686760

Whittington, D., Briscoe, J., & Barron, W. (1990). Estimating the Willingness to Pay for Water Services in Developing Countries : A Case Study of the Use of Contingent Valuation Surveys in southern Haiti. *Economic Development and Cultural Change*, *38*(2), 293–311.

Whittington, D., Davis, J., Prokopy, L., Komives, K., Thorsten, R., Lukacs, H., Bakalian, A., & Wakeman, W. (2009). How well is the demand-driven, community management model for rural water supply systems doing? Evidence from Bolivia, Peru and Ghana. *Water Policy*, *11*(6), 696–718. https://doi.org/10.2166/wp.2009.310

WHO, & UNICEF. (2020). JMP 2018 Annual Report. *WHO/UNICEF Joint Monitoring Programme for Water Supply, Sanitation and Hygiene (JMP)*, 2–2.

Appendix:

Table 7: Regression analysis and calculation of marginal effect of household attributes (i.e., location, size, income, water scarcity level) on willingness to pay for DWS attribute improvement

Variables (water attributes)	**WTP of the overall sample**	**WTP of rural households**	**WTP of urban households**	**WTP of households of 2-4 members**	**WTP of households of >4 members**	**WTP of poor households**	**WTP of better-off households**	**WTP of households with moderate water scarcity**	**WTP of households with extreme water scarcity**
Disaster resilience (1)	0.02***	0.02***	0.02***	0.01***	0.02***	0.01***	0.03***	0.01***	0.02***
Disaster resilience (2)	0.01***	0.01***	0.01***	0.01***	0.01***	0.01***	0.02***	0.01***	0.01***
Health risk (1)	0.04***	0.03***	0.05***	0.03***	0.04***	0.02***	0.05***	0.03***	0.04***
Health risk (2)	0.02***	0.02***	0.02***	0.02***	0.02***	0.01***	0.03***	0.02***	0.02***
Reliability (1)	0.00	0.00	-0.01	-0.00	0.00	-0.00	0.00	-0.00	0.00
Reliability (2)	0.02***	0.02***	0.02***	0.01***	0.02***	0.01***	0.02***	0.01***	0.02***
Taste (1)	0.02***	0.01***	0.02***	0.02***	0.01***	0.01***	0.02***	0.01***	0.02***
Taste (2)	-0.00***	-0.00	-0.02**	-0.00**	0.00	-0.00*	-0.00**	-0.01***	-0.00

Note:***,**, and * indicate the statistical significance at1%, 5%, and 10%, respective

CHAPTER 3

FACTORS AFFECTING CONSUMPTION OF WATER FROM A NEWLY INTRODUCED SAFE DRINKING WATER SYSTEM: THE CASE OF MANAGED AQUIFER RECHARGE (MAR) SYSTEMS IN BANGLADESH

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Abstract:

Rather than committing exclusively to one drinking water option, households in Bangladesh often use a portfolio of sources that in varying ways, to varying extents satisfy one or more out of several preferences they hold with regard to their drinking water. What happens if a new option is added to that mix? In communities of Bangladesh' Southwestern coastal region where a new option (managed aquifer recharge, or MAR) was recently introduced, we observe variation in the extent to which this source contributes to satisfying households' drinking water needs. Using multiple linear regression (n=636 households) we find that perceived risk, costs, taste, self-efficacy, and form and intensity of competition with alternative drinking water options, matter significantly.

Keywords:

rural drinking water systems; infrastructure; rural communities; managed aquifer recharge; MAR; innovation adoption; Bangladesh

Introduction

Despite remarkable progress, ensuring access of all to safe drinking water services worldwide still remains a major concern(Moretto et al., 2018; Peters et al, 2019; Van Houtven et al, 2017). It is estimated that only 55% of world's rural populations have access to safe drinking water sources (WHO/UNICEF & JMP, 2017). Drinking water scarcity leads to the spread of water borne diseases and it thwarts the socio-economic development (Veldkamp et al., 2015). Prüss-Üstün et al.(2008) estimate that in developing countries, every year, 1.5 million children die before the age of 5 due to reasons related with drinking water quality. Population growth, and climate change are expected to worsen water scarcity across the world (Kiguchi et al., 2014; Schewe et al., 2014). Also, Bangladeshexperiences severe scarcity of drinking water, especially in its rural areas (Murshed&Kaluarachchi, 2018). About 13% of the total population in the country has no access to safe drinking water (WHO/UNICEF, 2015). Every year, a rural child below 5 years suffers from on average 4.6 events of diarrhea leading to the death of approximately 2.3 thousand children (Piechulek et al., 2003). Water scarcity is more acute in the Southwestern coastal areas due to salinity intrusion, arsenic contamination, frequent natural disaster and human-made alteration of natural settings (Afroz et al., 2016).

In order to address drinking water scarcity in the region, over the last 3 decades, both the government and national or local NGOs, often financed by donors and international NGOs, have supported the introduction of multiple new rural drinking water systems, such as pond sand filters (PSF), rain water harvesting systems (RWHS), and reverse osmosis. The problem that we address in this paper is that many of those newly introduced drinking water solutions have unfortunately proven to be unable to (fully) deliver on the promise of adding significantly to the effort of mitigating the problem of drinking water scarcity (Hoque et al., 2004 ; Shafiquzzaman et al., 2009 ; Hossain et al., 2015).

One of the most recent attempts to solve water scarcity in the region uses Managed Aquifer Recharge, or MAR. MAR was introduced in 2010 by a consortium of Dhaka University's Geology Department (DU), the Department of Public Health Engineering (DPHE) and the Acacia Water - a Dutch consultancy firm - funded by the Dutch Embassy in Bangladesh and UNICEF. It is supposed to be operated and maintained by the local community. In a MAR system, water is collected from ponds and rooftop rainwater. After passing through a sand filter, the water is infiltrated into the aquifer to create a bubble of fresh water. Users can subsequently abstract the water using standard hand tube-wells. Compared to other major systems in the area, MAR is contamination-free and cyclone-proof, and it is reliable as it provides water in sufficient quantities throughout the year. In terms of operation and maintenance costs, MAR is claimed to be less expensive than the available alternatives. It is relatively easy to operate.These are all claims that MAR shares with the drinking water systems mentioned in the preceding paragraph.

The hydrogeological and technical feasibility of MAR is more or less established (Obergfell et al., 2019; Antoniou et al., 2013). However, as with previous attempts to introduce new and improved drinking water technologies (Fielding et al, 2015; Leviston et al., 2006; Wu et al., 2012), getting communities to actually use MAR will without a doubt proof to be difficult. Households do not rely exclusively on one sole drinking water source but use instead a portfolio of options. This portfolio of local drinking water options consists of sources that vary on a range of factors that actual and prospective users attach preferences to. Predicting what exactly pushes people asway from old drinking water routines and habits (that may be unsafe), and pulls them towards a newly introduced, presumably safe(r), cheaper and/or (more)reliable alternative, requires us to acknowledge this.

In an attempt to fill this knowledge gap, we seek to establish which factors might impact people's choice to use water from MAR. Building on the work of others before us (Mosler, 2012; Inauen et al., 2013; Kundu et al., 2016; Peal et al., 2010; Komives et al., 2008), we here focus on psychological factors and add to that the context-specific level of competition of the newly introduced option with alternative drinking water solutions.

Explaining variation in the use of new drinking water systems

There is a handful of theories and models that identify factors that might explain variation in the use of water and sanitation systems in developing countries. Among these, the Protection Motivation theory (Floyd et al., 2000) and the Health Action Process Approach (Schwarzer, 2008) have identified risk perception as a key factor while the Theory of Planned Behavior considers attitude, normative and ability factors as the most significant factors driving choices to engage in a certain type of behavior (such as starting to use a new drinking water system) (Ajzen, 1991; Ajzen, & Driver, 1992). Drawing insights from these theories, Mosler (Mosler, 2012) offers the RANAS model. In this model, psychological factors are clustered in five separate blocks, namely Risk, Attitudinal, Normative, Ability, and Self-regulation factors.

Risk factors regard the perceived likelihood of getting sick from using water from a particular source, and the consequences thereof. Attitudinal factors regard instrumental beliefs (i.e. the opinions of actual and prospective MAR users about effort and costs associated with using MAR) and affectional beliefs (i.e. the opinions of actual and prospective MAR users about the taste of MAR water). Normative factors regard descriptive norms (i.e. perceptions of which behaviors are typically performed) and injunctive norms (i.e. perceptions of which behaviors are typically approved or disapproved of by important others). Ability factors regard the belief in one's capabilities to organize and execute the course of actions required to manage prospective situations (i.e. self-efficacy) and knowing how to perform the behavior (i.e. action knowledge). Self-regulation factors include coping and planning (i.e. how the person plans to cope with distractions and barriers), and commitment (i.e. how committed a person is to the new behavior).

The importance of demand for the adoption of new and improved drinking water systems is well understood (Hoque et al., 2004). Still, we observe that both government and non-government organizations in low-income countries follow an approach that is largely supply-driven, i.e. community end-users are not or hardly involved in decisions about the physical infrastructure or its governance (Whittington et al., 2009). Attempts to understand why people do or don't use these new and improved drinking water system often do not consider the fact that such systems are not introduced in a vacuum: They compete with other, both newly introduced and already functioning drinking water solutions, all with varying levels of safety and reliability, and other factors that might affect preferences. Households are observed to use and rely on a variety of such sources at the same time. Therefore, it may be unrealistic to expect that the newly introduced option will replace what's already out there. Instead, it is more likely that it will occupy a place (that may range from unimportant to dominant) within the portfolio of options that households use or consider using.

We offer a model that combines the relevant psychological factors highlighted in the RANAS model with the expectation that newly introduced drinking water systems have to compete with what's already out there. For details of the variables we use, and the operationalization thereof, see table 2, below.

Materials and methods

The study took place in three south-western coastal districts of Bangladesh. Here, drinking water scarcity is severe due to salinity intrusion, arsenic contamination, tidal surges and drought (Islam et al., 2019; Mahmuduzzaman et al., 2014). In most part of this area, neither shallow nor the deep tube-wells are feasible due to a lack of suitable aquifers at reasonable depths (Hoque et al., 2004).Hoque (2009) finds that an estimated 30 million people are unable to collect potable drinking water due to a lack of available safe water sources.

Sample selection

By the time of our data collection,a total of 66 MAR sites was in place in the districts of Khulna, Bagerhat and Satkhira. To serve our study objectives, we grouped all of these 66 MAR communities into three categories based on the number of alternative options available within the community such as: MAR sites with a few alternatives (i.e. 1-2 alternative water options are available); MAR sites with some alternatives (i.e. 3 alternatives besides MAR are known to be available in the community); and finally, MAR sites with many alternatives (more than 3 alternative options are available).

Following a purposive sampling method, we chose 15 MAR communities in total (i.e. 5 from each category) (figure 1). At each site selected for our samples, we followed a random route sampling method (Hoffmeyer-Zlotnik, 2003) to select the households for a survey (for details see table 1).

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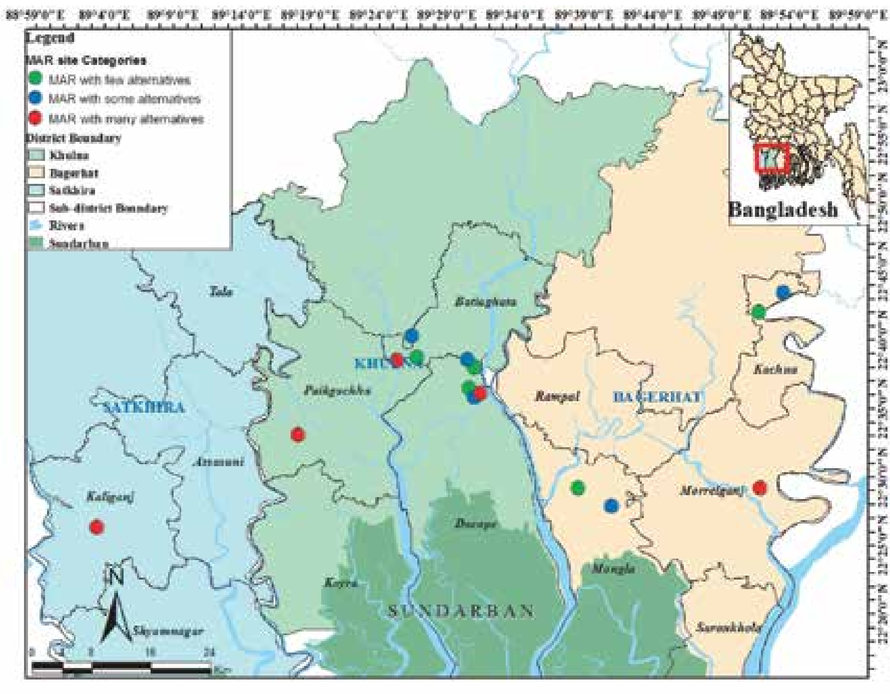


Figure 1. Study area.

Table 1. Sampling in the study

Sub-samples	Community name	Sub-district	District	MAR sites (#)	Respondents (survey)	Interviewees (experts)	Households (per community)*	Average income ($/month)**	Average education (years)**	Average household size**	Travel time to nearest urban center (minutes)***
MAR with a few alternatives (1-2 options)	Barunpara	Batiaghata	Khulna	1	35	2	486	144	7	4.23	40
	Bhogobotipur	Batiaghata	Khulna	1	57	2	276	131	6	4.40	45
	Chalna	Dacope	Khulna	1	55	2	326	176	9	4.98	20
	South Chadpai	Mongla	Bagerhat	1	62	2	426	141	6	4.82	30
	Boyer singagucchogram	Kochua	Bagerhat	1	49	2	72	129	4	4.94	40
MAR with some alternatives (3 option)	Kayemkhula	Botiaghata	Khulna	1	57	2	170	138	6	4.42	45
	Kollansree	Botiaghata	Khulna	1	55	2	360	136	4	4.84	60
	Duariara	Mongla	Bagerhat	1	56	2	152	190	8	4.54	50
	Achbua	Dacop	Khulna	1	51	2	667	206	9	4.45	60
	Gazalia	Kachua	Bagerhat	1	48	2	365	158	6	4.81	40
MAR with many alternatives (> 3 options)	Laxmikhula	Paikgacha	Khulna	1	48	2	220	142	7	5.21	60
	Kalikabari	Morrelgonj	Bagerhat	1	49	2	407	144	7	4.69	30
	Chalna bazar	Dacop	Khulna	1	48	2	278	120	6	4.46	15
	Bigordana	Paikgacha	Khulna	1	53	2	203	156	7	4.17	45
	Thekra Rahimpur	Kaligonj	Satkhira	1	57	2	421	151	7	4.72	40
Total	**15**	**7**	**3**	**15**	**780**	**30**	**4829**				

* Data obtained from the respective local administrations; ** Calculation based on data obtained from the survey applied to our sample; *** Data obtained from local key respondents. Numbers are based on the form of transportation that is most commonly used in the respective communities.

Operationalization

A standardized questionnaire was developed, pre-tested and then finalized to assess the consumption level of MAR and the factors expected to influence variation in these consumption levels. These factors include both psychological factors, and factors related with the level of competition MAR faces from other options. The questionnaire was translated from English to Bengali and then re-translated from Bengali into English to check the quality of translation. The dependent variable of this study is the percentage of MAR water in the total of water consumed for drinking purpose, during the dry season. To determine this, participants were asked to estimate the number of pitchers fetched from different water sources on a typical day during the dry season. To minimize a recall bias, the survey was administered during the dry season. The total water consumption from MAR was converted into a percentage of the total water consumption. This percentage can range from 0 to 100%. For the measurement of most variables, we used a forced-choice (ipsative) format (with four options) that forces respondents to form an opinion, as the safe neutral option is removed (Bartram, 2007). We measured taste, smell, and color was measured using a Likert rating-scale (with five options), because here neutral options matter. The availability of water alternatives was scored on 3-point scale (see table 2).

Table 2: Operationalization of the variables.

Dependent variable	Definition	Assessment	Response options
Consumption of MAR water (in percentage)	The percentage of total drinking water used during the dry season that comes from MAR	How many pitchers of water from the following watersources do you collect for drinking purpose on a typical day during the peak of the dry season (i.e. April)?	Open (all possible sources – including MAR – are presented to the respondent)
Risk			
Perceived vulnerability	A person's subjective perception of his/her risk of contracting a disease	What do you think is the chance that you will get sick from using MAR water?	Four-point scale from high risk (4) to no risk at all (1).
Perceived severity	person's perception of the seriousness of the consequences of contracting a disease	Imagine you contracted a disease (e.g. like arsenicosis, cholera or diarrhea) from your drinking water source, how severe would the impact be on your daily life?	Four-point scale from very severe (4) to not severe at all (1)
Factual knowledge	An understanding of how a person could become affected by a disease transmitted by drinking water	Factual knowledge about (i) actual contamination levels of MAR water, (ii) the actual medical conditions that may occur from drinking MAR water, and (iii) the treatment of MAR water.	Four-point scale from no knowledge (1) to maximum knowledge (4)
Attitude			
Instrumental beliefs	Opinion about the distance of the MAR site	How far is the MAR site located from your house?	Four-point scale from very far (4) to not far at all (1)
	Opinion about the costs of MAR	How expensive do you think it is for you to contribute to the operation and maintenance of MAR?	Four-point scale from very expensive (1) to very cheap (4)

Dependent variable	Definition	Assessment	Response options
	Opinion about the accessibility of the MAR site	How accessible do you think the MAR system is?	Four-point scale from not accessible (1) to very accessible (4)
Affective beliefs	Opinion about the taste of MAR water	Do you like the taste of the water from the MAR system?	Five-point from "I dislike it very much" (1) to "I like it very much" (5)
	Opinion about the smell of MAR water	Do you like the smell of the water from the MAR system?	Five-point from "I dislike it very much" (1) to "I like it very much" (5)
	Opinion about the color of MAR water	Do you like the color of the water from the MAR system?	Five-point from "I dislike it very much" (1) to "I like it very much" (5)
Norms			
Descriptive norm	Perceptions of which behaviors are typically performed	How many people in this neighborhood outside your family collect water from the MAR system?	Four-point scale from almost nobody (1) to almost everybody (4)
Injunctive norm	Perceptions of which behaviors are typically approved or disapproved of by important others	Do people that are important to you rather approve or disapprove of using water from the MAR system?	Four-point scale from strongly disapprove (1) to strongly approve (4)
Ability			
Self-efficacy	The belief in one's capabilities to organize and execute the course of actions required to manage prospective situations	How certain are you that you can collect as much safe water as you need from this source during the peak of the dry season from the MAR system?	Four-point scale from not at all certain (1) to completely certain (4)
Action knowledge	Knowing how to perform the behavior	How capable do you think the user committee responsible for MAR is?	Four-point scale from not capable at all (1) to very capable (4)

Dependent variable	Definition	Assessment	Response options
Self-regulation			
Coping planning	How the person plans to cope with distractions and barriers	Do MAR users have a plan regarding what to do when the MAR system gets broken?	Four-point scale from no detailed plan (1) at all to very detailed plan (4)
Commitment	How committed the person is to the new behavior (i.e. using MAR water)	Do you feel committed to collect water from MAR system?	Four-point scale from not at all committed (1) to completely committed (4)
Context			
Alternative options	The level of competition that MAR faces in a community	How many drinking water options alternatives to MAR system do you have in your community?	Three-point scale from many alternatives (3) to few alternatives (1)

Data collection

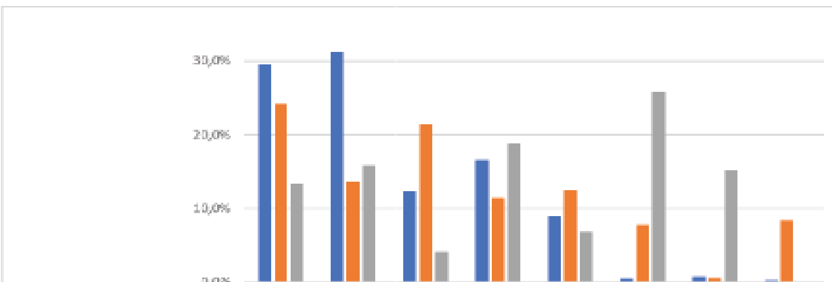
Data was collected through household surveys and informal interviews with the community members. Between December 2018 and February 2019, we conducted a total of 780 household surveys from 15 MAR sites with randomly selected households through a semi-structured questionnaire. Respondents were both users and non-users of MAR. A research team comprising seven graduate students of a local university assisted us in carrying out surveys. They were provided with guidelines and training on interviewing techniques. Before starting the final surveys, we conducted a pilot survey with 50 respondents from 3 MAR communities (one from each sample category) in order to ensure that respondents understood the questions as we intended. Interviewers conducted interviews with the person in the selected household that was responsible for water collection. Before starting the interview, every respondent was informed in detail about the study and their verbal consent was requested. Each interview took around 30-40 minutes on average. In addition, we also conducted informal interviews with local elected representatives and informal leaders (2 from each community). Moreover, data were collected by reviewing official documents, field reports, and annual reports at Dhaka University's MAR office.

Data analysis

Firstly, an independent sample T-test was computed to compare users and non-users of MAR in the overall sample regarding their demographic characteristics. Secondly, a Pearson chi-square (χ^2) test was performed to assess the correlation between the consumption of MAR (user and non-users) and the availability of varying levels of alternative options. Thirdly, multiple linear regression was conducted to identify the significant psychological and contextual determinants of consumption level of MAR water at a multi-variate level.

Results

Households seek to satisfy their various drinking water preferences by relying on a portfolio of sources. Each source may satisfy another aspect of the household's range of preferences. Therefore, we expected that the number of households that reported to use MAR water during the dry season would drop as more drinking water alternatives besides MAR were available. After all, households will benefit from the extra options to satisfy additional, different drinking water preferences. With a chi-square test we could corroborate this expectation (p=0.000). When few alternatives besides MAR are available, 45.8% of our respondents indicate to use MAR water. When there are many alternatives available, this percentage drops to 17.3%. Figure 2 shows the percentage of respondents that report to consider a particular system as either their most or their second most important drinking water source during the dry season.



	managed aquifer recharge	surface water	shallow tube well	rain water harvesting	deep tube well	reverse osmosis	pond sand filter	piped water
few alternatives besides MAR	29,5%	31,1%	12,4%	16,6%	8,9%	0,5%	0,7%	0,2%
some alternatives besides MAR	24,2%	13,7%	21,4%	11,5%	12,4%	7,8%	0,6%	8,4%
many alternatives besides MAR	13,4%	15,6%	4,2%	18,8%	6,8%	25,9%	15,2%	0,0%

* E.g. In communities with few drinking water alternatives besides MAR, 29.5% of all respondents indicate that managed aquifer recharge is their most or second most important drinking water source during the peak of the dry season.

Figure 2. Most and 2nd most important drinking water sources (combined) during the peak of the dry season (clustered per varying service levels)

In table 3, we present the descriptive statistics for the variables used in our model.

Table 3. Descriptive statistics.

		Descriptive statistics			
Factors	**Sub-factors**	*n*	Range	M	SD
Risk	Perceived vulnerability	636	(1-4)	2.70	1.09
	Perceived severity	636	(1-4)	1.84	0.78
	Factual knowledge	636	(1-4)	2.40	0.68
Attitude	Perceived distance	636	(1-4)	2.46	0.93
	Perceived cost	636	(1-4)	2.41	0.98
	Accessibility	636	(1-4)	2.47	1.06
	Perceived Taste	636	(1-5)	3.48	1.37
	Perceived Smell	636	(1-5)	3.08	1.44
	Color	636	(1-5)	4.16	1.20
Norms	Descriptive norm	636	(1-4)	2.15	0.98
	Injunctive norm	636	(1-4)	2.32	1.07
Ability	Self-efficacy	636	(1-4)	3.32	0.89
	Action knowledge	636	(1-4)	2.77	0.96
Self-regulation	Coping planning	636	(1-4)	2.22	0.86
	Commitment	636	(1-4)	2.35	1.20
Context	Availability of alternative options	636	(1-3)	2.14	0.81
Total household water consumption		780	open	23.27	8.56
% MAR water in total household water consumption		636	open	29.39	40.72

A linear regression analysis was conducted to identify the significant factors explaining variation in the consumption of MAR water. Table 4 shows the correlations between predictor and dependent variables (r), unstandardized regression coefficient (*B*), the standardized regression coefficient (β), standard error of B (SE B), adjusted R^2 and the significance level (p-value). The basic assumptions of normality, linearity, homoscedasticity of residuals and independence of errors were checked and found to apply.

Table 4:Linear regression analysis results.

		Correlation	Regression analysis				
Factors	**Sub-factors**	***R***	***B***	***SE B***	***β***	***t***	***P-value***
Risk	Perceived vulnerability	.422	4.016	1.237	.108	3.246	0.001***
	Perceived severity	.078	-.390	1.416	-.008	-0.275	0.783
	Factual knowledge	.253	7.239	1.682	.122	4.304	0.000***
Attitude	Perceived distance	.178	2.322	1.505	.053	1.542	0.123
	Perceived cost	.154	2.029	1.187	.049	1.709	0.088*
	Accessibility	.250	1.453	1.329	.038	1.094	0.274
	Perceived Taste	.348	2.841	1.044	.096	2.721	0.007***
	Perceived Smell	.250	-1.027	.937	-.036	-1.096	0.273
	Color	.145	-.848	1.002	-.025	-0.846	0.398
Norms	Descriptive norm	.583	11.201	1.409	.270	7.950	0.000***
	Injunctive norm	.678	16.109	1.432	.424	11.246	0.000***
Ability	Self-efficacy	.294	2.251	1.350	.049	1.667	0.096*
	Action knowledge	.182	-2.714	1.238	-.064	-2.193	0.029**
Self-regulation	Coping planning	-.089	-3.057	1.545	-.065	-1.979	0.048**
	Commitment	.293	.375	.978	.011	.384	0.701
Context	Availability of alternative options	.236	-2.937	1.670	-.058	-1.759	0.079*

Note: *p<0.10, **p<0.05, ***p<0.0; Adjusted $R^2 = .555$

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The regression analysis reveals that out of the 16 explanatory variables in our model, 10 factors correlate significantly at the 10% level with our dependent variable: In accordance with our expectation, perceived vulnerability, factual knowledge, perceived costs, perceived taste, descriptive norms, injunctive norms, and self-efficacy all correlate positively with the percentage of households' total drinking water needs that is covered by MAR. Also as expected, the availability of alternative options correlates negatively. Contrary to our expectation, action knowledge and coping planning correlate negatively with our dependent variable. Altogether, the adjusted R^2 indicates that 55.5% of the variation in the percentage of consumption of MAR water out of total amount of water consumed was predicted by the 16 independent variables in our model.

Discussion and conclusion

The novelty of our study regards the recognition of the fact that households in Bangladesh's coastal areas, just like in many other places in the world, (can) use a wide range of drinking water options – that can be both relatively safe (e.g. MAR, deep tube-well, and reverse osmosis) or relatively unsafe (e.g. surface or pond water, or water from an unsafe shallow tube-well, or contaminated rain water harvesting container). People do not necessarily stick to one single source. We find that on 36% of all households in our study report to rely on more than one source to satisfy their drinking water needs during the peak of the dry season. Therefore, rather than explaining why households would or wouldn't be willing to adopt one particular safe drinking water technology, we opted for explaining variation in the proportion of water from a safe option (i.e. MAR) within the entire portfolio of options used by a household. Related with this, we leave room in our analysis for the acknowledgement of the notion of *competition* between drinking water options that are being introduced and championed by a variety of (rival) agencies and organizations.

One might expect to find more or less the same service level experienced by people that live in the same area. However, we observe that although the service level (i.e. supply) may be similar (i.e. we sampled households in communities where we knew a MAR site was operation), households' use of these services (i.e. demand) vary significantly. In our sample, on average about 29% of households' drinking water needs are covered by MAR water, but the standard deviation is 40.72. What explains this considerable variation?

We find that risk factors, i.e. the extent to which people perceive to be vulnerable to contracting a disease from drinking MAR water, strongly affect the proportion of MAR water that is consumed at the household level. The more people trust MAR water not to make them sick, the higher the proportion of MAR water in the total household drinking water consumption during the peak of the dry season. This expected finding is in line with findings of earlier research that regards in particular the propensity to use arsenic-safe water options in Bangladesh (Inauen et al., 2013).

We also conclude that factual knowledge is a significant factor influencing the level of water consumption from a relatively safe source, such as MAR: The more one knows about medical conditions that can result from drinking unsafe water and about ways to prevent and/or treat these, the higher the proportion of MAR water that is consumed in a household during the peak of the dry season. This finding is convergent with the Huber and Mosler(2013) who found that knowledge was an important factor affecting safe water consumption in Ethiopia.

Furthermore, perceived costs emerged as a significant factor from our analysis. When people have the impression that the costs associated with using MAR water are reasonable, they'll use it more often. This finding is not surprising and consistent with earlier studies (Heri&Mosler, 2008).

Also as expected, we observe that the more people like the taste of MAR water, the more they will consume it. Perception or reputation play a role here, as well: When people *think* MAR water has a bad taste, they are less eager to use MAR systems. Also, this finding is in line with earlier research (Huber &Mosler, 2013; Heri&Mosler, 2008; George et al., 2017).

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We find that normative factors (i.e., injunctive and descriptive norms) are significantly associated with the level of household consumption of MAR water: The more people perceive others – especially others that matter – to approve of MAR, the higher the level MAR water consumption in a household. This finding is consistent with earlier studies (Inauen et al., 2013; Heri&Mosler, 2008; George et al., 2017; Mosler et al., 2010; Inauen&Mosler, 2014) that find that social norms are an important driver of the consumption of safe drinking water in Bangladesh, and elsewhere.

The stronger the belief in one’s capabilities to organize and execute the required course of actions required – operationalized here by means of a question about the respondent’s belief that she would be able to use as much MAR water as needed during the peak of the dry season – the higher the proportion of MAR water in their portfolio. As expected, people prefer reliable options – i.e. options that provide good quality water when it is needed – over sources that are less trustworthy.

Regarding the consumption of MAR water under varying levels of available alternatives, our findings reveal that people appear less interested in MAR when there are more alternatives available in a community. This may be due to the fact that MAR systems might not live up to people’s expectation about costs, taste or reliability. It may also be related with the fact that as the number of options increases, people will seek to benefit from these extra options to satisfy additional, different drinking water preferences. This finding is consistent with Komives et al. (Komives et al., 2008) who find that a drinking water source is more likely to be sustainable if it is the only source available in the community.

What is surprising, is the significant but *negative* association between action knowledge and MAR water consumption levels. This appears to signify that the more people trust the MAR user committee to be able to manage the operation of the MAR system, the lower the proportion of MAR water in the total household water consumption during the dry season. We suspect that this is related with the fact that people who do not use MAR systems *think* they are well-run, whereas people that do use the systems *know* that this is not always the case. Also, the significant, but *negative* association between coping planning and MAR water consumption levels is unexpected: If people think there is a plan regarding what to do when the MAR system gets broken, we see the amount of MAR water they use drop. Also, here we suspect that non-users *think* such plans exist, whereas MAR users know that this is not always the case.

Based on our findings, we recommend the following to those involved in safe rural drinking water provision in Bangladesh or in similar regions, elsewhere in the world. First, realize that the people you target have already solved part of their drinking water problems – i.e. people don't live where there is no drinking water. As our regression results show, the perception of people varies according to the number of available drinking water options. Also, realize that you may not be the only one who is, who has been, or who will be attempting to introduce a new and improved drinking water solution. So, rather than parachuting a new and improved drinking water system into a community from the top, first assess the number and nature of drinking water solutions that are already available, evaluate community preferences and perceptions (Anthoni et al., 2018), and create new or tap into existing local participatory capacities to align what you offer with these demands (Jiménez et al., 2019).

Second and related to the above, appreciate that rather than committing exclusively to one drinking water option, households may use a portfolio of sources that in varying ways, to varying extents satisfy one or more out of several preferences they have with regard to their drinking water needs. The size and composition of that portfolio may depend on local supply, time (i.e. season), the specifics of a family drinking water needs (i.e. family size and composition), household characteristics (e.g. income and location), and norms of the wider community that the household is a part of. Do not target full and exclusive acceptance of the drinking water option that you are advocating for.

Third and related to the above, realize that you are asking a lot when expecting people to switch routines that regard drinking water.

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Besides a focus on hardware (i.e. making sure that the physical infrastructure works optimally) also focus on *software* activities (i.e. activities regarding the changing of people's behavior) (Peal et al., 2010). Our results indicate that in order to get households on board of the newly introduced safe drinking water option, they must be convinced of the fact that the water from that source is safe. They must be provided with factual knowledge about the link between drinking water and getting sick. They must be convinced of the fact that the new drinking water system is reliable in the sense that it provides all the water that is needed when it is needed. Also, it must be avoided that the systems get the reputation of producing drinking water that is of foul taste, and expensive. Furthermore, rather than targeting individual households, create a community level norm that approves of the use of the source in question. Software activities go hand-in-hand with hardware activities: Engineering efforts must guarantee that MAR water is safe, and tasty, and that the systems are reliable and reasonably priced.

References

Afroz, S., Cramb, R., &Grunbuhel, C. (2016). Collective Management of Water Resources in Coastal Bangladesh: Formal and Substantive Approaches. *Human Ecology*, *44*(1), 17–31. https://doi.org/10.1007/s10745-016-9809-x

Ajzen, I. (1991). The theory of planned behavior. *Organizational Behavior and Human Decision Processes*, *50*(2), 179–211. https://doi.org/10.1016/0749-5978(91)90020-T

Ajzen, I., & Driver, B. L. (1992). Application of the Theory of Planned Behavior to Leisure Choice. *Journal of Leisure Research*, *24*(3), 207–224. https://doi.org/10.1080/00222216.1992.11969889

Anthonj, C., Fleming, L., Cronk, R., Godfrey, S., Ambelu, A., Bevan, J., Sozzi, E., & Bartram, J. (2018). Improving Monitoring and Water Point Functionality in Rural Ethiopia. *Water*, *10*(11), 1591. https://doi.org/10.3390/w10111591

Antoniou, E. A., Stuyfzand, P. J., & van Breukelen, B. M. (2013). Reactive transport modeling of an aquifer storage and recovery (ASR) pilot to assess long-term water quality improvements and potential solutions. *Applied geochemistry*, *35*, 173-186. https://doi.org/10.1016/j.apgeochem.2013.04.009

Bartram, D. (2007). Increasing validity with forced-choice criterion measurement formats. *International Journal of Selection and Assessment*, 15(3), 263-272. https://doi.org/10.1111/j.1468-2389.2007.00386.x

Fielding, K. S., Gardner, J., Leviston, Z., & Price, J. (2015). Comparing Public Perceptions of Alternative Water Sources for Potable Use: The Case of Rainwater, Stormwater, Desalinated Water, and Recycled Water. *Water Resources Management*, *29*(12), 4501–4518. https://doi.org/10.1007/s11269-015-1072-1

Floyd, D. L., Prentice-Dunn, S., & Rogers, R. W. (2000). A meta-analysis of research on protection motivation theory. *Journal of Applied Social Psychology*, *30*(2), 407–429. https://doi.org/10.1111/j.1559-1816.2000.tb02323.x

George, C. M., Inauen, J., Perin, J., Tighe, J., Hasan, K., & Zheng, Y. (2017). Behavioral Determinants of Switching to Arsenic-Safe Water Wells: An Analysis of a Randomized Controlled Trial of Health Education Interventions Coupled With Water Arsenic Testing. *Health Education and Behavior*, *44*(1), 92–102. https://doi.org/10.1177/1090198116637604

Heri, S., &Mosler, H. J. (2008). Factors affecting the diffusion of solar water disinfection: A field study in Bolivia. *Health Education and Behavior*, *35*(4), 541–560. https://doi.org/10.1177/1090198108321248

Hoffmeyer-Zlotnik, J. H. P. (2003). New sampling designs and the quality of data. *Developments in Applied Statistics*, *19*, 205–217. Retrieved from http://mrvar.fdv.uni-lj.si/pub/mz/mz19/abst/hoff.htm

Hoque, B. A., Hoque, M. M., Ahmed, T., Islam, S., Azad, A. K., Ali, N., Hossain, M., & Hossain, M. S. (2004). Demand-based water options for arsenic mitigation: An experience from rural Bangladesh. *Public Health*, *118*(1), 70–77. https://doi.org/10.1016/S0033-3506(03)00135-5

Hoque, M. R. (2009). *Access to Safe Drinking Water in Rural Bangladesh: Water Governance by DPHE*. BRAC University, Dhaka, Bangladesh.

Hossain, M., Rahman, S. N., Bhattacharya, P., Jacks, G., Saha, R., & Rahman, M. (2015). Sustainability of arsenic mitigation interventions: an evaluation of different alternative safe drinking water options provided in Matlab, an arsenic hot spot in Bangladesh. *Frontiers in Environmental Science*, *3, 30* . https://doi.org/10.3389/fenvs.2015.00030

Huber, A. C., &Mosler, H. J. (2013). Determining behavioral factors for interventions to increase safe water consumption: A cross-sectional field study in rural Ethiopia. *International Journal of Environmental Health Research*, *23*(2), 96–107. https://doi.org/10.1080/09603123.2012.699032

Inauen, J., Hossain, M. M., Johnston, R. B., &Mosler, H. J. (2013). Acceptance and Use of Eight Arsenic-Safe Drinking Water Options in Bangladesh. *PLoS ONE*, *8*(1). https://doi.org/10.1371/journal.pone.0053640

Islam, M., Ali Akber, M., &Atikul Islam, M. (2019). Willingness to pay for improved drinking water in Southwest coastal Bangladesh. *Water Science and Technology: Water Supply*, *19*(1), 1–10. https://doi.org/10.2166/ws.2018.047

Jiménez, A., LeDeunff, H., Giné, R., Sjödin, J., Cronk, R., Murad, S., Takane, M., & Bartram, J. (2019). The Enabling Environment for Participation in Water and Sanitation: A Conceptual Framework. *Water*, *11*(2), 308. https://doi.org/10.3390/w11020308

Kiguchi, M., Shen, Y., Kanae, S., &Oki, T. (2014). Re-evaluation of future water stress due to socio-economic and climate factors under a warming climate. *Hydrological Sciences Journal*, *60*(1), 14–29. https://doi.org/10.1080/02626667.2014.888067

Komives, K., Akanbang, B., Thorsten, R., Tuffuor, B., Wakeman, W., Larbi, E., … Whittington, D. (2008). Post-construction support and the sustainability of rural water projects in Ghana. *33rd WEDC International Conference*, 1–294.

Kundu, D. K., Gupta, A., Mol, A. P. J., & Nasreen, M. (2016). Understanding social acceptability of arsenic-safe technologies in rural Bangladesh: A user-oriented analysis. *Water Policy*, *18*(2), 318–334. https://doi.org/10.2166/wp.2015.026

Leviston, Z., Nancarrow, B. E., Tucker, D. I., & Porter, N. B. (2006). Predicting Community Behaviour : Indirect Potable Reuse of Wastewater through Managed Aquifer Recharge. *Land and Water Science Report 2906*, (*29*), *06*.

Mahmuduzzaman, M., Ahmed, Z. U., Nuruzzaman, A. K. M., & Ahmed, F. R. S. (2014). Causes of Salinity Intrusion in Coastal Belt of Bangladesh. *International Journal of Plant Research*, *4*(4A), 8–13. https://doi.org/10.5923/s.plant.201401.02

Moretto, L., Faldi, G., Ranzato, M., Rosati, F. N., IlitoBoozi, J. P., & Teller, J. (2018). Challenges of water and sanitation service co-production in the global South. *Environment and Urbanization*, *30*(2), 425–443. https://doi.org/10.1177/0956247818790652

Mosler, H. J. (2012). A systematic approach to behavior change interventions for the water and sanitation sector in developing countries: A conceptual model, a review, and a guideline. *International Journal of Environmental Health Research*, *22*(5), 431–449. https://doi.org/10.1080/09603123.2011.650156

Murshed, S. B., &Kaluarachchi, J. J. (2018). Scarcity of fresh water resources in the Ganges Delta of Bangladesh. *Water Security*, *4,* 8–18. https://doi.org/10.1016/j.wasec.2018.11.002

Obergfell, C., Bakker, M., & Maas, K. (2019). Estimation of average diffuse aquifer recharge using time series modeling of groundwater heads. *Water Resources Research*, *55*(3), 2194-2210. https://doi.org/10.1029/2018WR024235

Peal, AJ, Evans, BE and van der Voorden, C. (2010). Hygiene and Sanitation Software: An Overview of Approaches. *Water Supply and Sanitation Collaborative Council*.

Peters, C. N., Baroud, H., & Hornberger, G. M. (2019). Multicriteria Decision Analysis of Drinking Water Source Selection in Southwestern Bangladesh. *Journal of Water Resources*

Planning and Management, *145*(4), 05019004. https://doi.org/10.1061/(asce)wr.1943-5452.0001029

Piechulek, H., Al-Sabbir, A., & Mendoza-Aldana, J. (2003). Diarrhea and ARI in rural areas of Bangladesh. *Southeast Asian journal of tropical medicine and public health*, *34*(2), 337-342.

Prüss-Üstün, A., Bos, R., Gore, F., & Bartram, J. (2008). *Safer Water. Better Health: Costs, Benefits and Sustainability of Interventions to Protect and Promote Health.*Geneva: World Health Organization.

Schewe, J., Heinke, J., Gerten, D., Haddeland, I., Arnell, N. W., Clark, D. B., … Kabat, P. (2014). Multi-model assessment of water scarcity under climate change. *Proceedings of the National Academy of Sciences*, *111*(9), 3245–3250. https://doi.org/10.1073/pnas.1222460110

Schwarzer, R. (2008). Modeling health behavior change: How to predict and modify the adoption and maintenance of health behaviors. *Applied Psychology*, *57*(1), 1–29. https://doi.org/10.1111/j.1464-0597.2007.00325.x

Shafiquzzaman, M., Azam, M. S., Moshima, I., & Nakajima, J. (2009). Technical and Social evaluation of arsenic mitigation in rural bangladesh. *Journal of Health, Population and Nutrition*, *27*(5), 674–683. https://doi.org/10.3329/jhpn.v27i5.3779

Van Houtven, G. L., Pattanayak, S. K., Usmani, F., & Yang, J. C. (2017). What are Households Willing to Pay for Improved Water Access? Results from a Meta-Analysis. *Ecological*

Economics, *136*, 126–135. https://doi.org/10.1016/j.ecolecon.2017.01.023

Veldkamp, T. I. E., Wada, Y., de Moel, H., Kummu, M., Eisner, S., Aerts, J. C. J. H., & Ward, P. J. (2015). Changing mechanism of global water scarcity events: Impacts of socioeconomic changes and inter-annual hydro-climatic variability. *Global Environmental Change*, *32*, 18–29. https://doi.org/10.1016/j.gloenvcha.2015.02.011

Whittington, D., Davis, J., Prokopy, L., Komives, K., Thorsten, R., Lukacs, H., Bakalian, A., &Wakeman, W. (2009). How well is the demand-driven, community management model for rural water supply systems doing? Evidence from Bolivia, Peru and Ghana. *Water Policy*, *11*(6), 696-718. https://doi.org/10.2166/wp.2009.310

WHO/UNICEF, & JMP. (2017). *2017 ANNUAL REPORT WHO/UNICEF Joint Monitoring Programme for Water Supply, Sanitation and Hygiene (JMP)*. Retrieved from file:///C:/Users/Hasan002/AppData/Local/Google/Chrome/Downloads/JMP-2017-annual-report.pdf

WHO/UNICEF. (2015). *WHO/UNICEF Joint Monitoring Programme (JMP) for Water Supply and Sanitation, Bangladesh.* Geneve: World Health Organization

Wu, Z., McKay, J., &Keremane, G. (2012). Issues affecting community attitudes and intended behaviours in stormwater reuse: A case study of Salisbury, South Australia. *Water (Switzerland)*, *4*(4), 835–847. https://doi.org/10.3390/w4040835

CHAPTER 4

A COMMUNITY MANAGEMENT PLUS MODEL FOR THE GOVERNANCE OF RURAL DRINKING WATER SYSTEMS: A COMPARATIVE CASE STUDY OF POND SAND FILTER SYSTEMS IN BANGLADESH

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Abstract:

Rural drinking water systems (RDWS) in Bangladesh and elsewhere fail more often than we would want. The acknowledgement that pure community management models will not reverse this trend is growing: Communities of RDWS users need support. In an attempt to further understanding of what this support could look like we in particular zoom in on the role of public agencies. We ask, (i) *what conditions explain variation in collective action among the end-users of a RDWS?* and, (ii) *what conditions explain variation in collaboration between RDWS end-users and a public agency?* We lean on concepts and insights borrowed from the commons literature. After all, rural drinking water systems can be framed as a commons: its users face appropriation and above all provision dilemmas, that must be solved to avoid failure. Based on this literature we develop a list of enabling conditions for (i) collective action among RDWS end users, and (ii) collaboration between RDWS end users and a public agency. We applied these lists to study the governance of 30 pond sand filter (PSF) systems in the Southwestern coastal area in Bangladesh. Computing correlation, we find that a large group size, interdependency among the group members, heterogeneity of endowments, a high level of dependence on resource system, locally devised access and management rules and well-working collaboration between PSF users and the public agency are significantly associated with the occurrence of collective action among PSF users. We also find that the latter (i.e.

collaboration between PSF users and the public agency) is helped by transparency and inclusive decision-making procedures, but mostly by a relation that is characterized by trust.

Keywords:
Rural drinking water systems; pond sand filters; common pool resources; enabling conditions; community management; Bangladesh

Introduction

Pond sand filter (PSF) systems were introduced in Bangladesh in the early 1990s (Hoque, 2009). They are considered a low-tech, easy-to-operate drinking water infrastructure that can provide reasonably priced safe drinking water, reliably. PSF consists of a hand pump to pump water from a pond into a raised filter bed containing gravel and sand. After passing through the filter, drinking water is stored in a filter chamber from which it can be collected via a tap. Not only the technology is relatively simple, also the governance requirements seem straightforward enough: According to the National Policy for Safe Water and Sanitation (1998) local governments (i.e. *Union Parishad* and *Upazila Parishad*) select PSF sites. Subsequently, the Department of Public Health and Engineering (DPHE) is responsible for the installation of the infrastructure and can also be called upon in case of a need for big repairs, later. PSF users are responsible for operating and maintaining their drinking water system. To this end, they select a designated caretaker who is to be paid through user contributions. A committee comprising of five PSF users should take responsibility for organizing overall PSF management.

With roles and responsibilities allocated to communities, a public agency (DPHE) and local authorities, the governance arrangements for PSF correspond with what Hutchings et al. (2015) would call a *community management plus model* – i.e. management responsibilities are primarily assigned to the end-users of the drinking water system, but actors external to the community provide support where and when needed. With regard to *community management plus*, for the *community management* part to work, PSF end-users need to solve a basic collective action problem. For the *plus* part to be effective, the users of PSF need to collaborate well with the public agency, DPHE. (For details regarding the theoretical underpinnings of this assumption, see section 2, below.)

The problem we address in this study is the following. In spite of the simple technology, and seemingly straightforward governance arrangements, PSF has not quite delivered on its promise. In their study of arsenic mitigation technologies in Southeastern Bangladesh, Hossain et al. (2015) find levels of abandonment of PSFs of 87%. The aim of this study is to unveil some of the causes of this less-than-expected performance of PSF in Bangladesh. In order to narrow down this broad empirical question, we particularly zoom in on reasons that may have contributed to the non-optimal performance of the *community management plus* governance arrangement that applied to PSF.

Although we study PSF in Bangladesh, it is our ambition to formulate more general claims about the development of better *community plus management models* for rural drinking water systems. Apart from establishing if and to what extent generic preconditions for collective action in the context of shared resource governance also apply to rural drinking water systems, we in particular also zoom in on the effect of public agency support to community management. Our research questions are twofold: What conditions explain variation in *collective action among the end-users of PSF systems* in Southwestern coastal areas of Bangladesh? What conditions explain variation in *collaboration between PSF end-users and DPHE* in that same area*?*

Theory

Public provision models for rural drinking water systems (i.e. drinking water as a *public good*) have not had the expected impact on coverage and access due to among other things fiscal constraints, a lack of knowledge of communities' needs and preference, and corrupt civil servants" (Isham&Kähkönen, 1998). Private service models (i.e. drinking water as a *commodity*) didn't do a much better job, either. The answer to questions related with the impact of alternatively allocating responsibilities to the private sector remains largely contested (Prasad, 2006). As a consequence, an interest emerged in the 1990s in so-called community management models, where communities are supposed to operate and maintain the drinking water systems largely by themselves (i.e. rural drinking water systems as a *commons*) (Hutchings et al. 2015; Carter et al., 1999; Naiga et al, 2015). For community management, a form of self-governance, to succeed, institutional arrangements are needed that facilitate and foster collective action among users (Ostrom, 1990).

However, although crafting and self-imposing rules to credibly neutralize free riders – i.e. side-stepping those within the group that do not contribute enough, or that extract too much - is possible, it is also notoriously difficult for communities of shared resource users to pull this off without help (Barnes & Van Laerhoven, 2013, 2015). Therefore, apart from solving collective action problems, community management models need a *plus* in the form of well-working collaboration with a support entity, for example a public agency. What are the theoretical underpinnings regarding conditions that explain (i) collective action among users of a shared resource such as PSF, and (ii) collaboration of shared resource users and a support entity such as a public agency?

Collective action among users of shared rural drinking water systems

A rural drinking water systems such as a PSF is a classic example of a shared resource system. Multiple actors – ranging from end-users to international donors – are or can be involved in the provision of the physical infrastructure (i.e., the *resource system*, or stock) and the production of drinking water (i.e., the *resource units*, or flow). Individual users of a shared resource system face a *provision dilemma* when costs related with the investment in a resource system are private, whilst the benefits are shared among all users of that system. As a result, rational actors are tempted to under-invest in the provision of the resource system. *Appropriation dilemmas* occur when the benefits related with the extraction of harvestable

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units from the resource system (in this case, water) are private, whilst the costs of doing that (e.g., a decreasing production capacity of the resource system), are shared among the entire group of resource users. As a result, rational actors are drawn to over-harvesting units from the resource system. The combined effect of underinvestment in and over-harvesting from the resource system would result in an unavoidable resource system collapse, a.k.a. a tragedy of the commons (Hardin, 1968). The primary task of a governance system for shared resources is to neutralize and turn around the incentives that would otherwise have individual actors engage in behavior that would lead to the collapse of the drinking water system (see figure 1). This can be done through state regulation, privatization, self-governance, or a combination, thereof (Ostrom et al., 1992).

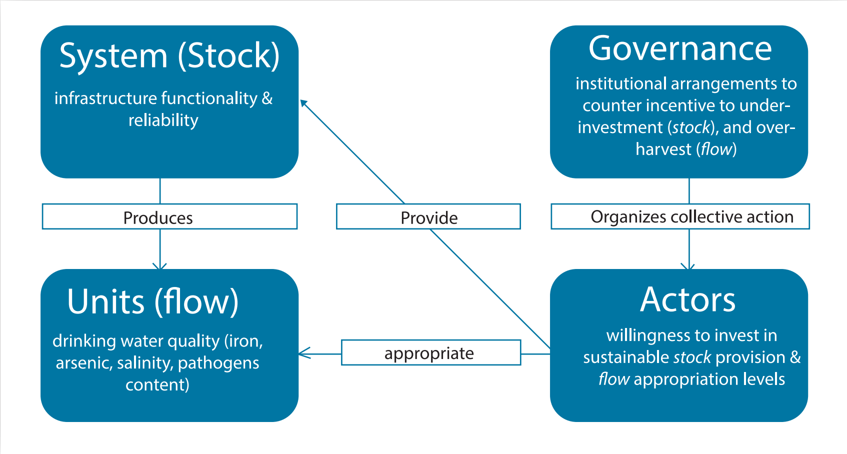

Figure 1: A system-analytical approach to governing shared resource systems

Based on the work of Ostrom (1990), Baland and Platteau (1996) and Wade (1988), Agrawal (2001) provides a review of enabling conditions for collective action among the users of a shared resource. In presenting his findings he follows the structure of the Institutional Analysis and Development (IAD) framework(e.g. Hess & Ostrom, 2005) and differentiates between conditions pertaining to the *resource system characteristics*, the *group characteristics*, the *institutional arrangements*, and the *external environment*, respectively. He adds to that a group of conditions that are related with the *relation between relationship between resource system characteristics and group characteristics*, and the *relationship between the resource system and institutional arrangements*.

We use the enabling conditions listed by Agrawal as a starting point for our analysis of collective action in the specific context of the governance of rural drinking water systems, but discard those related with *resource system characteristics* (as they do not vary across cases) and with the *relationship between the resource system and the institutional arrangements* (as the matching between harvesting and regeneration, and thus the risk of over-exploitation are not an issue with PSF). Conceptually, this interpretation leads to the following (figure 2).

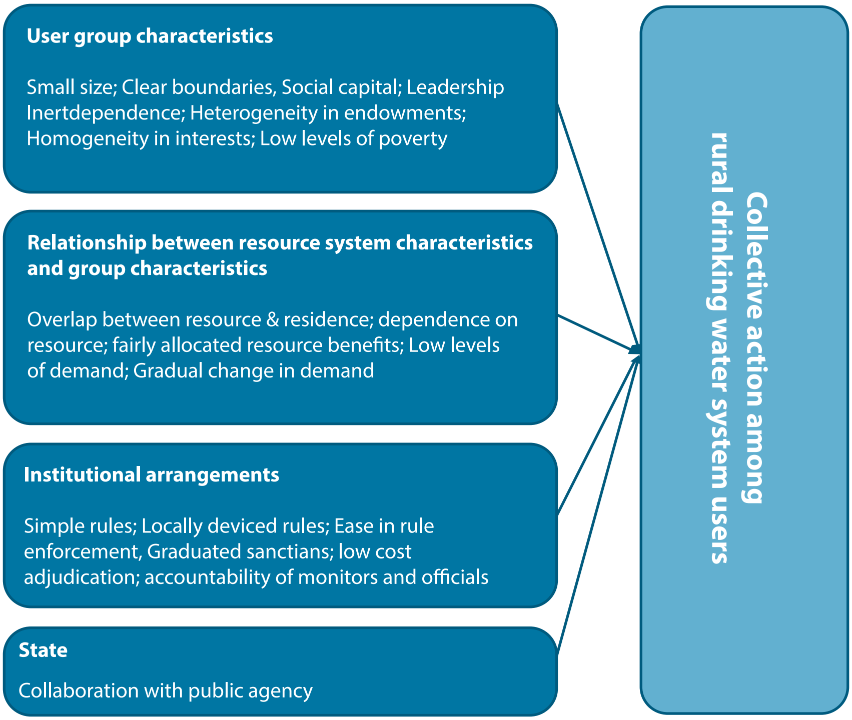

Figure 2: Conditions for collective action among rural drinking water system users

Collaboration between rural drinking water system users and a public agency

Carter et al. (1999, p.296) hold that for community management models to work, among other things, arrangements for support of community-level organization should be clearly set out. Also Harvey and Reed (2007, p.365) hold that "[i]f community management systems are to be sustainable, they require ongoing support." Hutchings et al. (2015) and Hutching et al. (2017) provide a useful overview of the literatures that have taken a stab at conceptualizing 'support' in the context of community management models. Support could come from NGOs (see Hasan et al, 2020) but also from the state.

One of the clusters of enabling conditions proposed by Agrawal (2001, see above) regards the role of the state (under *external environment*). He mentions that (i) governments should not undermine local authority, (ii) there must be supportive external sanctioning institutions, (iii) there must be appropriate levels of external aid to compensate local users for conservation activities, and (iv) there must be nested levels of appropriation, provision, enforcement and governance. We find the conditions he lists, not particularly relevant for a context of rural drinking water system governance: After all, in the case of governing rural drinking water systems governments are the ones promoting community management, so we expect that they will not undermine local authority, and that they will not tolerate the breaking of rules that regard the management of such systems. Compensation for conservation activities does not apply, here.

We do however feel that *the state* can be expected to play a role in determining the success of rural drinking water governance and will therefore seek to specify the enabling conditions for collaboration between rural drinking water system users and public agencies. In an attempt to tease out the enabling conditions for collaboration between rural drinking water system users and public agencies we look at clusters of conditions related with *user group characteristics* (see Agrawal, 2001), *public agency characteristics* (technical capacity, human and financial resources), the *relationship between RSDS users and the public agency* (trust, communication), and the *institutional arrangements* (inclusive decision-making, clarity on tasks and responsibilities, and transparency) (Ansell and Gash, 2008; Huxham, 2003). This interpretation leads to the following conceptual model (figure 3).

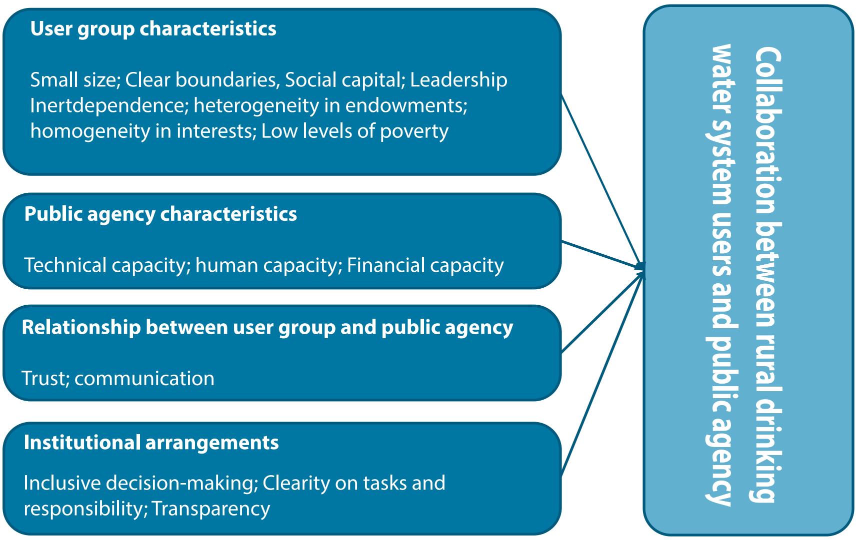

Figure 3: Conditions for collaboration between rural drinking water system users and public agency

Methods

The study employs a comparative case study approach. It was conducted in the Southwestern coastal areas of Bangladesh which is characterized by drinking water scarcity due to salinity intrusion, arsenic contamination, tidal surges and drought (Mahmuduzzaman et al., 2014). Hoque (2009) finds that in this area between 15-30 million people lack year-round access to safe drinking water. The main sources of drinking water are surface water from ponds, pond sand filters (PSF), and the rain water harvesting systems (RWHS). Often, neither shallow nor the deep tube-well pumps are feasible due to a lack of suitable aquifers at reasonable depths (Hoque et al., 2004). In order to keep control variables constant, we focus on one particular rural drinking water system, namely pond sand filter (PSF).

We selected three unions, the lowest tier of local government in Bangladesh, in the Southwestern coastal zone of Bangladesh: Dacope, Dhopakhali and Ishwripur. Close to similar conditions between the unions in terms of drinking water scarcity, and socio-economic, geographic and climatic conditions helped us to keep intervening control variables as constant as possible. In each union, we selected a sample of 10 PSFs. As no complete and accurate list of PSF sites is available, we could not rely on random sampling, but had to resort to a multi-stage cluster sampling technique, instead.

Data were collected in November-December, 2018. Per site, we conducted one structured interview with the local user group (with 8-12 users including PSF user committee members – see introduction, paragraph 1) (i.e. 30 group interviews in total), and with 6 key informants pertaining to the relevant branches of the relevant public agency (i.e. the Department of Public Engineering and Health, DPHE), that had the PSF site in question falling under its jurisdiction. We developed a set of questionnaires with the specific aim of operationalizing the enabling conditions for (i) *collective action among PSF* users and (ii) *collaboration between PSF users and the public agency*. Separate questionnaires were used with different types of respondents (i.e. PSF users and DPHE officials). We pre-tested the questionnaire aimed at PSF users in eight communities. The questionnaires meant for DPHE officials were pre-tested as well. In the group discussions, answers to the questions in the questionnaire were generated by consensus. After conducting the user group and the key informant interviews, a workshop was arranged with participation of all stakeholders involved to triangulate the data found in the fieldwork. In case of a mismatch between PSF users and DPHE answers, priority was given to the answers from the users. All interviews were recorded on a digital voice recorder. Additionally, data was collected by reviewing official documents, field reports, and annual reports collected from DPHE office, Upazila Parishad and Union Parishad. By relying on these various sources and methods we are confident that the reliability of our data and the validity of our results have not been significantly compromised. Due to the relatively low number of observations (n=30), we are unable to perform regressions. We resort to Pearson correlations, instead.

Results

Enabling conditions for collective action among PSF users

The dependent variable for this part of the analysis – i.e. collective action among PSF users – was established in the following way (table 1):

Table 1: Calculation of collective action among PSF users

Questionnaire question	Answer categories	N	Mean	StDev
1. Do or did you have a user committee?	0 = no; 1 = yes	30	.43	.504
2. Does of did the user committee actually meet?	0 = no; 1 = yes	30	.20	.407
3. Are maintenance and operation tasks shared among all members or out-sourced to one person?	0 = no; 1 = yes	30	.20	.407
4. Have multiple group members made contributions to cover part of the installation costs?	0 = no; 1 = yes	30	.27	.450
5. Do or did multiple group members contribute to cover costs related with maintenance and operation?	0 = no; 1 = yes	30	.57	.504
Determining Collective Action Variable Value: • Add scores for indicators 1-5 • Sum = 0-1: no or weak collective action (0) • Sum = 2-5: moderate or strong collective action (1)				

The resulting scores for collective action among PSF users were correlated with the scores for each one of the enabling conditions for collective action suggested in the literature on the governance of shared resources. Table 2 summarizes all data. The correlations are reported in table 3.

Table 2: Summary of the data

Enabling conditions for collective action among PSF users	PSF sites with moderate to strong collective action														PSF sites with weak or no collective action															
	a	b	c	d	e	f	g	h	i	j	k	l	m	n	a	b	c	d	e	f	g	h	i	j	k	l	m	n	o	p
User group characteristics																														
1. Small group size **	0	0	0	0	0	0	0	0	0	0	0	0	1	1	0	0	0	0	0	0	0	1	1	1	1	1	1	1	1	1
2. Clearly defined boundaries	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0
3. Past successful experiences—social capital	0	0	0	0	0	0	0	1	1	1	1	1	0	1	0	0	0	1	1	1	1	0	0	0	1	1	1	1	1	1
4. Appropriate leadership	0	0	0	1	1	1	1	1	1	1	1	1	1	1	0	0	1	0	1	1	1	0	1	1	0	0	0	0	1	1
5. Interdependence among members ***	1	1	1	1	1	1	1	0	1	1	1	1	1	0	0	1	0	0	0	1	1	0	0	1	0	0	0	0	0	1
6. Heterogeneity of endowments *	1	1	1	1	1	1	1	1	1	1	1	1	1	1	1	0	1	1	1	1	1	1	1	0	0	1	1	1	1	1
7. Homogeneity of identities and interests	1	0	1	1	1	1	1	0	1	0	1	0	1	1	0	1	1	0	1	1	1	1	1	1	0	1	1	1	1	1
8. Low levels of poverty	1	0	0	1	0	0	0	0	0	0	1	0	0	0	0	0	0	0	1	0	1	1	1	0	0	0	1	0	0	0
Relationship between resource system characteristics and group characteristics																														
9. Overlap between residence and resource	0	1	0	1	0	1	1	0	0	0	1	1	1	1	1	0	1	0	1	1	0	1	1	1	0	0	1	1	1	1
10. High levels of dependence on resource ***	1	1	1	1	1	1	1	1	1	1	1	1	1	0	0	1	1	1	0	1	1	0	0	0	0	1	1	0	1	0
11. Fairness in allocation of benefits	1	1	1	1	0	1	1	1	1	1	0	1	1	1	1	0	1	1	1	1	1	1	1	1	1	1	1	1	1	1
12. Low levels of user demand	1	1	1	1	1	0	1	1	0	0	1	0	1	1	0	1	1	0	1	1	1	0	1	1	1	1	1	1	1	0
13. Gradual change in levels of demand	1	1	0	1	1	1	1	1	1	1	1	1	1	1	1	1	1	1	1	1	1	1	1	1	1	1	1	1	1	0
Institutional arrangements																														
14. Rules are simple and easy to understand	1	1	1	1	1	1	1	1	1	1	1	0	1	1	1	1	1	1	0	1	1	1	1	0	1	0	1	1	1	1
15. Locally devised rules *	1	1	1	1	1	0	1	0	1	1	0	0	1	0	0	1	0	0	0	1	0	0	0	0	1	0	0	1	0	1
16. Ease in enforcement of rules	1	0	0	1	1	1	1	0	0	0	1	0	0	0	1	1	1	1	1	0	1	0	1	0	0	0	0	0	1	1
17. Graduated sanctions	0	0	0	0	1	1	0	0	1	0	0	1	0	0	0	0	1	1	0	0	1	1	1	1	0	0	0	1	0	1
18. Availability of low-cost adjudication	1	0	0	1	1	1	0	0	1	1	1	0	0	1	0	0	0	1	0	1	1	0	1	0	0	0	1	1	0	1
19. Accountability of monitors/officials	0	0	0	0	0	0	0	0	1	0	0	0	1	0	0	0	0	1	0	0	0	0	1	0	0	0	0	0	0	0
State																														
20. Collaboration public agency ***	1	1	0	1	1	1	1	0	1	0	1	1	1	1	0	0	0	0	0	1	0	0	0	1	0	0	1	1	0	1

Table 3: Correlations results for collective action

Enabling conditions for collective action among PSF users	Interview question	Answer categories	Mean	StDev	r	p (2tailed)	R^2
User group characteristics							
1. Small size	How many households are (were) allowed to use this PSF?	0= >100 1= ≤100	0.37	0.49	-0.43	0.016**	0.18
2. Clearly defined boundaries	Is it clearly defined who is allowed to use the PSF?	0=no 1=yes	0.00	0.00	n.a.	n.a.	
3. Past successful experiences—social capital	How many types of collective action (not related with PSF) did the community engage, previously? (shrimp farming, cooperative, irrigation, mosque construction, canal excavation, river embankment, and/or other)	0=0-1 1=2-4	0.83	0.38	-0.20	0.298	
4. Appropriate leadership—young, familiar with changing external environments, connected to local traditional elite	Does or did the user group have appropriate leadership? (composed from the answers to questions about capacity, connectedness, and fairness of leader)	0=no 1=yes	0.63	0.49	0.30	0.113	
5. Interdependence among group members	The members of user group depend on each other's contribution for well-functioning of PSF (composed of the answers to questions about interdependence regarding money, knowledge and labor)	0=weak 1=strong	0.57	0.50	0.55	0.002***	0.30
6. Heterogeneity of endowments	There are members that can step up to cover unforeseen costs	0=no 1=yes	0.90	0.31	0.31	0.093*	0.10
7. Homogeneity of identities and interests	All the members of user group have the same background in term of political identity (note: no variation observed with regard to ethnic and religious heterogeneity)	0=no 1=yes	0.77	0.43	-0.12	0.542	
8. Low levels of poverty	All the members of user group are capable to pay the contributions required for the installation of PSF (note: for all sites it was indicated that everyone is able to contribute to maintenance and operation)	0=no 1=yes	0.27	0.45	0.11	0.560	
Relationship between resource system characteristics and group characteristics							
9. Overlap between user group residential location and resource location	How much time users have to spend on collecting water?	0= >.5h 1= ≤ .5h	0.63	0,49	-0.12	0.527	

Enabling conditions for collective action among PSF users	Interview question	Answer categories	Mean	StDev	r	p (2tailed)	R^2
10. High levels of dependence by group members on resource system	What is/was the most important drinking water source during the dry season for the user group members?	0=not PSF 1=PSF	0.70	0.47	0.47	0.009***	0.22
11. Fairness in allocation of benefits from resource system	Do you think that fairness is maintained in the allocation of PSF water among the user group?	0=no 1=yes	0.90	0.31	-0.13	0.481	
12. Low levels of user demand	What is the estimated total quantity of drinking water (liter) used by a household on average per day?	0= >40 liters 1= ≤40 liters	0.73	0.45	-0.40	0.833	
13. Gradual change in levels of demand	Did the demand for PSF water increase sharply over the last few years?	0=yes 1=no	0.93	0.25	-0.18	0.925	
Institutional arrangements							
14. Rules are simple and easy to understand	Are the rules formulated in a clear way such that everybody understands and applies them in the exact same way?	0=no 1=yes	0.87	0.35	0.17	0.368	
15. Locally devised access and management rules	Who formulated the working rules for PSF usage and management?	0=others 1=users	0.47	0.51	0.33	0.075*	0.11
16. Ease in enforcement of rules	Do or did you experience difficulties enforcing the rules that apply to PSF usage and management?	0=yes 1=no	0.50	0.51	-0.13	0.481	
17. Graduated sanctions	Do you have rules that regard the sanctioning of rule breaking?	0=no 1=yes	0.40	0.50	-0.22	0.247	
18. Availability of low-cost adjudication	Do you have a mechanism to settle internal disputes related with PSF?	0=no 1=yes	0.50	0.51	0.13	0.481	
19. Accountability of monitors and other officials to users	Do you have a mechanism to hold monitors and user committee members accountable?	0=no 1=yes	0.13	0.35	0.26	0.891	
State							
20. Collaboration with public agency	Do or did you collaborate with the Department of Public Health and Engineering (DPHE)? (composed of answers to questions about DPHE support with regard (i) PSF installation, (ii) formation of a user committee, and (iii) repairs) (see table 4, below)	0=no 1=yes	0.53	.51	0.47	0.008***	0.22

Note: *p<0.10, **p<0.05, ***p<0.0

Enabling conditions for collaboration between PSF users and DPHE

The dependent variable for this part of the analysis – i.e. collaboration between PSF users and the DPHE – was established in the following way:

Table 4: Calculation of collaboration between PSF users and DPHE

Questionnaire question	**Answer categories**	**N**	**Mean**	**StDev**
DPHE collaborated with regard to the installation of the PSF	0 = no; 1 = yes	30	.40	.498
DPHE collaborated with regard to the formation of an operation and maintenance committee	0 = no; 1 = yes	30	.20	.407
DPHE collaborated with regard to repair and maintenance activities	0 = no; 1 = yes	30	.13	.346
Determining Collaboration Variable Value: • Add scores for indicators 1-3 • Sum = 0 = no collaboration (0) • Sum = 1-3 = moderate or strong collaboration (1)				

The resulting scores for collaboration between PSF users and DPHE were corelated with the scores for each one of the enabling conditions for collective action suggested in the literature on the governance of shared resources. A summary of the data is provided in table 5, the correlation results are presented in table 6.

Table 5: Summary of the data

	PSF sites with strong user-DPHE collaboration																PSF sites with weak user-DPHE collaboration													
	a	b	c	d	e	f	g	h	i	j	k	l	m	n	o	p	a	b	c	d	e	f	g	h	i	j	k	l	m	n
User group characteristics																														
1. Small size	0	0	1	1	1	1	0	0	0	0	0	0	0	1	0	1	1	1	0	0	1	0	0	0	0	0	0	1	0	1
2. Clearly defined boundaries	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0
3. Past successful experiences—social capital	1	0	1	1	1	0	1	1	0	0	0	0	0	0	1	1	1	0	0	0	0	1	0	1	0	1	1	1	1	1
4. Appropriate leadership	1	1	0	0	1	1	1	1	1	1	0	1	0	1	1	1	1	1	0	1	0	1	0	0	0	1	1	0	1	0
5. Interdependence among group members ***	1	1	0	0	0	1	1	1	1	1	1	1	1	1	1	1	0	0	0	0	0	0	1	0	1	1	1	0	0	0
6. Heterogeneity of endowments	1	1	1	1	1	0	1	1	1	1	1	1	1	1	1	1	1	1	1	1	1	1	0	1	1	1	1	0	1	1
7. Homogeneity of identities and interests	1	1	1	1	1	1	1	1	1	1	1	1	0	1	0	1	1	1	0	1	1	1	1	0	1	1	0	0	0	1
8. Low levels of poverty	0	1	1	0	0	0	0	1	0	0	1	0	0	0	0	0	0	1	0	0	1	1	0	0	0	1	0	0	0	0
Public agency characteristics																														
9. Technical capacity	0	1	1	1	1	1	0	1	1	1	1	1	1	0	1	0	0	1	1	1	1	1	1	1	1	0	0	0	0	0
10. Human resources	1	1	1	1	1	1	1	0	0	0	0	0	0	1	0	1	1	1	1	1	1	1	0	0	0	1	1	1	1	1
11. Financial resources	1	1	1	1	1	1	1	0	0	0	0	0	0	1	0	1	1	1	1	1	1	1	0	0	0	1	1	1	1	1
Relationship between user group and public agency																														
12. Trust ***	1	0	0	1	1	0	1	1	0	1	1	0	0	0	1	1	0	0	0	0	0	0	0	0	0	1	0	0	0	0
13. Communication	1	0	0	1	1	1	0	1	0	1	0	0	0	0	0	1	1	1	1	1	1	0	0	0	0	1	1	1	0	0
Institutional arrangements																														
14. Inclusive decision-making *	1	1	1	1	1	1	1	1	1	1	1	1	1	1	1	1	1	1	1	1	1	1	1	1	1	1	1	0	0	0
15. Clarity on tasks and responsibilities	1	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0
16. Transparency **	1	0	0	0	0	0	1	1	0	1	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0

Table 6: Correlation results for collaboration

Enabling conditions for collaboration between users and public agency	**Interview question**	**Answer categories**	**Mean**	**StDev**	**r**	**p**	**R^2**
User group characteristics							
1. Small size	How many households are (were) allowed to use this PSF?	0= >100 1= ≤100	0.37	0.49	0.18	0.923	
2. Clearly defined boundaries	Is it clearly defined who is allowed to use the PSF?	0=no 1=yes	0.00	0.00	n.a.	n.a.	
3. Past successful experiences—social capital	How many types of collective action (not related with PSF) did the community engage, previously?	0=0-1 1=2-4	0.83	0.38	-0.71	0.708	
4. Appropriate leadership	Does or did the user group have appropriate leadership?	0=no 1=yes	0.63	0.49	0.26	0.167	
5. Interdependence among group members	The members of user group depend on each other's contribution for well-functioning of PSF	0=weak 1=strong	0.57	0.50	0.53	0.003***	0.28
6. Heterogeneity of endowments	There are members that can step up to cover unforeseen costs	0=no 1=yes	0.90	0.31	0.13	0.481	
7. Homogeneity of identities and interests	All the members of user group have the same background in term of political identity	0=no 1=yes	0.77	0.43	0.27	0.143	
8. Low levels of poverty	All the members of user group are capable to pay the contributions required for the installation of PSF	0=no 1=yes	0.27	0.45	-0.40	0.833	
Public agency characteristics							
9. Technical capacity	This DPHE branch has sufficient technical capacity to perform its tasks with regard to the PSF of this	0=no 1=yes	0.67	0.48	0.189	0.317	

Enabling conditions for collaboration between users and public agency	Interview question	Answer categories	Mean	StDev	r	p	R^2
	community						
10. Human resources	This DPHE branch has sufficient human resources to perform its tasks with regard to the PSF of this community	0=no 1=yes	0.67	0.48	-0.236	0.209	
11. Financial resources	This DPHE branch has sufficient financial resources to perform its tasks with regard to the PSF of this community	0=no 1=yes	0.67	0.48	-0.236	0.209	
Relationship between user group and public agency							
12. Trust	We trust that DPHE will help us to operate our PSF (composed of the answers to questions about users trusting DPHE to help with running the user groups and effectuating repairs)	0=no 1=yes	0.33	0.48	0.520	0.003***	0.27
13. Communication	Do PSF users and DPHE communicate regularly?	0=no 1=yes	0.50	0.60	-0.134	0.481	
Institutional arrangements							
14. Inclusive decision-making	DPHE takes the opinion and interests of our user group into account	0=no 1=yes	0.90	0.31	0.356	0.053*	0.13
15. Clarity on roles and responsibilities	The respective tasks and responsibilities of our user group and DPHE are clear and well-understood	0=no 1=yes	0.03	0.18	0.174	0.359	
16. Transparency	Decision-making and operation of DPHE with regard to our PSF is transparent	0=no 1=yes	0.13	0.35	0.367	0.046**	0.13

Note: *p<0.10, **p<0.05, ***p<0.0

Discussion & conclusion

Discussion of the findings

Collective action among PSF users

With regard to our analysis of the enabling conditions for collective action among the users of PSF, it is striking that none of the 30 sites we studied had installed boundary rules. In their study of the introduction of another drinking water technology (i.e. managed aquifer recharge, or MAR) in the same area, Hasan et al. (2020) find that social norms prevent the formulation of rules that would restrict access to drinking water points. Still, setting boundaries for a shared resource is among the strongest predictors of successfully solving provision and appropriation dilemmas (Cox et al., 2010).

It is furthermore notable that for all sites we find PSF users reporting that they have the financial means to contribute to operation and maintenance of the PSF – at 73% of all PSF sites in our study users indicate that they also have the means to contribute to the installation of the infrastructure. Contrary to conventional wisdom, PSF failure is largely unrelated with the inability to pay for it. There is of course a distinction between having the means and using them, as studies on willingness-to-pay have shown (e.g. Dey et al., 2018).

Somewhat unexpected, is the direction of the significant association between group size and the occurrence of collective action among the PSF end-users. Were we would tentatively assume that smaller groups increase the chance of interaction and hence the building of trust between individuals (which in turn would lower the transaction costs association with collective action) (Poteete and Ostrom, 2004), we find that in our set larger groups show signs of collective action significantly more often than smaller groups. This may be related with efficiency gains resulting from economies of scale (Van Laerhoven, 2010).

Our results hint at the importance of (i) having group members with heterogenous endowments, and (ii) having locally devised rules. The correlations are significant but not very strong. With regard to heterogeneous endowments, we observe that better-off families often play a decisive role in setting up and operating successful drinking water infrastructures. This is congruent with the argument of Olson (1965) that successful collective action may require a disproportionate effort of some. It remains to be seen if this is positive or negative, in the end: On the one hand, such families can step up when needed (and others are not able to). On the other, one could also see how over-reliance on just one person or family could exacerbate existing inequality and dependence relations (see also Vedeld, 2000). The importance of locally devised rules has been recognized as one of the crucial design principles for the successful governance of other types of shared resources, as well (Ostrom, 1990; Cox et al., 2010). It is somewhat unexpected that this correlation is rather weak in the case of PSF. We suspect that this could be related with the fact that given the low level of institutional complexity, there wouldn't be much difference between locally devised and imposed rules, anyway.

Our strongest results regard the associations of collective action among PSF users with (i) the existence of interdependence among group members, (ii) a high level of dependence of the users on PSF for satisfying their drinking water needs, and (iii) the presence of collaboration with DPHE. Our finding that interdependence among group members correlates with the occurrence of collective action in the case of PSF, coincides with earlier findings for other types of shared resources (Baland and Platteau, 1996; Wade, 1988). We find that collective action is observed significantly more often in our sample, when PSF users report to have no alternative drinking water source at their disposal. The result that salience is important is in line with similar findings for other types of shared resources (e.g. Ascher, 1995; Gibson, 2001). The fact that our cases where collective action does take place do significantly more often report to collaborate with DPHE, than the cases in our sample that don't, supports the claim that community management models benefit from a *plus*. (e.g. Hutchings et al. (2015); Hutching et al. (2017); Hasan et al., 2020).

Collaboration between PSF users and DPHE

What do our results tell us about the drivers of collaboration between PSF users and DPHE? A first striking result from our explorative analysis is that there is a close to total lack of clarity on roles and responsibilities of both partners (i.e. PSF users and DPHE) with regard to PSF management. Although national policies and guidelines offer some guidelines, these guidelines may be too generic. They do for example not stipulate that DPHE should make an effort to create clarity.

Apart from interdependence between group members, there aren't any conditions related with the user group characteristics that seem to have an effect on the presence or absence of collaboration of PSF users with DPHE. This appears somewhat counter-intuitive to us, as we would have expected that it would emerge more strongly from our study that presence or absence of collaboration depends on group characteristics.

It is furthermore striking and maybe unexpected that the characteristics of the public agency doesn't seem to account for variation, either. Public agency capacity in terms of human resources, financial means and technical knowledge, is not significantly correlated with whether or not they engage in a collaborative relation with PSF users. The natural reflex of policy makers is often to transfer resources and training to agencies in an attempt to improve agency performance. This results hints at the fact that there might be more to it (see for example Kaufmann et al., 2019).

Institutional arrangement seem to explain some of the variation. The correlation of collaboration with (i) inclusive decision-making and (ii) transparency are significant but weak. Decision-making that involves users and DPHE is perceived as being inclusive most of the time. For the three cases where respondents indicate that it isn't, we report no to weak collaboration. In most of the cases we compared, respondents report that DPHE's ways with regard to PSF are mostly not transparent. For the four cases where respondent indicate that DPHE is transparent, we report moderate to strong collaboration.

The strongest correlation we find regards the role of trust. This is very much in line with the role assigned to trust in many earlier studies on collective action in a context of shared resource management (see for example Kramer et al., 1996).

Contribution to the literature

In our opinion, our contribution to the literature is twofold. Firstly, we contribute to commons scholarship. For their analysis, van Laerhoven et al. (forthcoming) compiled a data set consisting of 3,452 titles, indexed by Scopus, that present studies on commons or common pool resources. Only 10 of the titles mention the term 'drinking water' in either the title, the abstract, or the key words. In our study we show that concepts and insights gained by commons scholars are to a certain extent applicable to shared rural drinking water systems, as well. This observation is congruent with earlier findings. For example, Van Laerhoven & Ostrom (2007) speak of "The Big 5" when discussing the disproportionate attention in the study of the commons to forests, fisheries, rangeland, irrigation system, and water (i.e. not drinking water). In our study, we show that in spite of the sparse attention so far, conceptually it does make sense to approach the analysis of rural drinking water systems from a commons perspective. Just as in the case of other types of commons, the users of this shared resource will need to solve appropriation, and above all provision dilemmas, in order to avoid failure and abandonment. Our study adds nuance to the generic lists of enabling conditions (Agrawal, 2001), or design principles (Cox et al., 2010) for the successful governance of the commons. Just like Baggio et al. (2016) show how enabling conditions for success vary significantly between governance arrangements for forests, fisheries, and irrigation systems, respectively, we show that also rural drinking water systems' governance responds to its own particular dynamic. A dynamic according to which (for example) group size plays another than expected role, and salience (i.e. dependence on the resource) may be more important than for certain other types of commons.

The most important nuance that we add to the generic list of enabling conditions for sustainability on the commons regards the role of *the state*. This brings us at our second contribution to the literature: Our study adds to the growing understanding of how support can increase the likelihood of success of community management service models. In that sense, we build on and further develop notions put forward in the works of for example Hutchings et al. (2015), Hutchings et al. (2017), Carter et al. (1999), and Harvey and Reed (2007). Before, we have looked at how support to communities can be given by NGOs (Hasan et al., 2020). In this article we have complemented these insights by particularly zooming in on the possible supportive role of public agencies. This supportive role differs from the general conditions listed by Agrawal (2001). Agrawal mentions that governments should not undermine local authority and must offer supportive institutions for the enforcement of rules, and the sanctioning of infractions. We make a more detailed case for what goes into a successful collaboration between drinking water system users and the state, by zooming in on the characteristics of the users and the public agency, the nature of the relation between both, and the institutional arrangements in place.

Future research

Overall, the robustness of our findings can be increased by the employment of more sophisticated statistics. For that, it is needed that the current data set (see tables 2 and 5) gets expanded with more cases and observations. Future research may also want to look into ways to operationalize the conditions more validly (i.e. by means of other types of questions), or more nuancedly (i.e. by means of other than binary scales). The biggest challenge we see regards the unpacking of trust as a predictor of collaboration between rural drinking water systems and public agencies. We acknowledge that in our current explorative analysis it remains unclear for example what the causal direction might be (i.e. does trust 'cause' collaboration, is it the other way around, or a bit of both?). Untying this knot is important, as the presence of public agency support appears to contribute importantly to the success of a rural drinking water system.

Recommendations for champions of rural drinking water systems

Based on our findings, we would recommend the followings to those involved in rural drinking water provision in Bangladesh or in similar regions, elsewhere in the world. It appears to us that in spite of the apparent reluctance to do so, attempts should be made to set boundary rules that determine who can use the system. This is important to guarantee that benefits associated with appropriation (access to water) are proportional to provision costs (i.e. contributions to the operation and maintenance of the system). Second, form user groups that are large enough to achieve economies of scale – i.e. there should be enough members to pool the money needed for covering (unanticipated spikes in) operation and maintenance costs. Third, as working together is something you can learn, it would make sense to form groups with members that collaborated for other types of purposes, before. Fourth, make sure that your attempt to introduce a new and improved drinking water system is demand rather than supply-driven – i.e. the system you bring should be salient to the prospective users. Fifth, involve the users of the drinking water system in the crafting of all rules regarding its governance – i.e. both the operational and the collective choice rules. Finally, guarantee that a community management model can rely on a *plus*, i.e. a safety net in the form of support from (for example) a public agency. And in doing that, invest enough effort and time in creating trust between the users and the entity that is to support their community management endeavor, and in transparency with regard to the making and enforcing of rules.

References

Agrawal, A. (2001). Common property institutions and sustainable governance of resources. *World development*, *29*(10), 1649-1672. https://doi.org/10.1016/S0305-750X(01)00063-8

Ansell, C., & Gash, A. (2008). Collaborative governance in theory and practice. *Journal of public administration research and theory*, *18*(4), 543-571. https://doi.org/10.1093/jopart/mum032

Ascher, W. (1995).*Communities and sustainable forestry in developing countries*. San Francisco, CA: ICS Press.

Baggio, J. A., Barnett, A. J., Perez-Ibara, I., Brady, U., Ratajczyk, E., Rollins, N., ... & Anderies, J. M. (2016). Explaining success and failure in the commons: the configural nature of Ostrom's institutional design principles. *International Journal of the Commons*, *10*(2), 417-439. http://doi.org/10.18352/ijc.634

Baland, J.M., Platteau, J.P. (1996) *Halting degradation of natural resources: Is there a role for rural communities?* Clarendon Press, Oxford. DOI:10.1093/0198290616.001.0001

Barnes, C., & Van Laerhoven, F. (2013). Helping to self-help? External interventions to stimulate local collective action in Joint Forest Management, Maharashtra, India. *International Forestry Review*, *15*(1), 1-17. https://doi.org/10.1505/146554813805927246

Barnes, C., & van Laerhoven, F. (2015). Making it last? Analysing the role of NGO interventions in the development of institutions for durable collective action in Indian community forestry. *Environmental Science & Policy*, *53*, 192-205. https://doi.org/10.1016/j.envsci.2014.06.008

Carter, R. C., Tyrrel, S. F., &Howsam, P. (1999). The impact and sustainability of community water supply and sanitation programmes in developing countries. *Water and Environment Journal*, 13(4), 292-296. https://doi.org/10.1111/j.1747-6593.1999.tb01050.x

Cox, M., Arnold, G., & Villamayor Tomás, S. (2010). A Review of Design Principles for Community-based Natural Resource Management. *Ecology and Society*,*15*(4).

Dey, N. C., Parvez, M., Saha, R., Islam, M. R., Akter, T., Rahman, M., ... & Islam, A. (2018). Water Quality and Willingness to Pay for Safe Drinking Water in Tala Upazila in a Coastal District of Bangladesh. *Exposure and Health*, 1-14. https://doi.org/10.1007/s12403-018-0272-3

Gibson, C. (2001). Forest resources: institutions for local governance in Guatemala. In J. Burger, E. Ostrom, R.B. Norgaard, D. Policansky, B.D. Goldstein (Eds.), *Protecting the Commons. A Framework for Resource Management in the Americas*, Island Press, Washington, DC.

Hardin, G. (1968). The tragedy of the commons. *Science*, *162*(3859), 1243-1248. https://doi.org/10.1126/science.162.3859.1243

Harvey, P. A., & Reed, R. A. (2006). Community-managed water supplies in Africa: sustainable or dispensable? *Community*

Development Journal, 42(3), 365-378. https://doi.org/10.1093/cdj/bsl001

Hasan, MB. . Driessen, P. J. M., Zoomers, A., & van Laerhoven, F. (2020). How can NGOs support collective action among the users of rural drinking water systems? A case study of Managed Aquifer Recharge (MAR) systems in Bangladesh. *World Development, 126*, 104710.https://doi.org/10.1016/j.worlddev.2019.104710

Hess, C., & Ostrom, E. (2005). A framework for analyzing the knowledge commons: a chapter from understanding knowledge as a commons: from theory to practice. *Understanding Knowledge as a Commons: From Theory to Practice*, 41–82. http://surface.syr.edu/sul/21

Hoque, M. R. (2009). Access to Safe Drinking Water in Rural Bangladesh: Water Governance by DPHE. BRAC University, Dhaka, Bangladesh.

Hoque, B. A., Hoque, M. M., Ahmed, T., Islam, S., Azad, A. K., Ali, N., Hossain, M. S. (2004). Demand-based water options for arsenic mitigation: An experience from rural Bangladesh. *Public Health*, 118(1), 70–77. https://doi.org/10.1016/S0033-3506(03)00135-5

Hossain, M., Rahman, S. N., Bhattacharya, P., Jacks, G., Saha, R., & Rahman, M. (2015). Sustainability of arsenic mitigation interventions—an evaluation of different alternative safe drinking water options provided in MATLAB, an arsenic hot spot in Bangladesh. *Frontiers in Environmental Science*, 3, 30. https://doi.org/10.3389/fenvs.2015.00030

Hutchings, P., Chan, M. Y., Cuadrado, L., Ezbakhe, F., Mesa, B., Tamekawa, C., &Franceys, R. (2015). A systematic review of success factors in the community management of rural water supplies over the past 30 years. *Water Policy,*17(5), 963–983. https://doi.org/10.2166/wp.2015.128

Hutchings, P., Franceys, R., Mekala, S., Smits, S., & James, A. J. (2017). Revisiting the history, concepts and typologies of community management for rural drinking water supply in India. *International Journal of Water Resources Development*, 33(1), 152–169. https://doi.org/10.1080/07900627.2016.1145576

Huxham, C. (2003). Theorizing collaboration practice. *Public management review*, *5*(3), 401-423. https://doi.org/10.1080/1471903032000146964

Isham, J. and Kähkönen, S. (1998). Improving the delivery of water and sanitation: A model of coproduction of infrastructure services (Working Paper No. 210). IRIS Center, College Park.

Kaufmann, D., Mehrez, G., &Gurgur, T. (2019). Voice or public sector management? An empirical investigation of determinants of public sector performance based on a survey of publicofficials. *Journal of Applied Economics*, *22*(1), 321-348. http://dx.doi.org/10.2139/ssrn.316865

Kramer, R. M., Brewer, M. B., & Hanna, B. A. (1996). Collective trust and collective action. In R. M. Kramer and T. R. Tyler (eds), *Trust in organizations: Frontiers of theory and research*, 357-389. Thousand Oaks: Sage Publishers. http://dx.doi.org/10.4135/9781452243610.n17

Mahmuduzzaman, M., Ahmed, Z. U., Nuruzzaman, A. K. M., & Ahmed, F. R. S. (2014). Causes of Salinity Intrusion in Coastal Belt of Bangladesh. *International Journal of Plant Research*, 4(4A), 8–13. doi:10.5923/s.plant.201401.02

Naiga, R., Penker, M., &Hogl, K. (2015). Challenging pathways to safe water access in rural Uganda: From supply to demand-driven water governance. *International Journal of the Commons*, *9*(1), 237-260. http://doi.org/10.18352/ijc.480

Olson, M. (1965). *The Logic of Collective Action. Public goods and the theory of groups*, Cambridge, Mass. Harvard University Press

Ostrom, E. (1990). *Governing the commons: The evolution of institutions for collective action*. New York: Cambridge University Press.

Ostrom, E., Walker, J., & Gardner, R. (1992). Covenants with and without a sword: Self-governance is possible. *American political science Review*, *86*(2), 404-417. https://doi.org/10.2307/1964229

Poteete, A. R., & Ostrom, E. (2004). Heterogeneity, group size and collective action: the role of institutions in forest management.

Development and change, *35*(3), 435-461. https://doi.org/10.1111/j.1467-7660.2004.00360

Prasad, N. (2006). Privatisation results: private sector participation in water services after 15 years. *Development Policy Review*, 24(6), 669-692. https://doi.org/10.1111/j.1467-7679.2006.00353.x

Van Laerhoven, F. (2010). Governing community forests and the challenge of solving two-level collective action dilemmas—a large-N perspective. *Global Environmental Change*, *20*(3), 539-546. https://doi.org/10.1016/j.gloenvcha.2010.04.005

Van Laerhoven, F., & Ostrom, E. (2007). Traditions and Trends in the Study of the Commons. *International Journal of the Commons*, *1*(1), 3-28. http://doi.org/10.18352/ijc.76

Vedeld, T. (2000). Village politics: heterogeneity, leadership and collective action. *The Journal of Development Studies*, *36*(5), 105-134. https://doi.org/10.1080/00220380008422648

Wade, R. (1988). *Village republics: Economic conditions for collective action in South India*. Oakland: ICS Press.

CHAPTER 5

HOW CAN NGOS SUPPORT COLLECTIVE ACTION AMONG THE USERS OF LOCAL DRINKING WATER SYSTEMS? A CASE STUDY OF MANAGED AQUIFER RECHARGE (MAR) SYSTEMS IN BANGLADESH

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Abstract

In this article, we link NGO-supplied drinking water infrastructure projects with collective action development approaches. Although governing local, shared drinking water systems (DWS) requires users to act collectively, users rarely organize such collective action successfully by themselves. Non-governmental organizations (NGOs) are therefore frequently called upon to support local communities to set up or consolidate the kind of local collective action required for governing DWSs. However, the effectiveness of such forms of NGO support remains unclear. Therefore, this paper attempts to assess the form and impact of this kind of NGO support. Combining insights gained from theory on institutions for collective action in the context of shared resource systems, we develop a set of requirements presumed necessary for guaranteeing both day-to-day and long-term collective action among local shared DWS users. We apply this framework to empirically explore if, how and why NGO support targets these requirements, and whether this support influences users' capacity for collective action. To this end we examine 11 cases where NGOs have worked with users of Managed Aquifer Recharge (MAR) systems in Bangladesh. We collected data through focus group discussions, semi-structured interviews with local leaders, NGO officials, and project staff, and by reviewing project documentation. We find that NGO support favors long-term requirements over the requirements for day-to-day collective action. NGO activities seem based on applying standard approaches to training and awareness raising, and less on empowering users to craft their own solutions. A case for a lasting impact of NGO support on any of the requirements is hard to make. Our results imply that when attempting to organize effective and long-lasting forms of collective action among the users of shared resource systems, both NGOs and commissioners of projects need to engage more explicitly in learning what works and what doesn't. 5

Key words:
Non-governmental organizations; community management; collective action; managed aquifer recharge; drinking water systems; Bangladesh

Introduction

In this article, we study the link of NGO-supplied drinking water infrastructure projects with collective action development approaches. Despite decades of trying, those in the realms of practice, policy and science still do not seem to have worked out completely how to optimally execute a task that at first sight seems rather straightforward: the provision of safe, reliable, and affordable drinking water solutions for all in rural communities in developing countries. Consequently, failed drinking water projects can be found in many places in Asia, Africa, and Latin America (Reddy et al., 2011; Whaley & Cleaver, 2017). According to Hutchings et al. (2017), with specific regard to piped water, 30% of Indian villages that had achieved full drinking water coverage in the past are now back to partial coverage due to system failure. In their study of arsenic mitigation technologies in Southeastern Bangladesh, Hossain et al. (2015) find levels of abandonment of pond sand filter systems and rain water harvesting systems of 87% and 60%, respectively.

In this paper, we apply a system-analytical approach in which drinking water systems (DWSs) are considered the actual infrastructure (i.e., the *resource system*) that produces drinking water (in other words the *resource units*), plus the set of end-users that together with others (i.e., the *actors*) engage in the *governance* of the system. Conceptualizing RDWSs in this way allows us to disentangle the indicators of RDWS performance in a meaningful manner. Stock performance regards the functionality of the infrastructure and refers to its capacity to supply safe drinking water, reliably. Flow performance regards drinking water quality, e.g. in terms of iron, arsenic, salinity and pathogenic content. Actor performance regards the extent to which RDWS end-users are willing to invest in stock provision, and sustainable flow appropriation. Governance performance regards the extent to which institutional arrangements counter the end-users propensity to under-invest in the stock, and over-harvest from the flow. In our empirical analysis, we focus on the actors and governance performance. We will tentatively speculate about the expected consequences for stock and flow performance in the discussion. Figure 1 provides a schematic overview of how we conceive of RDWSs as socio-technological systems consisting of components, relations, and feedbacks. It also includes broad-stroke performance indicators associated with each one of the building blocks.

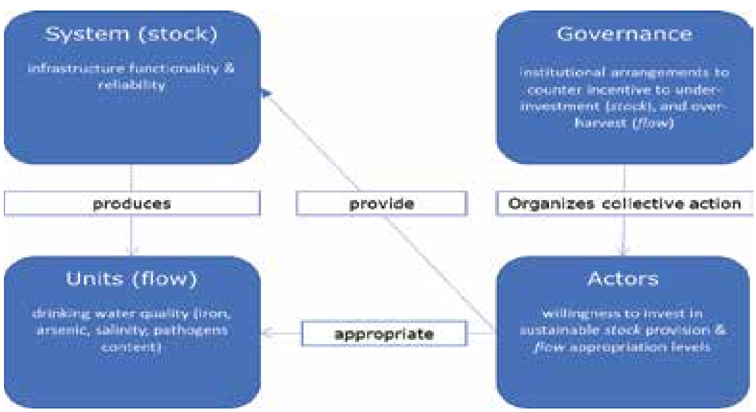

Figure 1: A system-analytical approach to governing shared resource systems (Hasan et al, 2020)

Although we appear to have become reasonably good at building well-working physical infrastructures for supplying drinking water, crafting a well-working governance system still seems to be a major challenge. By governance we mean the range of political, organizational, and administrative processes through which government and non-government stakeholders articulate their interests, exercise their legal rights, take decisions, meet their obligations, and mediate their differences. Broadly speaking, governance refers to an ensemble of *actors*, *institutions*, and *content* (Driessen et al., 2012).

Koehler et al. (2018) reframe cultural theory (Douglas, 1994) for waterpoint management, and propose a typology of management cultures that is based on contextual risks and values. A *community culture* is defined, in this context, as the adoption of a risk-sharing approach by informal groups. A hierarchism or *bureaucratic culture* represents institutionalized authority, where risk is determined by rules and regulations. An *individualistic culture* sees risk as an opportunity and is characterized by private ownership and entrepreneurship.

Loosely following Koehler et al, (2018), we see archetypical forms of drinking water service models ranging from public provision with no community role (i.e. drinking water as a public good), via community management or self-governance models (i.e. RDWS as a commons, or club good), to private service models (i.e. drinking water as a commodity) (fig 2). However, on closer inspection, when implemented in its purest form, each one of these types appears to have a questionable to poor track record.

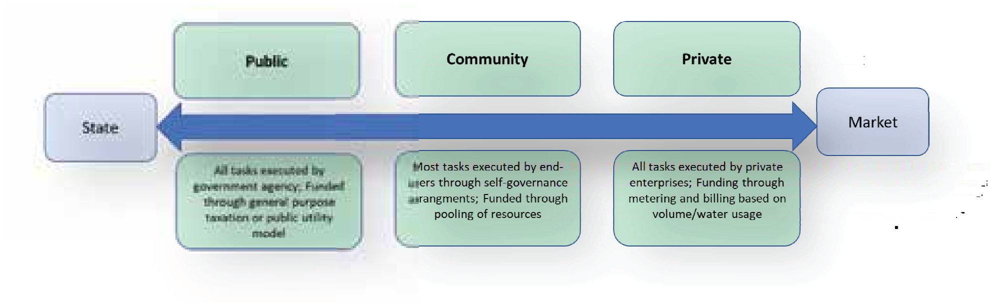

Figure 2: A typology of drinking water service models

Prior to the 1980s, most forms of RDWS governance in low- and middle-income countries relied predominantly on public agencies with the exclusive responsibility to plan, construct, operate and maintain (Harvey & Reed, 2006). However, the realization that pure public service models were largely inefficient due to fiscal constraints, a lack of knowledge of communities' needs and preference, and corrupt civil servants" (Isham&Kähkönen, 1998) led to a search for alternative service models.

As of the 1980s, under the flag of a neo-liberal paradigm, international lending institutions, often together with national governments, began to see the privatization of water management as a means to increase the efficiency of water use (Boelens&Zwarteveen, 2005). However, by the turn of the century, the realization kicked in that privatization was not the silver bullet that it was once hoped to be. Responses to the impact of privatization on coverage and equitable access remain contested (Prasad, 2006).

As a consequence, with donors, international NGOs, and policy makers warming to the idea of community participation, as of the early 2000s, interest emerged in so-called community management models, where communities operate and maintain the RDWS largely by themselves. However, quoting Reddy et al. (2010) and Baumann (2006) – who point at the high rate of community management failure in Sub-Saharan Africa and Asia – Hutchings et al. (2015) raise valid questions about the ultimate effectiveness and sustainability of the community management model. Quoting Lockwood and Smiths (2011, p.1), Hutchings et al. (2015, p.153) state that "*for too long the assumption that consumers can run their own water supply has led to situations of 'communities unable to cope with management of their schemes, poor maintenance, lack of financing, breakdowns, poor water quality, lack of support and, ultimately, an unreliable and disrupted supply of water to households*."

Carter et al. (1999, p.296) hold that for community management models to work, among other things, arrangements for support of community-level organization should be clearly set out. Also, Harvey and Reed (2007, p.365) hold that "[i]*f community management systems are to be sustainable, they require ongoing support.*" With this now recognized need for community support in mind, both scholars and practitioners set out to explore what it could or should look like. Hutchings et al. (2015) and Hutching et al. (2017) provide an excellent overview of the literatures and have conceptualized 'support' in the context of community management models. Relevant concepts identified include 'community management plus' (Baumann, 2006), post-construction support (Bakalian & Wakeman, 2009), and institutional support (Lockwood, 2002), among others.

In this study, we look in particular at NGO-supplied drinking water infrastructure projects that include collective action development components. Collective action refers to activities taken by a group of people in pursuit of a shared interest or a common objective (Olson, 1965).The evidence suggests that shared resource users often face collective action dilemmas that are difficult for them to overcome, independently (Ostrom, 1990). Therefore, external actors – such as NGOs – are often called upon to support or consolidate collective action among shared resource system users.

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We still seem to know little about the precise role and impact of external actors – in particular NGOs – in initiating the kind of collective action in which the end-users need to engage in order to govern a shared resource sustainably (but see Andersson, 2013; Barnes & Van Laerhoven, 2013, 2015; Wright & Andersson, 2013). There is scant evidence of what NGOs working on DWSs do with regard to collective action, why they choose to engage in particular actions, and whether their actions have an impact on the ability of DWS end-users to act collectively regarding drinking water provision, either on a day-to-day basis or in the long run. Consequently, we address the following two research questions in this study: (1) To what extent does NGO support address the requirements for day-to-day and long-term collective action? (2) To what extent does NGO support have an impact on the requirements for collective action? To answer these research questions, we studied a DWS called Managed Aquifer Recharge (MAR)[1] in Bangladesh, a country where NGOs have a long history of involvement in the support of communities with specific regard to drinking water (e.g., Abedin and Shaw, 2018; Peters et al., 2019).

Requirements for organizing day-to-day and long-term collective action

The organization of collective action in a context of shared resource systems such as a DWS is complicated by what are called *provision* and *appropriation* dilemmas (Ostrom, 1990). Individual users face a

[1] For more details on MAR, see below (methods section).

provision dilemma, as costs related to the investment in a resource system (e.g., users investing effort or resources in community management activities) are private costs, whereas the benefits of the joint investment (e.g., a well-working DWS) are shared among the group of users of that system. As a result, rational actors tend to under-invest in the provision of the system. *Appropriation dilemmas* occur because the benefits related to the extraction of harvestable units from a system (water, in the case of a DWS) are private benefits, whereas the costs of this extraction (e.g., decreasing the resource system's production capacity) are shared among the whole group of resource users. As a result, rational actors tend to over-harvest units (e.g., water) from the system.

These dilemmas make it extremely difficult to organize the type of collective action among end-users that is essential for a successful co-production arrangement for a DWS. Consequently, external actors such as NGOs, ranging from local community-based organizations to large international organizations, can be found supporting local communities to organize the type of collective action deemed necessary for the governance of their shared resource systems (Andersson, 2013; Barnes & Van Laerhoven, 2013, 2015; Barsimantov, 2010; Beitl, 2014; Espinosa-Romero et al., 2014; Jones, 2013; Wright & Andersson, 2013; Van Laerhoven & Barnes, 2014).

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Some studies consider NGOs a viable alternative to both the government and private enterprise for promoting development, reducing poverty, and empowering the marginalized (Johnson & Prakash, 2007; Lewis, 2014; Mitlin et al., 2007). However, a more critical strand in the literature on NGOs questions whether NGOs can make a difference with regard to these issues (e.g. Fisher, 1997; Banks et al., 2015; Bebbington, 2004).

Research on the impact of NGO support for organizing the potential for collective action by the end-users of a shared (natural or manufactured) resources system – i.e., investigating how they approach this task and how effective their support is – is relatively new (e.g., Barnes & Van Laerhoven, 2013, 2015; Andersson, 2013; Wright & Andersson, 2013; Barsimantov, 2010; Espinosa-Romero et al., 2014), and the findings of the studies that have been conducted so far seem inconclusive. Moreover, we have found no studies into the impact of NGOs on the end-users' capacity for collective action in the specific context of local DWSs.

We know the approximate conditions under which local people are more likely to engage in collective action with respect to the provision of and the appropriation from a shared resource system. According to Poteete and Ostrom (2004), *functioning collective action* is characterized by the following requirements: (i) *regular meetings*; (ii) the presence of *rules* on (a) entry, (b) appropriation;

and (iii) the presence of a *system to enforce the rules* by means of (a) monitoring, (b) graduated sanctioning, (c) the monitoring of monitors, and (d) low-cost adjudication. Based on Ostrom's 'design principles' (1990) and on the work of Wade (1988) and Baland&Platteau (1996), Agrawal (2001) compiled a list of 35 critical enabling conditions for the long-lasting community-led governance of shared resources. Upon realizing that only some of the conditions easily lend themselves to being manipulated by NGO interventions, Barnes and Van Laerhoven (2015) derived from this list a sub-set of preconditions for durable collective action in the specific context of community forestry in India. This list was in part based on their realization that "it appears that in broad strokes, sustainable forms of collective action are characterized by knowledgeable actors that have management and communication skills, plus sufficient material and financial resources" (p. 195). We adapted the list such that it more accurately reflects the sector-specific and place-specific circumstances. We derived the following requirements for day-to-day (i.e., functioning) and long-term (i.e., durable) collective action in the specific context of governing shared DWSs (Table 1).

Table 1: Requirements for day-to-day and long-term collective action among DWS users

Requirements	**Description**	**References supporting the indicators**
	Requirements for day-to-day collective action	
Regular meetings	Resource users have an arrangement of regular meetings in place to discuss the issues related to the operation and maintenance of the resource system	Poteete & Ostrom, 2004
Rules-in-use		
(a) on entry	There is a clear arrangement regarding who has access to the resource system	Poteete & Ostrom, 2004
(b) on appropriation	There are rules in place regarding who can extract how many resource units, and when	Poteete & Ostrom, 2004
Rule enforcement		
(a) monitoring system	There is a mechanism in place to monitor the resource use and rule compliance	Ostrom, 1990; Agrawal, 2001; Nagendra &Ghate, 2005
(b) (graduated) sanctioning system	There is a mechanism in place to punish rule breakers	Ostrom, 1990; Agrawal, 2001

Requirements	Description	References supporting the indicators
(c)the monitoring of monitors	There is a mechanism in place to hold monitor/s accountable to the resource users.	Ostrom, 1990; Agrawal, 2001; Nagendra & Ghate, 2005
(d) low-cost adjudication	There is a low-cost system in place to resolve conflict between users	Ostrom, 1990; Agrawal, 2001
Requirements for long-term collective action		
Understanding of relevant policies	All resource users understand the rules and policies guiding the management of the resource system	Gomes et al., 2018; Ghate, 2009;
Participation of users in decision-making	General users – not only committee members – have the opportunity to participate at all levels of the decision-making process regarding DWS governance	Agrawal, 2001; Baland and Platteau, 1996; Rydin & Pennington, 2000
Management capacity of resource users	Resource users have the technical and managerial skill and knowledge required to manage and operate the resource system	Ostrom, 2005; Gomes et al., 2018
Fair allocation of benefits	There is a system in place to fairly allocate the benefits associated with the resource among the users	Agrawal, 2001; Dayton-Johnson, 2000; Baland and Platteau, 1996; Ostrom, 1990

Requirements	Description	References supporting the indicators
Ability of users to pay	The users have sufficient financial means to pay for the operation and maintenance of the resource system	Barnes and Van Laerhoven, 2015; Gomes et al., 2018
Willingness of users to pay	The users are willing to pay for the operation and maintenance of the resource system	Islam et al., 2019
Awareness of users	All the resource users are aware of the resource system, its operation and maintenance rules and the activities of the committee that is responsible for resource management	Cundill and Fabricius, 2009
Dynamic leadership	Leadership is closely familiar with the changing external governance environment, has frequent interactions with resource users and regular contact with local traditional leaders	Baland and Platteau, 1996; Lobo et al., 2016
Supportive external environment	The autonomy of users to manage their resource system is not undermined by any external authority	Agrawal , 2001; Pomeroy et al., 2001

When supporting the end-users of DWSs, do NGOs target the requirements that various sources in the literature claim they should be targeting (and what are the reasons for their choice)? Does NGO support targeting these requirements have the expected impact on day-to-day and expected long-term collective action? We kept these questions in mind when deciding on the research methods.

Methods

Our research is set in Bangladesh. Hoque (2009) finds that in Bangladesh between 15-30 million people lack year-round access to safe drinking water. In the research area in particular (see figure 1), drinking water is scarce due to salinity intrusion, arsenic contamination, tidal surges and drought (Mahmuduzzaman et al., 2014). The main sources of drinking water in this area are surface water from ponds, pond sand filters (PSF), and the rain water harvesting systems (RWHS). Generally, neither the shallow nor the deep tube-well is feasible due to a lack of suitable aquifers at reasonable depths (Hoque et al., 2004).

The governance of most rural drinking water systems in Bangladesh has a history of community involvement (see Sultana, 2009). Bangladesh's National Policy for Safe Water Supply and Sanitation (1998) calls for community participation in the governance of drinking water systems and invites support from external actors, including local NGOs. Traditionally, water vendors created market opportunities based on pricing the *distribution* of drinking water. However, the *production* of water through community DWSs is hardly ever based on a commercial business model. In the previous decade pond sand filters (PSF) were installed in the study area by a local NGO (Shushilon) with funding from the Word Bank. Rain water harvesting and storage systems have also been promoted by different international NGOs and projects. Currently, another NGO (Rupantor) is implementing reverse osmosis (RO) systems, also with financial support from international donors. Anecdotal evidence suggests that the community management of such systems has mostly underperformed.

In order to keep control variables constant, we focus on one particular DWS, namely the Managed Aquifer Recharge system (MAR), that has recently been introduced in three southwestern coastal districts: Khulna, Satkhira and Bagerhat (Figure 3). A MAR is a community-based DWS that is supposed to ultimately be operated and maintained by the local community.

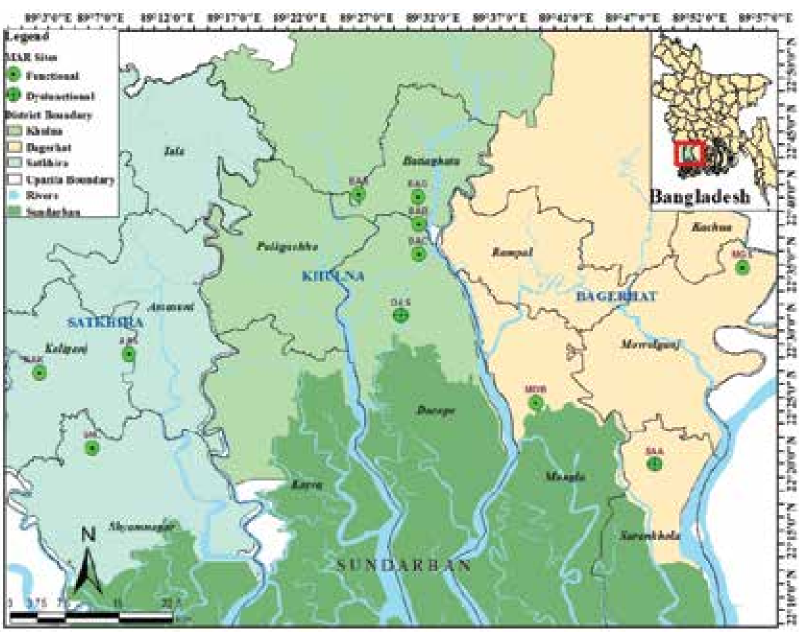

Figure 3: Study area

In a MAR system, water is collected from ponds and rooftop rainwater. After passing through a sand filter, the water is infiltrated into the aquifer to create a bubble of fresh water. Users can subsequently abstract the water using standard hand tube-wells. Compared to other major systems in the area, MAR is contamination- and cyclone-proof, and it is reliable as it provides water in sufficient quantities throughout the year. In terms of installation costs, MAR is considerably less expensive than the available alternatives. It is also relatively easy to operate.

As is the case with most drinking water technologies in developing countries, external actors played a major part in the introduction of MAR. In 2009, a consortium of Dhaka University's Geology Department (DU), the Department of Public Health Engineering (DPHE) and Acacia Water (AW, a Dutch consultancy firm) started implementing MAR in the coastal areas as part of a pilot[2]: DU was responsible for selecting the sites, based on geohydrological and socio-economic indicators. DU, together with AW then provided a site-specific design. The MARs were built by DPHE. UNICEF and

[2] As MAR has only recently been developed to fit the Bangladesh context, and given the fact that the introduction is in its pilot phase, still, the technology cannot be purchased on the local market, yet. This also requires inquiry into institutional design and enablers to set up collective action.

the Dutch Embassy in Bangladesh provided the funding. Given the pilot character of the MAR project, contrary to some other existing drinking water systems in the area (such as pond sand filters) local governments – i.e., Upazila Parishad and Union Parishad – have no formal role in the governance of MAR, yet. However, we observed that sometimes local governments engage themselves informally (e.g., with regard to site selection, liaising with DPHE on behalf of the community, or granting time to awareness-raising and community mobilization efforts during local government meetings).

DU and DPHE started by consulting with community leaders and local government representatives to gauge local drinking water needs and preferences - i.e., in theory, prospecting communities are given the choice to opt in or out. In case of an apparent match between supply and demand, DU and DPHE proceeded to organize a plenary meeting with prospecting MAR users in the community, to discuss respective roles and responsibilities. Emphasis was put on preparing users to ultimately carry out a community management model. In parallel, DU proceeded to engage with local stakeholders to select the most appropriate site – this could be on the premises of the local school, on public or on private land, depending on geohydrological suitability and/or the willingness of land owners to have a MAR system built on their land.

Given that MAR systems were not built-in response to an explicit community demand, the project consortium did not expect local communities to become meaningfully engaged in MAR community management without some form of support. In 2013, the DU signed a memorandum of understanding (MoU) with seven NGOs (Tolk et al, 2014). Six are local NGOs with a staff of between 16-55, the seventh is a national NGO with a staff of 666. The NGOs were instructed to provide support to the community with regard to site management, community mobilization, technical supervision, capacity building, the development of guidelines for operation and maintenance, and building relationships with local government entities . However, the NGOs had considerable discretion regarding the implementation of these tasks and responsibilities. Thus, it was expected that community management models could be tailored to the needs and preferences of the community.

From 2009-2015, a total of 20 MARs were installed as part of a pilot project. Given our interest in the effect of NGOs on communities' collective action capacity, we chose to work with the eleven MAR sites that had been handed over to community management by the time of our data collection (Table 2)[3]. Of our sample of eleven MARs, two had already ceased functioning by the time of our data collection. In both, the abandonment was triggered by a technical

[3] At the time of our data collection, at nine out of the 20 installed MARs, NGOs were still in the process of completing the community support activities. Hence, the complete hand-over of these sites to the communities was still pending.

problem that required major repair work. A combination of lack of knowledge and resources, but above all the availability of other affordable drinking water alternatives in the localities, seems to have led to the collapse of the MAR. We found little variation in terms of performance between the remaining nine functioning MAR sites.

Table 2: MAR sites in our study

District	**Upazila (Sub-district)**	**Union Parishad**[4]	**MAR sites (#)**	**Respondents (#)**	**Households using MAR (#)**
Khulna	Batyaghata	Gangarampur	2	10x2=20	50+50=100
		Surkhali	1	10	50
	Dacope	Chalna	1	10	60
		Kamarkhola	1	10	60
Bagerhat	Mongla	Sundarban	1	10	50
	Morolganj	Hoglapasha	1	10	50
	Shoronkhola	Dhansagor	1	10	60
Satkhira	Kaliganj	Kusholia	1	10	50
	Ashasuni	Sreeula	1	10	50
	Shyamnagar	Shyamnagar	1	10	60
Total	**8**	**10**	**11**	**110**	**590**

[4] A Union Parishad is smallest rural administrative and local government unit in Bangladesh

In the guidelines drafted by the consortium running the pilot, it is stated that the MAR user group must select a caretaker, to be paid by the users, for the day-to-day operation of the system. A user committee consisting of 5-7 members (at least one of whom should be female) is to be elected by all users. The committee should meet once every month, and it should collect a monthly fee from all users to cover operational and maintenance costs (including the caretaker's salary). Households are to contribute approximately 30 Bangladesh taka (approximately US$0.40) per month (however, in practice, we find that actual payment varies from household to household based on the households' economic status). The user committee is to open its own bank account to manage its finances. Furthermore, the committee is expected to take responsibility for monitoring the technical operation of the MAR and its users' behavior, and to resolve any conflict that may occur. MAR water can only be used for consumption (drinking and cooking), and not for irrigation or other purposes. In case of major technical problems, the DPHE is expected to help repair the MAR.

Between October 2017 and January 2018, we organized eleven focus group discussions (one for each site) with local MAR users, including user committee members. Each session was attended by at least 10 participants drawn from both the user committee and

5

general users[5]. We purposefully aimed for active participation by females, as they are their household's main water managers. At each site, we also conducted in-depth, semi-structured interviews with the chairperson of the user committee. In addition, we conducted semi-structured interviews with a total of 15 NGO staff members (in their headquarters and in field offices), who together represented all seven local NGOs responsible for supporting local governance of the eleven MARs in our sample. We also interviewed four Dhaka University MAR officials, and we held informal discussions with the local social elite (an average of two people per site) and eleven local government officials (i.e., Union Parishad elected representatives). When we found persistent differences or contradictions in the information extracted in these ways, we gave priority to the community's response. Table 3 provides an example of how data on one of the criteria ('regular meetings') was collected by means of survey questions or a topic list from members of the users committee and NGO representatives, respectively[6]. Additionally, data was collected by reviewing official documents, field reports, and annual reports at Dhaka University's MAR office and the NGO offices.

[5] We excluded the committee's chairperson when discussing the chairperson's performance (for example when reviewing participation of all users in decision-making, the fair allocation of benefits, and dynamic leadership).

[6] Questionnaires used for this research can be provided upon request.

The data gathered in this way allowed us to establish if the NGO had targeted a specific requirement for collective action. The set-up of both surveys allowed us to triangulate: In case an NGO claimed to have undertaken a certain activities, but the community stated that the NGO didn't, we opted for the community response. The data furthermore allowed us to establish whether a requirement for collective action appeared to be met in a community (e.g., Do users meet regularly? Are there rules on entry? Etc.). The discussions that resulted from the surveys and topic list, and the document reviews led to a wealth of additional details that were interpreted qualitatively through coding principles based on the requirements listed in table 1.

Table 3: Operationalization of criteria: example

Criteria	**Description**	**Interview topic list for focus group discussion with MAR users**	**Interview topic list for NGO representatives**
Regular meetings	Resource users have an arrangement of regular meetings in place to discuss the issues related to the operation and maintenance of the resource system	• Do/did you have user committee • If yes, how did the user committee get selected in this community? • Does it have female members? • Does it meet? How frequent? • Did you receive support from an NGO with regard to establishing a committee? What did the support consist of?	• Does/did this community have a user committee? • If yes, how did the user committee get selected in this community? • Does it have female members • Does it meet? How frequent? • Did you provide support with regard to establishing a committee? What did the support consist of? • If not, why not?

Our data collection was driven by our objective to operationalize the requirements listed in Table 1. First, we looked for variation in the way in which the NGOs addressed the requirements, as well as in the extent to which they did so. Second, we looked for correlations between reported NGO activities geared towards certain requirements and currently ongoing community action regarding the same requirements. Based on our findings, below we discuss the impact of NGOs on collective action capacity of DWS users.

Results

We will first present an analysis of the types of support offered by the NGOs in an attempt to increase potential for local collective action. We will then present an analysis of the impact of this support.

Analyzing types of NGO support

NGO support for day-to-day collective action

Within our sample of MAR sites, of the seven enabling requirements we identified as representing day-to-day collective action (see Table 1), only four were reported to be targeted by NGO support (Table 4).

Table 4: NGO support addressing the requirements for day-to-day collective action

	Requirements for day-to-day collective action (# of NGOs)	Reported NGO activities
All sites (11)	Rules on monitoring (11)	Setting up and running a monitoring system with users, and gradually handing it over to the community
Most sites (6-10)	Regular meetings (9)	Convening monthly meetings with the user group; Providing informal guidelines for the continuation of monthly meetings
	Rules on entry (7)	Conducting household surveys to assess (i) willingness to join and (ii) household drinking water needs; Selecting 50 to 60 prospective households based on the outcome of the survey
	Rules on appropriation (9)	Providing formal (written) and informal (verbal) instructions on MAR operation and maintenance
Few sites (≤ 5)	n.a.	n.a.
No sites	Graduatedsanctions	n.a
	Availability of low- cost adjudication	n.a.
	Accountability of monitors and other officials to users	n.a.

In all eleven sites in our sample, NGOs were found to have supported the creation of a monitoring mechanism. They provided the communities with monitoring guidelines on the usage of the MAR, on the payment of fees (to support the caretaker and to cover repair expenses), on the functionality of the system, and on the performance of the caretaker. They took the lead in setting up and running the MAR, after which it was gradually handed over to the users.

In most of the sites (9), NGOs helped MAR users to arrange and hold regular meetings. The creation of a functioning meeting structure was mostly stimulated by (i) NGO officials directly convening meetings, (ii) providing informal guidelines and (iii) motivating people to continue to hold such meetings. The guidelines included advice on roles and responsibilities (for example of users and committee members, specific leadership roles, and the composition of the committee), topics for the agenda (regular versus emerging issues), and decision-making procedures (quorum rules, discussion rules, and expression of opinions).

At most of the sites, we also found that the NGOs supported MAR users in drawing up rules on entry (7) and appropriation (9). This was done by first surveying households to assess their water needs and their interest in joining, and subsequently selecting 50-60 prospective households and providing them with formal (written) and informal guidelines for MAR use.

The reason for focusing on these particular forms of support appears to be related to the content of the MoU instructions as well as to the core values of the NGOs, as is illustrated by the following quote from an NGO official:

"Apart from a clear instruction from the MAR implementing authority to provide the users with necessary guidelines on entry, appropriation, regular meetings and monitoring the enforcement of guidelines of MAR, we focus on these guidelines as we also found these crucial for the sake of a smooth operation and maintenance of MARs"

Conflict may occur, for example when certain individuals tap too much water or do not contribute the agreed upon fees. Sanctioning mechanisms to penalize people who do not abide by the rules is often mentioned as a critical factor in rule enforcement in the context of shared resource management (e.g. Ostrom, 1990). None of the NGOs was found to support MAR users in developing a graduated sanctioning and/or a low-cost adjudication system. NGO representatives mentioned that they preferred not to deal with issues related with conflict and sanctioning, as this was seen as potentially stirring up tensions regarding local politics, socio-economic relations, or cultural–religious identities. One high-level NGO official remarked that:

"We cannot provide any sanction and conflict resolution mechanism to the community as there is hierarchy and heterogeneity among the local users related with political identity, economic status, clan, religion, gender, etcetera. If we

were to do so, this might be used against the poor and weaker section of the community. However, we can impose such kinds of sanctions and conflict resolution mechanisms on the community people and force them to follow those rules if they [the sanctions] *are registered under a certain formal body."*

In none of the sites were the NGOs found to have contributed to the development of mechanisms for holding monitors accountable. NGO representatives saw this as the responsibility of the MAR users themselves. When pressed, some NGO representatives reported that the voluntary nature of MAR monitoring made it difficult to urge MAR users to monitor the monitors.

What is striking in these results is the top-down nature of much of the reported NGO support regarding meeting the requirements for day-to-day collective action: the guidelines and instructions are imposed rather than developed together with the communities. The NGOs appear to rely on what Barnes and Van Laerhoven (2015, p.196) call an objective approach to institutional design: "The NGO itself is the primary change agent. Activities are focused on creating incentives through designing institutions. It applies a generic approach, imposing institutional arrangements that have proven to work elsewhere."

5

NGO support for long-term collective action

Our results indicate that NGOs seem to emphasize the support of long-term collective action requirements. Of the nine requirements we identified as representative of requirements for long-term collective action, no less than eight were targets of NGO support (Table 5).

Table 5: NGO support addressing the requirements for long-term collective action

	Requirements for long-term collective action (# of NGOs)	**Reported NGO activities**
All sites (11)	Management capacity of resource users (11)	Training the caretaker; providing basic tools
	Dynamic leadership (11)	Training the chairperson of the user committee; organizing workshops with committee chairpersons; connecting the user committee chairperson with local governments and agencies

	Requirements for long-term collective action (# of NGOs)	Reported NGO activities
Most of sites (6-10)	Understanding of relevant policies (8)	Conducting monthly meetings with user groups; organizing workshops with the user committee chairperson
	Participation of users in decision-making (9)	Providing informal advice to the user committees; motivating user committees to include the general users in decision-making processes
	Ability of users to pay (10)	Assisting the user group in collecting community contributions (to cover operational costs and set up emergency funds); setting up a monthly payment structure; Providing material support
	Willingness of users to pay (9)	Motivating users through monthly meetings with them; informal household visits

	Requirements for long-term collective action (# of NGOs)	**Reported NGO activities**
	Awareness of users (9)	Meetings at the Upazila (sub-district) premises involving local administrator, local government representatives, DPHE officials and local people; monthly meetings (i.e., tea stall meetings, yard meetings, mosque meetings) with the user group; Bi-weekly meetings with female users; bi-weekly sessions with teachers and students at educators; regular door-to-door visit to households; Handing out leaflets to local people; banners on MAR in the villages
	Supportive external environment (9)	Advocacy and lobbying with external actors (i.e. Dhaka University MAR office, DPHE, local administration, and local government representatives, etc.)
Few sites (≤ 5)	n.a.	n.a.
No sites	Fair allocation of benefits	n.a.

At all sites in our sample, the NGOs were found to have aimed at supporting the management capacity of MAR users by giving formal and informal training to caretakers on the operation of the motor, cleaning the MAR equipment, bookkeeping, collecting monthly fees from the users, and providing basic tools for testing water quality and minor repairs. In addition, at all eleven sites the leadership qualities of committee chairpersons were targeted by means of workshops on mobilizing community people connecting with local governments and relevant government agencies.

Moreover, at eight of the eleven sites in our sample, the NGOs were reported to have targeted their support at increasing MAR users' understanding of relevant policies. They aimed to do so by means of monthly meetings with the user group and by organizing workshops with the user committee chairperson.

At nine sites, the NGOs aimed to ensure that general users participated in making decisions about the governance of the MAR. This was done by giving informal advice and by motivating the user committee to involve general users in major decisions.

At nine sites, the NGOs were found to have tried to enhance the ability of MAR users to contribute financially to the operation and maintenance of their DWS. To that end, the NGOs assisted user groups in collecting financial contributions from the users. They were reported to have helped set up a monthly payment system to cover the costs of the day-to-day operation and maintenance of the MAR and to have suggested that user groups create an emergency fund as a buffer for covering major repairs. They also provided some material support. We found that at eight sites the NGOstried to boost users' willingness to pay for MAR operation and management, for example by means of monthly meetings with users and frequent household visits.

At nine of the sites in our sample, the NGOs were found to have targeted user awareness of the system, the rules, and the role of the user committee. They did so through (1) meetings on the Upazila (i.e., sub-district) premises, which involved local administrators, local government representatives, DPHE officials, and local people; (2) monthly meetings (i.e., tea-stall meetings, yard meetings, and mosque meetings) with user group members; (3) bi-weekly meetings with female users; (4) bi-weekly sessions with teachers and students; (5) frequent door-to-door household visits; and (6) distributing leaflets and banners.

In nine MAR sites, the NGOs had supported users by ensuring the support of external actors by means of advocacy and by lobbying the Dhaka University MAR office, the DPHE, and the local administration.

None of the NGOs was found to have supported the users in developing the mechanism for the fair allocation of benefits from the MAR. NGO officials pointed out that they did not see this as their responsibility, adding that users can create such a mechanism themselves. One NGO official pointed out:

> *"Community people are better positioned to set up mechanisms for the fair allocation of MAR water. We cannot do this because different families have different financial means and different numbers of family members, resulting in different drinking water requirements. A poor family with many family members needs much water but cannot afford to buy it from outside. If we were to impose a mechanism of water usage, then those poor people would be likely to suffer".*

The NGOs seemed to give more emphasis to the requirements we have associated with long-term collective action than to those related with day-to-day collective action. They appeared less willing to become involved in issues that are or may be controversial due to strong local norms and values (i.e., sanctioning, conflict resolution, and fair allocation of resources).

Again, what strikes us – as also noted above with regard to NGO support targeting day-to-day collective action – is that most forms of NGO support relating to long-term collective action seem to be based on a top-down, objective approach to institutional design. We found no evidence of NGOs working jointly with user groups to craft tailor-made solutions. When asked, the NGOs indicated that the manner in which they deploy their activities and target the requirements for collective actions is partly rooted in routines and experience gained in previous situations. This is illustrated by the following quote from an NGO representative:

> *"Along with carrying out instructions of the implementing authority* [i.e., the Dhaka University MAR office]*, we also implemented other community mobilization and capacity development activities based on our previous knowledge and experiences in these regards".*

Analyzing the impact of NGO support for collective action

After having established whether, how, and why the NGOs targeted what we consider to be key requirements for collective action, we now explore whether their work can be argued to have had an impact on the ability of MAR users to sustainably govern their shared resource system. We do this by relating the reported NGO support (section 4.1) to evidence of MAR users continuing to meet the requirements for day-to-day and long-term collective action, also after the NGOs have withdrawn and MAR users no longer have their assistance. In Figure 4, any box that combines a green area with a yellow area indicates a relationship established between NGO support (green) and a community continuing to meet the given requirement after NGO support has stopped (yellow). In case of a relationship, we try to determine its cause, based on data retrieved from focus group discussions with MAR users and in-depth interviews with NGO officials.

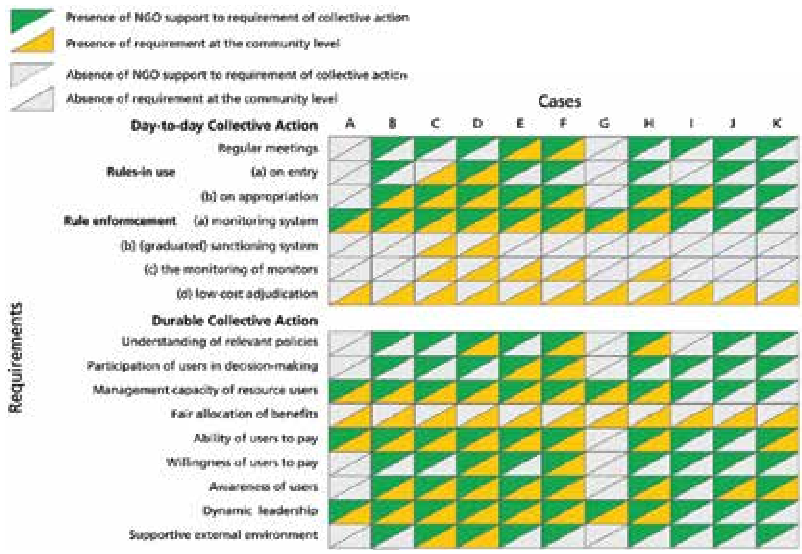

Figure 4: Apparent impact of NGO support to requirements of day-to-day and long-term collective action

The impact of NGO support on day-to-day collective action

In all eleven sites, the NGOs supported user groups in developing a set of formal and informal monitoring rules. At eight sites, MAR users continued to have monitoring rules even after the withdrawal of the NGO. There were nine sites where we found evidence of NGO support regarding the design of appropriation rules; at seven of these, such rules were still in place after the withdrawal of the

NGO. This occurrence of community action with regard to appropriation and monitoring rules is attributable to NGO support. In a focus group session with users, a schoolteacher remarked that:

> *"There were some rules for regulating appropriation and monitoring that we initially could not understand. After the NGO explained the rules during various meetings, we can understand them more easily".*

This quote also illustrates the top-down or objective approach to institutional design, as generically designed rules are imposed and then explained, rather than crafted by the empowered community itself.

NGO support regarding entry rules and regular meetings is much less strongly associated with ongoing community attention to these requirements. At only two of the nine sites where NGO support for regular meetings was found were meetings still held regularly. Moreover, at only two of the nine sites that received support did we find evidence of entry rules still in place. Respondents reported that the meeting structure imposed by the NGOs did not match well with the daily schedules and priorities of the proposed attendees. The entry rules resulting from NGO support proved ineffective due to social and religious factors: most of the NGO officials stated that it is almost impossible to restrict local people from accessing MAR. As one high-level NGO official pointed out:

> *"Although we make an exclusive list of households that are allowed to use MAR, in reality, many people beyond that list use MAR water. Social norms and values do not allow anybody to restrict people from accessing to MAR water"*.

Impact of NGO support for long-term collective action

The NGOs engaged in capacity-building activities at all eleven sites. At eight, we found evidence of sufficient management capacity among users. It seems reasonable to claim that NGO support contributes to the present-day management capacity of MAR users, particularly the caretakers. In a focus group discussion with users, a participating caretaker remarked that:

> "*NGO officials trained us in operation and maintenance procedures of MAR and they also frequently came to us to show MAR's operation and maintenance procedures. As a result, some of us now can operate and maintain this MAR site properly"*.

It is more difficult to explain the strong association between the eleven sites that have benefited from NGO support regarding dynamic leadership and sites where we found evidence of ongoing dynamic leadership, as the NGOs did not select MAR leaders randomly but instead worked with local leaders who arguably already had leadership qualities. Nor is it easy to explain the relationship between NGO support to increase MAR users' ability to contribute financially (ten sites) and the ongoing ability of users to pitch in (eight sites), as our surveys revealed that the NGOs tended to list households with sufficient financial means to participate in MAR initiatives.

The NGOs put much emphasis on awareness raising, which seems to have been part of their core business, independent of their involvement with MAR. At eight of the nine sites where we found evidence of NGO support for this requirement, MAR users still showed evidence of high awarenessafter the withdrawal of the NGO. As with capacity building, this association is unsurprising. One elected representative of Union Parishad (the lowest tier of local government) stated that:

> *"NGOs had frequent meetings and sessions with us where they told us about the background of MAR, MAR water quality, operation and maintenance procedures, the role of the users committee and their responsibilities. Before the NGOs' programs, we knew nothing about MAR".*

Although at eight sites the NGOs supported the requirement that users are to understand relevant policies, we found evidence of sufficient continued comprehension of the policies at only three of the sites. MAR users suggested that the NGO staff were not well informed about policies themselves, a contention that was partly corroborated in our interviews with NGO representatives.

Attempts to guarantee the structural inclusion of all MAR users in decision-making – a requirement for long-term collective action that is prominently mentioned in the literature – were part of NGO support activities at nine of our sites. However, we found evidence of continued participation of all users in decision-making at only two sites. NGO officials and MAR users both attributed the failure to establish a more inclusive form of MAR governance to the prevailing hierarchy, according to which decisions are virtually always made by the local elite.

We found that at nine sites the NGOs had been making an effort to increase the willingness of MAR users to contribute financially, but at only two sites did we find evidence of continued willingness to pay. Most NGO officials stated that they lacked the time and resources to conduct adequate motivational activities (an argument that underlines the blurred boundary between NGOs and consultants). In addition, people have long been used to having free drinking water. In this respect, a high-level NGO official remarked that:

> *"The time and resources we got for motivating the MAR users were in no way enough. Most people of this area have long been accustomed to using drinking water from ponds and rain for free. For orienting and motivating them to a new technology like MAR and make them willing to pay for MAR water, it takes more time and effort that we did not get in this project".*

Attempts by NGOs to create a supportive external environment also appear to have had little impact in most cases: only two of the nine sites where we found evidence of NGO activities targeting this reported that they saw the support from local governments (i.e., the Upazila Parishad and Union Parishad) and government agencies (e.g., the DPHE) as constructive. Many of our NGO respondents attributed this limited impact to the fact that local governments had not been assigned a formal role in the design of the MAR pilot project.

Discussion and conclusions

We explicitly set out to study whether and how NGO activities address the criteria that are claimed to be associated with successful collective action in the context of the governance of a shared resource. We were also interested as to whether such NGO activities have an impact on the extent to which communities ultimately meet these criteria. To this purpose, we derived a set of putative requirements for day-to-day and long-term collective action from relevant empirical literatures. Although it was explicitly not our goal to test whether or not meeting these criteria does ultimately lead to improved RDWS performance, a quick scan of the of the system components' performance seems to suggest that there is a correlation between the extent to which requirements for collective action are met, on the one hand, and stock, flow, and actor performance, on the other (table 6).

Table 6: Rural drinking water system (RDWS) performance

	Stock performance*	Flow performance**	Actor performance***	Governance performance****
A	Moderate	Moderate	Moderate	Moderate (2, 4)
B	High	High	Low	Moderate (3, 5)
C	High	Moderate	Low	High (6, 6)
D	High	High	Moderate	High (6, 8)
E	High	High	Moderate	High (5, 6)
F	Moderate	Moderate	Moderate	High (5, 8)
G	Moderate	Moderate	Low	Low (2, 3)
H	Moderate	Low	Low	Moderate (4, 6)
I	Moderate	Moderate	Low	Low (2, 1)
J	Low	Low	Low	Low (1, 2)
K	Low	Low	Low	Low (1, 3)

Data source: Stock performance and actor performance scores are based on interview data. Flow performance scores are obtained from Dhaka University's Geology Department. Governance performance scores are based on the analysis presented in this paper (see in particular figure 4.)

* Stock performance: low = has not supplied water during the last 6 months; moderate = supplies water during some time of the year; high = supplies water uninterruptedly.

** Flow performance: low = iron, arsenic and salinity levels exceeding acceptable levels; moderate = iron, arsenic and salinity present but at acceptable levels; high = water is free of iron, arsenic and salinity.

*** Actor performance: low = very few users are willing to contribute money, time and labor; moderate = some users are willing to contribute; high = many user are willing to contribute.

**** Governance performance: low = between 0-5 of the requirements for collective action are met; moderate = between 6-10 of the requirements are met; high = between 11-16 of the requirements are met. (In parentheses the number of requirements for day-to-day, and long-term collective action, respectively, are reported.)

Using multiple methods and sources of data collection we explored whether, how and why NGOs supporting the users of eleven DWSs in Bangladesh targeted these requirements. We then established whether and to what extent DWS users still met the requirements after the NGO’s withdrawal. We used any association between evidence of past NGO support and ongoing user attention for the requirement in question as the basis for determining whether the correlation was causal, in other words, did NGO support actually have an impact?

Regarding the *day-to-day collective action*, we found that in our sample of eleven sites, most NGOs support four of the seven requirements that we listed in this category, namely *rules on entry*, *rules on appropriation*, *monitoring*, and *regular meetings*. The NGOs' support appears to be largely positively associated with the occurrence of community action relating to *rules on appropriation* and *monitoring*. However, the relationship between NGO support and community action regarding *rules on entry* and *regular meetings* was much weaker. Overall, our results suggest that the NGO support has had only minimal impact on day-to-day collective action among the MAR users. This observation is consistent with the findings of Wright and Andersson (2013) and Barnes and Van Laerhoven (2015). Our analysis also shows that NGOs tend not to become involved in sensitive issues. This might account for the lack of reported support for the requirements related to *graduated sanctioning*, *low-cost adjudication*, and the *monitoring of monitors*. The findings are also in line with those from previous studies (e.g., Cleaver 2002; Afroz et al., 2016).

In our study, the NGO support addresses most of the requirements for *long-term collective action*. Eight of the nine requirements we listed under this category are well-covered by NGO support. The exception is *fair allocation of benefits*: none of the NGOs targeted this requirement; yet, interestingly, at all sites there was evidence of users having been able to meet this requirement. There was no one-to-one association between NGO support and the extent to which users were continuing to meet the requirements after NGO withdrawal. Only four requirements (i.e., *management capacity*, *users' ability to pay*, *awareness of users*, and *dynamic leadership*) show a positive association between NGO support explicitly targeting the requirement on the one hand, and ongoing attention to the requirement from MAR users after the withdrawal of the NGO, on the other.

The impact of NGO support on management and user awareness should not come as a surprise; providing training on management tasks and providing information on the ins and outs of the DWS may be expected to have a lasting effect. The ability of NGOs to influence *ability to pay* should be accepted with caution, given a clear selection bias: NGOs seem to prefer working with prospective users that have been found to have sufficient means. Caution is also necessary in relation to the positive relationship found regarding dynamic leadership, as the community members the NGOs targeted for leadership training arguably already possessed leadership qualities. This tendency of NGOs to work with communities that are likely to respond more favorably to their support has been described elsewhere (see Kerr et al., 2002).

The association between NGO support and ongoing community action is much less pronounced for *understanding of relevant policies,users' participation in decision-making*, *users' willingness to pay*, and a *supportive external environment*. We suggest that the lack of impact of NGO support may be related to the quality of the NGO support (e.g., NGO staff who are insufficiently aware of relevant policies), local norms (e.g., no tradition of inclusive decision-making and a history of free access to drinking water), and pilot project design (e.g., not embedding MAR in the existing institutional arrangements from the start).

Overall, we found that the NGOs relied on routines and experiences gathered during previous engagements, during which they focused on capacity building, training, awareness raising, and social mobilization. When working with MAR users, they tended to continue to apply the generic approach that emerged from previous work. As such, we would label many of the NGO support strategies that we encountered in our research as examples of *objective institutional design*, which Barnes and Van Laerhoven (2015) oppose to the alternative of a *subjective institutional crafting* approach. In the latter approach the NGO would consider the target community as the primary change agent. Moreover, this approach aims at facilitating a reflective-dialogic process among resource users with the ultimate purpose of empowering communities (e.g.,

5

through action research techniques) to allow them to define their own problems along with tailor-made preferred, viable solutions. Related to the generic nature of most forms of NGO support that we encountered is the observation that overall there appeared to be no coherent vision of promoting collective action. The NGOs never explicitly or implicitly framed their work and objectives in terms of collective action; they were largely unaware of the progress reported in academic literature on this topic. As a result, their activities targeting the requirements we derived from that literature were often rather ad hoc.

An important caveat that cannot remain unmentioned here, regards the role of historic power relations in community management models. O'Toole and Meier (2004) hold that inclusive or participatory governance is political, i.e. it magnifies the tendency toward inequality already present in the social setting. Also,Swyngedouw (2005) assesses governance-beyond-the state critically: it inherently empowers some while disempowering others and may thus lead a democratic deficit. The fact that community management of shared resources may lead to elite capture, has been documented, before (e.g. Andersson & van Laerhoven, 2007). Sultana (2009) provides a compelling argument regarding how community participation in water resource management in Bangladesh responds to this same logic and may result in exacerbated inequality, for example along gender lines. In our case, community leaders and local authorities served as the first point of entry when MAR was introduced. This approach raises questions about whether site selection and the allocation of leadership roles were based on and subsequently spurred truly inclusive decision-making. However, we argue that this concern is partly addressed by our focus on the analysis of NGOs activities that regard things like the monitoring of monitors, low-cost adjudication, participation of users on decision-making, and the fair allocation of benefits.

What we have gained in terms of internal validity is – as mostly happens with case study designs (see Gerring, 2006) – offset by what we have lost in terms of external validity. External validity is also compromised by the fact that our sample consists of cases from one single project. Consequently, we are limited in our ability to extend our analysis results beyond the specific context that we studied. However, we place ourselves in a tradition of scholars keeping track of the interface of theory and practice in the specific context of developing the collective action potential of communities of commoners (see e.g., Andersson, 2013; Barnes & Van Laerhoven, 2013, 2015; Wright & Andersson, 2013). With this caveat in mind, we propose the following recommendations.

In view of our findings, we recommend that NGOs prioritize the support of collective action among the users of shared resource systems – DWSs in particular – over more conventional forms of support that focus on knowledge transfer (such as training, capacity building, and awareness raising) and resources (such as infrastructure and financial contributions). In doing so, it appears necessary to develop an explicit vision and strategy that prioritize collective action among users of shared resource systems. Experimenting with different approaches and activities, as well as monitoring and evaluating their outcomes over an extended period of time, should then focus on learning what works and what does not – in other words, on the approaches and support activities that actually influence the long-term capacity of shared resource users to overcome and solve provision and appropriation dilemmas. Preferably, this kind of learning should take variation in local contexts into account, such as local norms, values, and relationships. In this regard, we recommend trying out approaches, focusing on community empowerment, and allowing users to craft their own ways of meeting the requirements for successful and durable forms of collective action, rather than imposing generic design principles based on earlier experiences. As NGOs often operate as de facto contractors, the commissioners (e.g., donors, project consortia, and government agencies) will need to move away from providing NGOs with rigid instructions based on predefined problem definitions.

Our study contributes to the development of emerging theory on how to support community management of shared resources such as

RDWSs. Hutchings et al. (2015) hold that community institutions need a ‘plus’ in order for community management models to work. The most common external ‘plus’ factors that they find in successful cases include financial support and provision of materials, capacity building on technical skills, capacity building on management, access to advice on technical issues, access to advice on management and finance, access to loan and microfinance, access to supply chain of spare parts and services, decentralized system/regulatory framework which includes monitoring and evaluation. We complement these findings by showing how ‘external pluses’ (in the form of NGO support) could contribute to a necessary ‘internal plus,’ namely, long enduring collective action among RDWS end-users.

In terms of a *support focus*, NGOs seem to show a tendency to shy away from supporting contentious requirements for collective action (e.g., sanctioning and conflict resolution) and emphasize long-term over day-to-day requirements. In terms of *support activities*, they arguably tend to focus on what they have previously proven to be good at (e.g. capacity building and awareness raising) without questioning the relevance or effectiveness of these activities in a different context. In terms of a *vision on support*, they tend to prefer imposing generic, top-down approaches over approaches focused on bottom-up, community empowerment. Our study confirms the seemingly ad hoc nature of NGO support to collective action.

Whereas most applications in our domain have so far studied community forestry cases, ours is one of the few that have looked at a context of DWS governance. We think that we have shown more clearly than previous studies that despite the effort, NGO support in its current form does not seem to have an impact on the continued capacity of shared resource system users to act collectively for an extended period.

Future research should substantiate the findings and claims based on this research. Firstly, the validity of the set of requirements for collective action that we have mentioned here needs to be assessed. Do groups of users of shared resource systems that meet these requirements manage to stay engaged in the forms of collective action necessary for resource governance for an extended period? Should the list be expanded and is there scope for this? Should items be removed or redefined? Can weights be associated with the requirements? Do different social or physical contexts alter the configuration of requirements? Secondly, the ways in which external actors – particularly NGOs– can be expected to leave their mark on the requirements must be studied more thoroughly. Our modest sample of eleven sites cannot presume to be representative, given the multitude of NGOs active in community organizations worldwide, the variation in shared resource system users that they are working with, and the range of approaches, strategies, and activities that all of them have been employing for multiple decades.

We hope that the learning approach of NGOs to systematically work out what works, where it works, and when it works will strengthen the ways in which practice and science can learn from each other.

5

References

Abedin, M. A., & Shaw, R. (2018). Constraints and coping measures of coastal community toward safe drinking water scarcity in Southwestern Bangladesh. In: Shaw, R., Koichi Shiwaku, K., and Izumi, T (eds) *Science and Technology in Disaster Risk Reduction in Asia.* Academic Press. https://doi.org/10.1016/B978-0-12-812711-7.00025-0

Afroz, S., Cramb, R., & Grunbuhel, C. (2016). Collective Management of Water Resources in Coastal Bangladesh: Formal and Substantive Approaches. *Human Ecology*, *44*(1), 17–31. https://doi.org/10.1007/s10745-016-9809-x

Agrawal, A. (2001). Common Property Institution and Sustainable Governance of Resources. *World Development*, *29*(10), 1649–1672. https://doi.org/https://doi.org/10.1016/S0305-750X(01)00063-8

Andersson, K. (2013). Local Governance of Forests and the Role of External Organizations : Some Ties Matter More Than Others. *World Development*, *43*, 226–237. https://doi.org/10.1016/j.worlddev.2012.09.001

Andersson, K., & van Laerhoven, F. (2007). From Local Strongman to Facilitator. *Comparative Political Studies*, *40*(9), 1085–1111. https://doi.org/10.1177/0010414006288977Bakalian, A., &Wakeman, W. (2009). Post-construction support and sustainability in community-managed rural water supply: Case studies in Peru, Bolivia, and Ghana.

Baland, J., & Platteau, J. (1996). *Halting degradation of natural resources: Is there a Role for Rural Communities?* Oxford:Clarendon Press.

Banks, N., Hulme, D., & Edwards, M. (2015). NGOs, States, and Donors Revisited: Still Too Close for Comfort? *World Development*, *66*, 707–718. https://doi.org/10.1016/j.worlddev.2014.09.028

Barnes, C, & Laerhoven, F. Van. (2013). Helping to Self-Help? External Interventions to Stimulate Local Collective Action in Joint Forest Management, Maharashtra, India:. *International Forestry Review*, *15*(1), 1–17. https://doi.org/10.1505/146554813805927246

Barnes, Clare, & van Laerhoven, F. (2014). Making it last? Analysing the role of NGO interventions in the development of institutions for durable collective action in Indian community forestry. *Environmental Science and Policy*, *53*, 192–205. https://doi.org/10.1016/j.envsci.2014.06.008

Barsimantov, J. A. (2010). Vicious and virtuous cycles and the role of external non-government actors in community forestry in Oaxaca and Michoac??n, Mexico. *Human Ecology*, *38*(1), 49–63. https://doi.org/10.1007/s10745-009-9289-3

Baumann, E. (2006). Do operation and maintenance pay? *Waterlines*, *25*(1), 10–12. https://doi.org/10.3362/0262-8104.2006.033

Bebbington, A. (2004). NGOs and uneven development:

Geographies of development intervention. *Progress in Human Geography*, *28*(6), 725–745. https://doi.org/10.1191/0309132504ph516oa

Beitl, C. M. (2014). Adding Environment to the Collective Action Problem: Individuals, Civil Society, and the Mangrove-Fishery Commons in Ecuador. *World Development*, *56*, 93–107. https://doi.org/10.1016/j.worlddev.2013.10.026

Boelens, R., &Zwarteveen, M. (2005). Prices and politics in Andean water reforms. *Development and Change*, *36*(4), 735-758.*Environment Journal*, *13*(4), 292-296. https://doi.org/10.1111/j.0012-155X.2005.00432.x

Carter, R. C., Tyrrel, S. F., &Howsam, P. (1999). The impact and sustainability of community water supply and sanitation programmes in developing countries. *Water and*

Cleaver, F. (2002). Reinventing institutions: Bricolage and the social embeddedness of natural resource management. *The European Journal of Development Research*, *14*(02), 11–30.

Cundill, G., &Fabricius, C. (2009). Monitoring in adaptive co-management: toward a learning based approach. *Journal of Environmental management*, *90*(11), 3205-3211.https://doi.org/10.1016/j.jenvman.2009.05.012

Dayton-Johnson, J. (2000). Determinants of collective action on the local commons: a model with evidence from Mexico. *Journal of development economics*, *62*(1), 181-208, https://doi.org/10.1016/S0304-3878(00)00080-8

Douglas, M. (1994). Risk and blame: Essays in cultural theory. London: Routledge.

Driessen, P. P., Dieperink, C., Van Laerhoven, F., Runhaar, H. A., & Vermeulen, W. J. (2012). Towards a conceptual framework for the study of shifts in modes of environmental governance–experiences from the Netherlands. *Environmental policy and governance*, *22*(3), 143-160, https://doi.org/10.1002/eet.1580

Espinosa-Romero, M. J., Rodriguez, L. F., Weaver, A. H., Villanueva-Aznar, C., & Torre, J. (2014). The changing role of NGOs in Mexican small-scale fisheries: From environmental conservation to multi-scale governance. *Marine Policy*, *50*, 290–299. https://doi.org/10.1016/j.marpol.2014.07.005

Fisher, W. F. (1997). DOING GOOD? The Politics and Antipolitics of NGO Practices. *Annual Review of Anthropology*, *26*(1), 439–464. https://doi.org/10.1146/annurev.anthro.26.1.439

Gerring, J. (2006). *Case Study Research: Principles and Practices*. : Cambridge University Press.

Ghate, R. (2009). Decentralizing forest management: Pretense of reality? Paper presented at the *WOW-IV Conference*.

Ghate, R., & Nagendra, H. (2005). Role of monitoring in institutional performance: forest management in Maharashtra, India. *Conservation and society*, 3(2), 509-532.

Gomes, S. L., Hermans, L. M., Islam, K. F., Huda, S. N., Hossain, A. T. M., & Thissen, W. A. (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

Harvey, P. A., & Reed, R. A. (2007). Community-managed water supplies in Africa: Sustainable or dispensable? *Community Development Journal*, *42*(3), 365–378. https://doi.org/10.1093/cdj/bsl001

Hoque, B. A., Hoque, M. M., Ahmed, T., Islam, S., Azad, A. K., Ali, N., Hossain, M., & Hossain, M. S. (2004). Demand-based water options for arsenic mitigation: An experience from rural Bangladesh. *Public Health*, *118*(1), 70–77. https://doi.org/10.1016/S0033-3506(03)00135-5

Hoque, M.R. (2009). *Access to Safe Drinking Water in Rural Bangladesh: Water Governance by DPHE*. BRAC University, Dhaka, Bangladesh.

Hossain, M., Rahman, S. N., Bhattacharya, P., Jacks, G., Saha, R., & Rahman, M. (2015). Sustainability of arsenic mitigation interventionsâ€"an evaluation of different alternative safe drinking water options provided in Matlab, an arsenic hot spot in Bangladesh. *Frontiers in Environmental Science*, *3, 30.* https://doi.org/10.3389/fenvs.2015.00030

Hutchings, P., Chan, M. Y., Cuadrado, L., Ezbakhe, F., Mesa, B., Tamekawa, C., & Franceys, R. (2015). *A systematic review of success factors in the community management of rural water supplies over the past 30 years*. *Water Policy*, *17*(5), 963–983. https://doi.org/10.2166/wp.2015.128

Hutchings, P., Franceys, R., Mekala, S., Smits, S., Hutchings, P., Franceys, R., Mekala, S., & Smits, S. (2017). Revisiting the history , concepts and typologies of community management for rural drinking water supply in India. *International Journal of Water Resources Development*, *33*(1), 152–169. https://doi.org/10.1080/07900627.2016.1145576

Isham, J. and Kahkonen, S. (1998). *Improving the Delivery of Water and Sanitation: A Model of Coproduction of Infrastructure Services* (Working Paper No. 210).

Islam, M., Ali Akber, M., & Atikul Islam, M. (2019). Willingness to pay for improved drinking water in Southwest coastal Bangladesh. *Water Science and Technology: Water Supply*, *19*(1), 1–10. https://doi.org/10.2166/ws.2018.047

Jones, S. (2013). How can INGOs help promote sustainable rural water services? An analysis of wateraid's approach to supporting local governments in mali. *Water Alternatives*, *6*(3).

Johnson, E., & Prakash, A. (2007). NGO research program: A collective action perspective. *Policy Sciences*, *40*(3), 221-240., DOI 10.1007/s11077-007-9043-x

Kerr, J. M., Pangare, G., &Pangare, V. (2002). *Watershed development projects in India: an evaluation* (Vol. 127). Intl Food Policy Res Inst.

Koehler, J., Rayner, S., Katuva, J., Thomson, P., & Hope, R. (2018). A cultural theory of drinking water risks, values and institutional change. *Global Environmental Change*, *50*, 268-

277.https://doi.org/10.1016/j.gloenvcha.2018.03.006

Lewis, D. (2014). *Non-governmental organizations, management and development*. Routledge.

Lobo, I., Velez, M., & Puerto, S. (2016). Leadership, entrepreneurship and collective action: A case study from the Colombian Pacific region. *International Journal of the Commons*, *10*(2). 982–1012. DOI: http://doi.org/10.18352/ijc.640

Lockwood, H. (2002). *Institutional support mechanisms for community-managed rural water supply & sanitation systems in Latin America*. Environmental Health Project, US Agency for International Development.

Lockwood, H., & Smits, S. (2011). Supporting Rural Water Supply: Moving towards a Service Delivery Approach. *Practical Action Publishing*, 202. https://doi.org/10.1017/CBO9781107415324.004

Mahmuduzzaman, M., Ahmed, Z. U., Nuruzzaman, A. K. M., & Ahmed, F. R. S. (2014). Causes of salinity intrusion in coastal belt of Bangladesh. *International Journal of Plant Research*, *4*(4A), 8-13.

Mitlin, D., Hickey, S., & Bebbington, A. (2007). Reclaiming Development? NGOs and the Challenge of Alternatives. *World Development*, *35*(10), 1699–1720. https://doi.org/10.1016/j.worlddev.2006.11.005

Olson, M. (1965). *The Logic of Collective Action, Public Goods and*

the Theory of Groups. Harvard University Press.
Ostrom, E. (1990). *Governing the Commons: The Evolution of Institutions for Collective Action* (Ist edition). Cambridge University Press. https://doi.org/10.1017/CBO9780511807763
O'Toole Jr, L. J., & Meier, K. J. (2004). Desperately seeking Selznick: Cooptation and the dark side of public management in networks. *Public Administration Review*, *64*(6), 681-693.
Peters, C. N., Baroud, H., & Hornberger, G. M. (2019). Multicriteria Decision Analysis of Drinking Water Source Selection in Southwestern Bangladesh. *Journal of Water Resources Planning and Management*, *145*(4), 05019004. https://doi.org/10.1061/(asce)wr.1943-5452.0001029
Pomeroy, R. S., Katon, B. M., &Harkes, I. (2001). Conditions affecting the success of fisheries co-management: lessons from Asia. *Marine policy*, *25*(3), 197-208. https://doi.org/10.1016/S0308-597X(01)00010-0
Poteete, A., Janssen,M., Ostrom, E. (2010). *Working Together: Collective Action, the Commons, and Multiple Methods in Practice*. Princeton University Press.
Prasad, N. (2006). Privatisation results: Private sector participation in water services after 15 years. *Development Policy Review*, *24*(6), 669-692.https://doi.org/10.1111/j.1467-7679.2006.00353.x
Ratna Reddy, V. R., Rammohan Rao, M. S., & Venkataswamy, M. (2011). 'Slippage': The Bane of Rural Drinking Water Sector

(A Study of Extent and Causes in Andhra Pradesh). *Journal of Social and Economic Development*, *13*(2), 163–188.

Rydin, Y., & Pennington, M. (2000). Public participation and local environmental planning: the collective action problem and the potential of social capital. *Local environment*, *5*(2), 153-169.https://doi.org/10.1080/13549830050009328

Sultana, F. (2009). Community and participation in water resources management: gendering and naturing development debates from Bangladesh. *Transactions of the Institute of British Geographers*, *34*(3), 346-363., https://doi.org/10.1111/j.1475-5661.2009.00345.x

Swyngedouw, E. (2005). Governance innovation and the citizen: The Janus face of governance-beyond-the-state. *Urban studies*, *42*(11), 1991-2006.

Tolk, L., Tuinhof, A., ter Winkel, T., Ahmed, K.M. & Bolton, M. (2014) Underground fresh water storage: A practical solution to increase water security in saline deltas.

Van Laerhoven, F., & Barnes, C. (2014). Communities and commons: the role of community development support in sustaining the commons. *Community Development Journal*, *49*(suppl_1), i118-i132, https://doi.org/10.1093/cdj/bsu005

Wade, R. (1988). Village Republics: Economic Conditions for Collective Action in South.India,, Oakland:ICS Press

Whaley, L., & Cleaver, F. (2017). *Can ‘ functionality ’ save the*

5

community management model of rural water supply ?9(March), 56–66. https://doi.org/10.1016/j.wrr.2017.04.001

Wright, G., & Andersson, K. (2013). Non-Governmental Organizations, Rural Communities and Forests: A Comparative Analysis of Community-NGO Interactions. *Small-Scale Forestry*, *12*(1), 33–50. https://doi.org/10.1007/s11842-012-9206-2


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CHAPTER 6

SYNTHESIS

Introduction

Sustainable Development Goal (SDG) 6 focuses on the importance of clean water and sanitation, and aims to ensure the availability and sustainable management of water and sanitation for all. The basic statistics presented on the UN's website dedicated to the SDGs leave no room for doubt regarding the urgency of problems related to water: More than 2 billion people in the world lack safely managed drinking water and more than 4 billion lack safely managed sanitation (Sachs et al., 2020).

This dissertation began with the observation that the performance of shared drinking water systems (DWSs) in the global South is often not optimal. The poor performance of drinking water delivery approaches that rely on either the market or the state has been attributed to, among other things, technological issues and a lack of resources among DWS users (Isham & Kahkonen, 1998); limited financial and technical capacities of governments, poor alignment of supply and demand, and opportunistic behavior of civil servants (Harvey & Reed, 2007; Isham & Kahkonen, 1998; Moriarty et al., 2013). Subsequently, since the 1980s approaches to the delivery of drinking water that depend more on community management have been tried as an alternative (e.g., Briscoe & Garn, 1995; Evans, 1992). However, an increasing number of studies on the performance of community-run DWSs suggest that pure community management may not be the answer either (e.g., Harvey & Reed, 2007; Moriarty et al., 2013).

Service delivery that is based on the joint responsibilities of both beneficiaries and the government has been practiced and studied for decades, and has been labeled, for example, as *co-production*(e.g., Ostrom, 1996; Parks et al., 1981), *co-management* (e.g., Berkes, 2009; Jentoft, 2003), or *cooperative management* (e.g., Pinkerton, 1989). Building on this tradition, and with specific regard to the governance of DWSs, some have begun using the term *community management plus* (CM+) to refer to arrangements whereby communities are responsible for the operation and maintenance of a DWS and receive support from local or central government agencies and/or NGOs (Baumann, 2006). The rationale is that CM+ is expected to bring together different areas of expertise, it helps to build a range of communities' capacities, and it can benefit from local knowledge about topics ranging from local geographies to cultural norms and sensitivities (Hall et al., 2005). In this dissertation, I have further developed this concept of CM+ in the specific context of governing shared DWSs in the global South.

I have also tried to bring together insights from various literatures in an attempt to provide a comprehensive and integrated overview of factors and conditions that contribute to the success of approaches to drinking water delivery that are based on CM+. To that purpose, I studied DWSs in 15 communities in seven sub-districts of the three districts of Khulna, Satkhira, and Bagerhat in the southwestern coastal area of Bangladesh, interviewing well over a 1,000 household representatives, water user group members, public officials, and representatives of local authorities. The main question of the research underlying this dissertation was: **How can community drinking water systems be successfully governed?**

In this concluding chapter, I first provide a summary of the main results of the empirical research that is presented in chapters 2 to 5, and in doing so, provide my answer to the research question. I also reflect on the contributions of my research to both theory building and the achievement of SDG 6, namely *to ensure the availability and sustainable management of water and sanitation for all*.

Drinking water delivery – a very brief history

Ideally, drinking water delivery comprises both hardware elements (i.e., the physical infrastructure) and software components (e.g., skills, knowledge, capacities, institutions) (Lockwood & Smits, 2011). Until the 1980s, two types of approaches to drinking water delivery in developing countries were dominant, that is, approaches based on the market and those based on state regulation (Moriarty et al., 2013; Pahl-Wostl, 2009; Smits, 2013). Since the International Drinking Water Supply and Sanitation Decade (1981–90), a third approach has been added, namely one based on community management (e.g., Evans, 1992). According to this approach, infrastructures may be provided by external agencies, but end users living in close proximity to the DWS act collectively to operate and maintain those infrastructures. A number of studies imply that this alternative approach can be successful (e.g., Ajeng et al., 2018 for

Indonesia; Chitonge, 2011 for Zambia; Fielmua, 2011 for Ghana; Madrigal et al., 2011 for Costa Rica; Wegerich, 2009 for Uzbekistan). However, it is now clear that, unfortunately, community management is not the holy grail it was once hoped it would be. For example, some statistics indicate that up to nearly one third of community-managed DWSs in Asia and Africa are underperforming or have failed (Baumann, 2006; Ratna Reddy et al., 2014; Whaley & Cleaver, 2017).

As noted above, in response to the realization that there is still much room for the optimization of drinking water delivery, CM+ has recently been added as yet another way to both conceptualize and organize drinking water delivery (Baumann, 2006b; Hutchings et al., 2017). CM+ builds on a long-respected scholarly and practical tradition of thinking about the production and provision of public services in terms of joint responsibilities between citizens and governments (Jentoft, 2003; Ostrom, 1996; Parks et al., 1981). What these approaches have in common is that in order for community management to succeed, communities need a "plus," that is, ongoing support from an external support entity. In this dissertation, I have presented the results of my research regarding the prerequisites for CM+ success in the particular context of Bangladesh.

Prerequisites for CM+ success

In sum and in broad strokes, the research presented in chapters 2 and 3 concerned the role of **household preferences** in predicting CM+

success, while that in chapters 4 and 5 focused on the role of **collective action and collaboration**. In all of my empirical research, it became clear that **local context matters.**

Chapter 2 presents my attempt to reveal the DWS and household attributes that influence household preferences for a DWS.I found that households prefer DWSs that are disaster-resilient and reliably produce water that poses no risk to health and tastes good. I furthermore established that income, size, location, and water scarcity levels explain variation in households' willingness to pay for water from a DWS with varying attribute levels.

In chapter 3, I present the results of my research into the socio-psychological factors that contribute to the likelihood of households switching to a newly introduced, safer DWS. My findings indicate that perceived risk, costs, taste, self-efficacy, and form and intensity of competition from alternative drinking water options matter significantly.

Chapter 4 focused on the conditions that explain variation in collective action among the end users of a DWS, and these conditions explain variation in collaboration between DWS end users and a public agency. I show that that especially having a large group size, interdependency, dependence on resource system, and collaboration with the public agency are significantly associated with the occurrence of collective action among DWS users. Collaboration between DWS users and the public agency is, in turn, positively influenced mostly by a relationship that is characterized by trust, as well as by transparency and inclusive decision-making procedures.

Chapter 5 concludes this dissertation with a study into the role of NGO support in governance arrangements based on CM+. The study assessed the form and impact of this kind of NGO support and established what NGOs actually do (i.e., NGOs favor long-term requirements for collective action over the requirements for day-to-day collective action, and support is focused on standard approaches to training and awareness raising, and less on empowering users to craft their own solutions). However, based on the outcomes of my study, a case for a lasting impact of NGO support on any of the requirements is hard to make.

Cumulatively, the findings presented in these individual chapters feed into an overall answer to the main research question, namely: How can community drinking water systems be successfully governed? Moving beyond the nitty-gritty and the details of my findings, I see three prerequisites for the success of a CM+ approach to the sustainable governance of community DWSs emerging from my research: (i) people's preferences and perceptions should be the point of departure; (ii) the "+" in CM+ regards help with organizing collective action and collaboration, and (iii) context matters and situations on the ground differ, and this needs to be taken into consideration (in other words, there are no one-size-fits-all panacea solutions to drinking water delivery problems). In what follows, I present my reflections on each of these prerequisites, and also on their interrelation. I put them in the context of the wider literature and speculate about what is needed to meet them.

People's preferences and perceptions are the point of departure

In my research, the success of CM+ was found to depend on what the local people prefer (chapter 2) and how they perceive new DWSs as compared to the systems that they are already using (chapter 3). Although my results are congruent with the findings of earlier studies (see for example Brouwer & Crescent, 2015; Hasan et al., 2019; Wendimu & Bekele, 2015), the introduction of new and improved DWSs is too often still driven by supply, rather than demand (Naiga et al., 2015)—despite the growing consensus among water professionals that the effective and durable solving of drinking water delivery problems should start with offering solutions that are in tune with what people want (Whittington et al., 1998). In broad strokes, a demand-driven, bottom-up approach to drinking water delivery can be defined as one in which (i) households are involved in decisions about the location, the infrastructure, and the governance arrangements; (ii) women in particular play a decisive role in the decision-making; and (iii) households commit financially by contributing to capital investment and operational costs (Sara & Katz, 1997; Whittington et al., 2009).

Although claiming that in order for DWSs to succeed they need to offer what people want seems like stating the obvious, in chapters 2 and 3 I showed that getting to understand "what people want" is far from easy. This is an especially important observation in settings where an efficient market for DWSs is absent, and government agencies and/or donors need to come up with ways to elucidate preferences.

In chapter 2, I meticulously unpacked households' DWS preferences and showed that they are made up of DWS attributes that include the levels of disaster resilience, risk to public health, reliability, taste, and price. Rather than simply preferring one DWS over another, households determine what they prefer based on how they value a range of different attributes of a DWS. This means that a low score on one attribute may be compensated for by a high score on another. Also, households with different attributes value different DWS attributes differently.

In chapter 3, I furthermore showed that besides the economics of preferences, supply, and demand (see chapter 2), the answer to the question "what do people want?" is also determined by socio-psychological factors. The fact that households are attached to the way in which they have always fetched their drinking water, has been widely shown to be related to factors such as risk, attitude, norms, ability, and self-regulation (see, for example, Huber & Mosler, 2013; Inauen et al., 2013; Kundu et al., 2016; Mosler et al., 2010). Getting households to switch to a safer, better, cheaper DWS is therefore not a straightforward matter.

Even if agencies and donors want to work on a demand-driven basis (which most of the time they appear to be unwilling to do), my research shows that they would have a harder time than one would think to establish what people want. After all, I found that there is variation in how different DWS attributes are considered and valued by the DWS users. I show that this variation is driven by context and household attributes. A market arrangement would have households putting their money where their mouths are, but in a non-market context getting households to reveal their true preference is a complex matter, as I showed in chapters 2 and 3. Careful consideration of household preferences is, however, key to long-term success: The abandonment of PSF (chapter 4) and MAR systems (chapter 3) that I reported on in this dissertation, can be partly attributed by the supply-driven nature of their introduction into the community.

Support must target the organization of collective action

My research shows that both public agency and NGO support are most effective when, rather than focusing on the transfer of resources (i.e., money and materials) and information (i.e., awareness and capacities), they focus on the crafting of institutions for collective action and collaboration, both among DWS users and between DWS users and the support entity itself. In this dissertation (chapter 5 in particular), I divided *DWS performance* into stock, flow, and actors' performance. *Stock performance* concerns the functionality of the infrastructure and refers to its capacity to reliably supply safe drinking water. *Flow performance* concerns drinking water quality, for example, in terms of iron, arsenic, salinity, and pathogenic content. Finally, *actor performance* concerns the extent to which users of the system are willing to invest in stock provision and sustainable flow appropriation. I suggest that there is a correlation between the occurrence of collective action on the one hand, and stock, flow, and actor performance on the other.

I approach a DWS as a shared resource and can therefore lean on the rich scholarly literature on the governance of the commons. Using a set of enabling conditions for collective action and collaboration drawn from that literature (e.g., Agrawal, 2001; Baland & Platteau, 1996; Cox et al., 2010; Ostrom, 1990), I investigated the conditions that are likely to forge and promote collective action among DWS users on the one hand, and collaboration between the DWS users and external public agency on the other. My main findings (see above) mostly confirm that what others have found to hold for other types of commons (such as forests, irrigation systems, fisheries, and groundwater) also holds for shared DWSs. A somewhat unexpected finding is that groups that have successfully organized collective action, are often larger rather than smaller. I also observed that rules that would guarantee that the right to extract water is proportional to one's contribution are entirely absent, which according to theory would increase the risk of free riding. Concerning the collaboration between DWS users and the public agency, my findings regarding the importance of trust, transparency, and inclusive decision-making resonate with the work of earlier authors on this topic (e.g., Ansell & Gash, 2008; Huxham, 2003). Part of my research focused particularly on the role of NGOs in offering support to communities in their attempt to govern a shared DWS.My findings are consistent with research that has studied other types of shared resources (e.g., Barnes & Laerhoven, 2013; Barnes & van Laerhoven, 2014), which appears to validate my decision to use commons literature as the analytical departure point for the study of shared DWSs. An interesting finding of my study is that none of the NGOs was found to support DWS users in developing a sanctioning and a low-cost adjudication mechanism.

For public agencies and local NGOs to be effective in supporting the communities, I suggest that they adopt an approach to institutions that is based on *crafting*, rather than on *designing* (Barnes & van Laerhoven, 2014; Cleaver, 2002).The focus should be on empowering communities and allowing them to craft for themselves the institutions that are required for the performance of durable collective action, rather than on the top-down imposition of generic institutional arrangements that are based on earlier experiences, elsewhere. My research shows that normative principles matter for collective action and collaboration. In chapter 4, I showed how trust is likely to be both the effect and the result of inclusive and transparent decision-making.

There are no panaceas – Local contexts matter

My research makes clear that local context—such as physical circumstances (climate, hydrology, geomorphology, etc.) and socioeconomic situations on the ground—matters. There is no blanket, one-size-fits-all solution to drinking water delivery problems. For example, chapter 2 showed that household preferences for DWS options vary according to household size, location, income, and its prior experience of drinking water scarcity. Chapter 3 reveals that contextual factors such as the nature and number of alternative DWS options in a locality affect the likelihood of adoption of new and improved DWSs. In chapter 4, I presented a range of contextual factors that concern (i) user group characteristics, (ii) the relationship between resource system characteristics and group characteristics, (iii) institutional arrangements, and (iv) the relation of communities with state actors, and that account for variation in CM+ success. Finally in chapter 5, I showed how different NGOs hold different views and employ different support activities with different levels of effectiveness. This observation contrasts with the many practices that are primarily driven by the temptation to seek out panaceas. Ostrom et al. (2007) warn of the perils associated with creating panacea models in addressing the human–environment issue. They argue that a panacea often fails in the case of the governance of shared resources, because people's preferences and perceptions vary according to context and lived experiences. In addition, problems related to shared resource governance are rarely attributable to one single cause.

6

The history of attempts to solve drinking water delivery problems seems to be dominated by the search for the "next big thing." Based on my findings, I suggest to stop putting so much emphasis on panacea-like, blanket solutions, and instead to acknowledge the importance of context. This could be done by giving priority to local demands and preferences (doing justice to all its complications) and to the importance of community empowerment and locally *crafted* institutions for collective action (rather than to the top-down imposition of *designed* institutions). The prerequisites presented here are interrelated, presumably in the following way (figure 1).

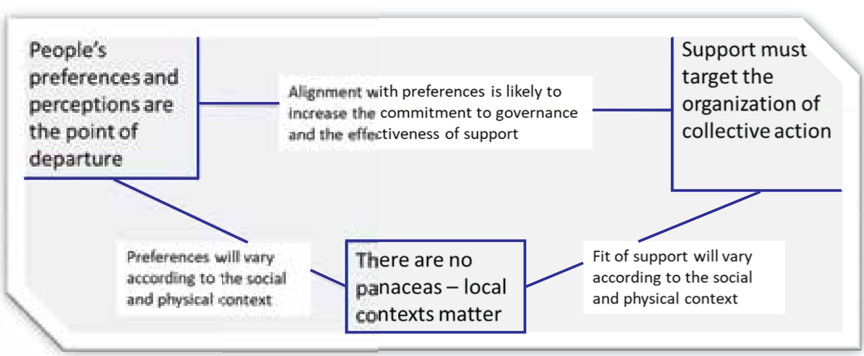

Figure 1: Interrelation between the prerequisites of the success of CM+

Generalizability of my findings

Although the findings of my research concern the coastal area of Bangladesh, the lessons learned are also applicable elsewhere in the global South and to other forms of shared resource governance, such as the governance of forests, irrigation systems, and fisheries. The potential for extrapolating my findings to either other countries or other sectors seems highest in areas where (i) governance is based or partly based on strong community involvement; (ii) legal provisions, policies, and/or public agency mandates leave room for and actively encourage co-production (i.e., where provisions exist that stipulate joint responsibilities of local communities and public agencies); (iii) NGOs are afforded a role in preparing local communities for governing their own resource; and (iv) due to imperfect markets, government actors or donors are left with the task of revealing true household and community preferences.

Contributions of the study

The research underlying this dissertation was aimed at identifying prerequisites for the success of CM+ as a service delivery approach in the context of shared DWSs in coastal Bangladesh. As a result, this dissertation is able to make contributions to both theory development and the solving of important societal problems.

Contributions to theory development

The dissertation contributes to the conceptualization and organization of drinking water delivery approaches. CM+ is the latest addition to the family of approaches to delivering drinking water (although, of course, it leans heavily on a much older tradition). It is argued to have the potential to overcome the shortcomings of public, private, and community-based approaches.

In chapter 2, I used economic theory on consumer preferences (e.g. Hanley et al., 2002; Lancaster, 1966; Marschak, 1960) and applied it to a domain to which it has been scarcely applied, namely the analysis of ways in which DWS solutions can be aligned with varying household preferences. In doing so, I managed to add nuance and details to what "preference" and "demand" mean in the particular context of DWSs, by disentangling these terms in a way that allows us to understand how households characterized by different attributes differ in how they value the bundle of DWS attributes that go into the establishment of DWS preferences. In particular, I found that household preferences are determined by a configuration of considerations related to the DWS (i.e., its reliability and resilience to natural disasters) and the water it produces (i.e., its quality in terms of health risks, taste, and price).

In chapter 3, I used theories from psychology and sociology (e.g. Ajzen, 1991; Floyd, et al,, 2000; Mosler, 2012; Schwarzer, 2008) and on the adoption of innovations, and applied these somewhat differently. Mosler (2012) designed and used his RANAS framework to understand why people would or would not adopt a certain safe drinking water technology. The contribution of my study is that I have shown how to use and build on the RANAS framework to add to the understanding of the conditions under which CM+ could be expected to do a better job at solving drinking water delivery problems than its predecessors.

In chapter 4, I applied theories from economics (e.g. North, 1990; Olson, 1965) and political science (e.g. Agrawal, 2001; Ansell & Gash, 2008; Baland & Platteau, 1996; Huxham, 2003; Ostrom, 1990) on collective action among the users of shared resources and on collaboration between those users and external actors that act in support of these communities. In doing so, I showed that it makes analytical sense to conceive of DWSs as commons. By confirming most of the findings from these literatures, I have contributed to rendering these findings more robust.

In chapter 5, I applied institutional and development theories on NGO support (e.g. Andersson, 2013; Andersson & van Laerhoven, 2007; Banks et al., 2015; Barnes & Laerhoven, 2013; Barnes & van Laerhoven, 2014; Barsimantov, 2010; Cleaver, 2002) to an area in which they had previously not been used. My work shows that NGO activities seem to be based on applying standard approaches to training and awareness raising, and less on empowering users to craft their own solutions. Based on my analysis, a strong case for a lasting impact of NGO support is hard to make, suggesting that there is a need to intensify the dialogue between scholars of collective action and practitioners.

When I started my research, the factors leading to the success of CM+ were mostly unexplored. In this dissertation, I have started to fill this knowledge gap. To explore the prerequisites for the success of CM+, my research drew on insights from different bodies of literature. I bundled theories and concepts from these literatures into an integrated and coherent whole. That is arguably the largest contribution to theory development that I offer in this dissertation.

Contributions to the solving of societal problems

Drinking water scarcity is a major concern, not only in Bangladesh but across the world (Madrigal et al., 2011b). It hampers both socioeconomic and ecological development (Shrimali, 2015). In 2015, the United Nations adopted Sustainable Development Goal 6 (SDG 6) in an attempt to ensure the availability and sustainable management of water and sanitation for all by 2030. SDG 6 includes eight targets to be measured by eleven indicators. The targets call not only for the ensuring of universal and equitable access to safe drinking water for all, but also for the sustainable governance of drinking water sources (Sadoff et al., 2020). The present research explored the factors and prerequisites that will contribute to the success and sustainable performance of DWSs in rural coastal Bangladesh. Thus, the findings can be seen as a modest contribution to the achievement of SDG 6.

As a contribution to the solving of societal problems, I offer a small set of very practical recommendations for donors, policymakers, and practitioners that are derived from my analyses.Although these recommendations are tailored to the situation in the southwestern coastal areas of Bangladesh, they might also provide lessons for preventing the failure of shared DWSs in other parts of the global South.

First, as a demand-driven, bottom-up approach is preferred, when designing and planning for a new DWS, the implementing organizations should first assess drinking water options that are already available in the communities. They should evaluate local preferences and perceptions, and appreciate intra-community variation.In this regard, local government institutes and/or local NGOs can cooperate with the implementing agency, as they are locally based and have access to accurate information and knowledge about the local contexts and situations.Keeping track of the number, nature, and functionality of the DWSs that are already available in the communities seems an easy first step. This would reduce the chance that new DWSs are installed in localities where there is no actual need for them. In Bangladesh, the Upazila Parishad (the second tier of local government) could play a role in the implementation of this coordination.

Second, maybe more important for CM+ success than the *hardware* (the physical infrastructure), is the fostering of *software* (skills, knowledge, capacities, institutions). With some structural and functional changes (see chapter 5 for details), local NGOs could play an even more important role in software development than they already do, as they are often well-positioned to have accurate knowledge and information about local contexts, norms, and people's preferences.

Third, I recommend the creation of a formalized structure of collaboration and communication between the public agency at the local level (which in Bangladesh is the sub-district level) and the end users of the DWS (and in particular with the members of a DWS users' committee). To do so effectively, the human, financial, and technical capacity (including the capacity to work on what I call software development, and particularly on gender issues) of the public agency at the local and the regional level should be improved. In Bangladesh, local government institutes could also play a coordinating role in this respect.

Finally,and maybe most importantly, I suggest that both NGOs and commissioners of DWS projects make an effort to constantly and very explicitly engage and invest in learning what works and what does not. An iterative approach to monitoring, evaluating, and reconsidering strategies is key to CM+ success.

Future research to address the limitations

The questions that still need to be answered are: What are the limitations of the present research and what are the remaining knowledge gaps that future research can help to fill? What more do we need to learn about the prerequisites for a system that will guarantee the reliable delivery at a reasonable price of a sufficient quantity of safe drinking water to all who need it? And how can future research help to establish what is needed to meet the three prerequisites for CM+ success that were highlighted in this chapter? I offer the following suggestions.

First, the study was carried out in particular coastal areas of Bangladesh. Extrapolating the results to other regions would require the testing of my propositions in contexts that differ in terms of, for example, geography, socioeconomics, and institutional arrangements. Future research in other parts of Bangladesh and elsewhere in the global South would increase the general validity of the findings.

Second, when analyzing enabling factors that are held to facilitate collective action, some of the findings were not congruent with earlier findings. In particular, this concerns the influence of group size and boundary rules. The latter, I speculated, could be explained by considering religion and taboos. Future research could look into these factors with more precision.

Third, the present research focused on assessing the support of particularly the public agency and local NGOs. However, it appears that in the context of Bangladesh, also local government institutes (especially the Union Parishad and Upazila Parishad) can play an important role in determining the performance of DWSs. They are crucial in the selection of targeted sites for the construction of

DWSs, and it appears that opportunism and political clientelism play a possible role in this process. This is something to also consider in future research.

Finally, gender issues are at the center of water provision and management in Bangladesh and elsewhere in the global South. Although women and girls are mostly responsible for fetching water in the rural coastal areas of Bangladesh, they seem to have little or no say in decision-making about the governance of DWSs in a community. Women's representation is a relatively recent obligation that donors have pushed for, but it remains to be seen how this will alter the balance of power between men and women. The present research did not give center stage to gender issues. However, I recommend that future research does.

As I have shown in this dissertation, governance is the key to sustainable community DWSs, which in turn are key to achieving SDG 6. According to the most recent figures (Sachs et al., 2020), 2.2 billion people lack access to safe drinking water. This is an unacceptably high number. It is my hope that by seeking to answer the question "How can community drinking water systems be successfully governed?" I have made a modest contribution to bringing that number down.

References

Agrawal, A. (2001). Common Property Institution and Sustainable Governance of Resources. *World Development*, *29*(10), 1649–1672. https://doi.org/https://doi.org/10.1016/S0305-750X(01)00063-8

Ajeng, R., Roekmi, K., Baskaran, K., & Chua, L. H. C. (2018). Community-based water supplies in Cikarang , Indonesia : are they sustainable ? *Natural Resources Forum*, *42*(2), 108–122. https://doi.org/10.1111/1477-8947.12146

Ajzen, I. (1991). The theory of planned behavior. *Organizational Behavior and Human Decision Processes*, *50*(2), 179–211. https://doi.org/https://doi.org/10.1016/0749-5978(91)90020-T

Andersson, K. (2013). Local Governance of Forests and the Role of External Organizations : Some Ties Matter More Than Others. *World Development*, *43*, 226–237. https://doi.org/10.1016/j.worlddev.2012.09.001

Andersson, K., & van Laerhoven, F. (2007). From Local Strongman to Facilitator. *Comparative Political Studies*, *40*(9), 1085–1111. https://doi.org/10.1177/0010414006288977

Ansell, C., & Gash, A. (2008). Collaborative governance in theory and practice. *Journal of Public Administration Research and Theory*, *18*(4), 543–571. https://doi.org/10.1093/jopart/mum032

Baland, J., & Platteau, J. (1996). *Halting degradation of natural* *resources: Is there a Role for Rural Communities?*Oxford:Clarendon Press .

Banks, N., Hulme, D., & Edwards, M. (2015). NGOs, States, and Donors Revisited: Still Too Close for Comfort? *World Development*, *66*, 707–718. https://doi.org/10.1016/j.worlddev.2014.09.028

Barnes, C, & Laerhoven, F. Van. (2013). Helping to Self-Help? External Interventions to Stimulate Local Collective Action in Joint Forest Management, Maharashtra, India:. *International Forestry Review*, *15*(1), 1–17. https://doi.org/10.1505/146554813805927246

Barnes, Clare, & van Laerhoven, F. (2014). Making it last? Analysing the role of NGO interventions in the development of institutions for durable collective action in Indian community forestry. *Environmental Science and Policy*, *53*, 192–205. https://doi.org/10.1016/j.envsci.2014.06.008

Barsimantov, J. A. (2010). Vicious and virtuous cycles and the role of external non-government actors in community forestry in Oaxaca and Michoac??n, Mexico. *Human Ecology*, *38*(1), 49–63. https://doi.org/10.1007/s10745-009-9289-3

Baumann, E. (2006). Do operation and maintenance pay? *Waterlines*, *25*(1), 10–12. https://doi.org/10.3362/0262-8104.2006.033

Berkes, F. (2009). Evolution of co-management: Role of knowledge generation, bridging organizations and social learning. *Journal* *of Environmental Management*, *90*(5), 1692–1702. https://doi.org/10.1016/j.jenvman.2008.12.001

Briscoe, J., & Garn, H. A. (1995). Financing water supply and sanitation under Agenda 21. *Natural Resources Forum*, *19*(1), 59–70. https://doi.org/10.1111/j.1477-8947.1995.tb00593.x

Brouwer, R., & Crescent, F. (2015). Comparing Willingness to Pay for Improved Drinking-Water Quality Using Stated Preference Methods in Rural and Urban. *Applied Health Economics and Health Policy*, 81–94. https://doi.org/10.1007/s40258-014-0137-2

Chitonge, H. (2011). A decade of implementing water services reform in Zambia: Review of outcomes, challenges and opportunities. *Water Alternatives*, *4*(3), 279–300.

Cleaver, F. (2002). Reinventing institutions: Bricolage and the social embeddedness of natural resource management. *The European Journal of Development Research*, *14*(02), 11–30.

Cox, M., Arnold, G., & Villamayor, S. (2010). A Review of Design Principles for Community-based Natural Resource Management. *Ecology and Society*, *15*(4), 28. https://doi.org/38

Evans, P. (1992). *Community management of improved water supply systems : a preliminary review*. *706191*. http://www.ircwash.org/sites/default/files/205.1-92CO-10003.pdf

Fielmua, N. (2011). The Role of the Community Management Model towards Improved and Sustainable Access to Potable

Water in Ghana (A Case of Nadowli District). *Journal of Sustainable Development*, *4*(3), 174–184. https://doi.org/10.5539/jsd.v4n3p174

Floyd, D. L., Prentice-Dunn, S., & Rogers, R. W. (2000). A meta-analysis of research on protection motivation theory. *Journal of Applied Social Psychology*, *30*(2), 407–429. https://doi.org/10.1111/j.1559-1816.2000.tb02323.x

Hall, D., Lethbridge, J., & Lobina, E. (2005). Public–Public Partnerships in Health and Essential Services. *MSP Occational Paper No. 9*, *July*. http://gala.gre.ac.uk/3639/

Hanley, N., Mourato, S., & Wright, R. E. (2002). Choice Modelling Approaches: A Superior Alternative for Environmental Valuatioin? *Journal of Economic Surveys*, *15*(3), 435–462. https://doi.org/10.1111/1467-6419.00145

Harvey, P. A., & Reed, R. A. (2007). Community-managed water supplies in Africa: Sustainable or dispensable? *Community Development Journal*, *42*(3), 365–378. https://doi.org/10.1093/cdj/bsl001

Hasan, M. B., Driessen, P. P. J., Majumder, S., Zoomers, A., & van Laerhoven, F. (2019). Factors Affecting Consumption of Water from a Newly Introduced Safe Drinking Water System: The Case of Managed Aquifer Recharge (MAR) Systems in Bangladesh. *Water*, *11*(12), 2459. https://doi.org/10.3390/w11122459

Huber, A. C., & Mosler, H. J. (2013). Determining behavioral factors for interventions to increase safe water consumption: A cross-sectional field study in rural Ethiopia. *International Journal of Environmental Health Research*, *23*(2), 96–107. https://doi.org/10.1080/09603123.2012.699032

Hutchings, P., Franceys, R., Mekala, S., Smits, S., Hutchings, P., Franceys, R., Mekala, S., & Smits, S. (2017). Revisiting the history , concepts and typologies of community management for rural drinking water supply in India. *International Journal of Water Resources Development*, *33*(1), 152–169. https://doi.org/10.1080/07900627.2016.1145576

Huxham, C. (2003). Theorizing collaboration practice. *Public Management Review*, *5*(3), 401–423. https://doi.org/10.1080/1471903032000146964

Inauen, J., Hossain, M. M., Johnston, R. B., & Mosler, H. J. (2013). Acceptance and Use of Eight Arsenic-Safe Drinking Water Options in Bangladesh. *PLoS ONE*, *8*(1). https://doi.org/10.1371/journal.pone.0053640

Isham, J. and Kahkonen, S. (1998). *Improving the Delivery of Water and Sanitation: A Model of Coproduction of Infrastructure Services* (Working Paper No. 210).

Jentoft, S. (2003). Co-management-the way forward. *Fish and Fisheries Series*, *26*, 1–16.

Kundu, D. K., Gupta, A., Mol, A. P. J., & Nasreen, M. (2016). Understanding social acceptability of arsenic-safe technologies in rural Bangladesh: A user-oriented analysis. *Water Policy*, *18*(2), 318–334. https://doi.org/10.2166/wp.2015.026

Lancaster, K. J. . (1966). A New Approach to Consumer Theory. *The Journal of Political Economy*, *74*(2), 132–157.

Lockwood, H., & Smits, S. (2011). Supporting Rural Water Supply: Moving towards a Service Delivery Approach. *Practical Action Publishing*, 202. https://doi.org/10.1017/CBO9781107415324.004

Madrigal, R., Alpízar, F., & Schlüter, A. (2011). Determinants of Performance of Community-Based Drinking Water Organizations. *World Development*, *39*(9), 1663–1675. https://doi.org/10.1016/j.worlddev.2011.02.011

Marschak, J. (1960). Binary choice constraints on random utility indications. In Arrow K (Ed.), *Stanford Symposium on Mathematical Methods in the Social Sciences*. Stanford University Press.

Moriarty, P., Smits, S., Butterworth, J., & Franceys, R. (2013). Trend in rural water supply: Towards a service delivery approach. *Water Alternatives*, *6*(3), 329–349.

Mosler, H. J. (2012). A systematic approach to behavior change interventions for the water and sanitation sector in developing countries: A conceptual model, a review, and a guideline. *International Journal of Environmental Health Research*, *22*(5), 431–449. https://doi.org/10.1080/09603123.2011.650156

Mosler, H. J., Blöchliger, O. R., & Inauen, J. (2010). Personal, social, and situational factors influencing the consumption of drinking water from arsenic-safe deep tubewells in Bangladesh. *Journal of Environmental Management*, *91*(6), 1316–1323. https://doi.org/10.1016/j.jenvman.2010.02.012

Naiga, R., Penker, M., & Hogl, K. (2015). Challenging pathways to safe water access in rural Uganda: From supply to demand-driven water governance. *International Journal of the Commons*, *9*(1), 237–260.http://doi.org/10.18352/ijc.480

Ostrom, E. (1990). *Governing the Commons: The Evolution of Institutions for Collective Action* (Ist editio). Cambridge University Press. https://doi.org/10.1017/CBO9780511807763

Ostrom, E. (1996). Crossing the Great Divide : Synergy , and Development. *World Development*, *24*(6), 1073–1087. https://doi.org/10.1016/0305-750X(96)00023-X

Ostrom, E., Janssen, M. A., & Anderies, J. M. (2007). Going beyond panaceas. *Proceedings of the National Academy of Sciences of the United States of America*, *104*(39), 15176–15178. https://doi.org/10.1073/pnas.0701886104

Pahl-Wostl, C. (2009). A conceptual framework for analysing adaptive capacity and multi-level learning processes in resource governance regimes. *Global Environmental Change*, *19*(3), 354–365. https://doi.org/10.1016/j.gloenvcha.2009.06.001

Parks, R. B., Baker, P. C., Kiser, L., Oakerson, R., Ostrom, E., Ostrom, V., Percy, S. L., Martha, B., Whitaker, G. P., & Wilson, R. (1981). *The concept of coproduction of public services has captured increased attention as a potential means* *of increasing the effec- tiveness and efficiency of local government . In this article we ex- plore the concept of coproduction in an effort to sharpen th*.

Pinkerton, E. (Ed. . (1989). *Co-operative management of local fisheries: new directions for improved management and community development*. UBC Press.

Ratna Reddy, V., Srinivasa Reddy, M., & Rout, S. K. (2014). Groundwater governance: A tale of three participatory models in Andhra Pradesh, India. *Water Alternatives*, *7*(2), 275–297.

Sadoff, C. W., Borgomeo, E., & Uhlenbrook, S. (2020). Rethinking water for SDG 6. *Nature Sustainability*, *3*(5), 346–347. https://doi.org/10.1038/s41893-020-0530-9

Sara, J., & Katz, T. (1997). Making Rural Water Supply Sustainable: Report on the Impact of Project Rules. *UNDP - World Bank Water and Sanitation Program*, 1–87.

Schwarzer, R. (2008). Modeling health behavior change: How to predict and modify the adoption and maintenance of health behaviors. *Applied Psychology*, *57*(1), 1–29. https://doi.org/10.1111/j.1464-0597.2007.00325.x

Shrimali, H. V. (2015). A brief review on reverse osmosis technology. *International Journal of Research in Advent Technology*, *3*(5), 93–97.

Smits, S. (2013). *Service delivery models*. IRC International Water and Sanitation Centre. https://www.ircwash.org/news/service-delivery-models

Wegerich, K. (2009). The hidden urban tail-enders - Drinking water supply as a common pool resource problem in Khorezm, Uzbekistan. *International Journal of Sustainable Society*, *1*(3), 240–254. https://doi.org/10.1504/IJSSOC.2009.027622

Wendimu, S., & Bekele, W. (2015). Determinants of individual willingness to pay for quality water supply : The case of Wonji Shoa Sugar Estate , Ethiopia. *Journal of Ecology and the Natural Environment*, *3*(15), 474–480. https://doi.org/10.5897/JENE11.089

Whaley, L., & Cleaver, F. (2017). *Can ' functionality ' save the community management model of rural water supply ?9*(March), 56–66. https://doi.org/10.1016/j.wrr.2017.04.001

Whittington, D., Davis, J., & McClelland, E. (1998). Implementing a demand-driven approach to community water supply planning: A case study of Lugazi, Uganda. *Water International*, *23*(3), 134–145.

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SUMMARY

Sustainable development goal (SDG) 6 aims to ensure the availability and sustainable management of water and sanitation for all. Drinking water scarcity has been a major concern, especially in developing countries. The main question underlying this research is: how to successfully govern sustainable community drinking water systems (DWS)? Pure public, private or self-governance arrangements do not always lead to optimal performance in the domain of drinking water delivery in developing countries. In response, both scholars and practitioners have turned to co-production arrangements. Community management plus (CM+) is one such approach to solving drinking water problems, that affords roles to both communities and external actors. The particular focus of this dissertation is on the CM+ model. CM+ implies an arrangement where the responsibility for operation and maintenance is shared between communities of drinking water system users and government agencies or local NGOs. This question is answered in this thesis in four steps - and in four successive chapters. Bangladesh's Southwestern coastal region served as the basis for the empirical research.

First, people's preferences for drinking water systems were established (chapter 2). For drinking water supply systems to continue working, the alignment between supply and demand is crucial. However, a well-working market for drinking water delivery

solutions is often absent in countries in the so-called Global South. Therefore, government agencies and/or donors need to come up with alternative ways to elucidate household preferences, instead. I designed a choice experiment that can serve as such an alternative. In applying it to a sample of 882 households I show that rather than simply preferring one drinking water system over the other, households determine what they prefer based on how they value a range of different attributes of such a system. Also, households with different attributes are found to value different drinking water system attributes, differently.

Second, I studied the impact of the availability of a range already present DWS alternatives in a community on the likelihood that a newly introduced DWS is successfully governed (Chapter 3). Rather than committing exclusively to one drinking water option, households in Bangladesh often use a portfolio of sources that in varying ways and to varying extents satisfy one or more out of several preferences they hold with regard to their drinking water. What happens if a new option is added to that mix? In 15 communities of Bangladesh' Southwestern coastal region where a new option (managed aquifer recharge, or MAR) was recently introduced, I observe variation in the extent to which this source contributes to satisfying households' drinking water needs. Using multiple linear regression (n=636 households) I find that perceived risk, costs, taste, self-efficacy, and form and intensity of competition with alternative drinking water options, matter significantly.

Third, I turn to characteristics of the relation between a community of DWS users, on the one hand, and public agencies, on the other, in my attempt to better understand the conditions for successful DWS governance under a CM+ regime (Chapter 4). Leaning on concepts borrowed from the commons literature, I developed a list of enabling conditions for (i) collective action among DWS users, and (ii) collaboration between DWS users and a public agency. I applied these lists to 30 pond sand filter (PSF) systems in the Southwestern coastal area in Bangladesh. Computing correlation, I find that group size, interdependency, heterogeneity, dependence on the resource system, locally devised rules and collaboration between PSF users and the public agency are significantly associated with the occurrence of collective action among PSF users. I also find that the latter (i.e. collaboration between PSF users and the public agency) is helped by transparency and inclusive decision-making procedures, but mostly by a relation that is characterized by trust.

Fourth, I have studied the role of NGOs in supporting DWS users in governing their shared resource successfully (Chapter 5). Although governing local, shared drinking water systems requires users to act collectively, users not always manage to organize such collective action successfully by themselves. NGOs are therefore frequently called upon to support local communities to set up or consolidate the kind of local collective action required for governing DWSs. However, the effectiveness of such forms of NGO support remains unclear. Therefore, I have assessed the form and impact of this kind of NGO support. To this end I examined 11 cases where NGOs have worked with users of Managed Aquifer Recharge (MAR) systems in Bangladesh. NGO activities seem based on applying standard approaches to training and awareness raising, and less on empowering users to craft their own solutions. A case for a lasting impact of NGO support on any of the requirements is hard to make. The results imply that when attempting to organize effective and long-lasting forms of collective action among the users of shared resource systems, both NGOs and commissioners of projects need to engage more explicitly in learning what works and what doesn't.

The theoretical contributions of this dissertation regards the conceptualization and organization of drinking water delivery approaches. I use economic theory on consumer preferences to add nuance and details to what "preference" and "demand" mean in the particular context of DWSs. I use theories from psychology and sociology on the adoption of innovations and added to the understanding of the conditions under which CM+ could be expected to do a better job at solving drinking water delivery problems than its predecessors. I apply theories on collective action and show that it makes analytical sense to conceive of DWSs as commons. I apply institutional and development theories on NGO support to show that NGO activities seem to be mostly based on applying standard approaches to training and awareness raising, and less on empowering users to craft their own solutions. When I started my research, the factors leading to the success of CM+ were mostly unexplored. In this dissertation, I have started to fill this knowledge gap. To explore the prerequisites for the success of CM+, my research draws on insights from different bodies of literature. I bundle theories and concepts from these literatures into an integrated and coherent whole. That is arguably the largest contribution to theory development that I offer in this dissertation.

In conclusion, how to successfully govern sustainable community drinking water systems? The answer to this question based on the research presented in this dissertation can be summarized as follows. First, peoples' preferences and perceptions should be the point of departure. In the absence of a market for drinking water solutions, a choice experiment can serve as a substitute to reveal household preferences. Efforts to establish what household want and need, require attention for the disaster resilience and reliability of the system, the health risks and taste of the drinking water, and socio-psychological factors such as community norms. Second, since DWSs have the characteristics of a commons, support (i.e., the "+" in "CM+") must target the organization of collective action (rather than (only) transferring resources (i.e., money and materials) and information (i.e., awareness and capacities). Public agencies must be transparent when engaging with communities, and allow for inclusive decision-making. NGOs must focus their support activities on empowerment and the development of self-governing capabilities. Third, throughout the dissertation I show that context matters, and that there are no panacea solutions to drinking water delivery problems. These broad-strokeprerequisites are interrelated.

NEDERLANDSE SAMENVATTING

Duurzame Ontwikkelingsdoel (SDG) 6 beoogt de beschikbaarheid en het duurzaam beheer van water en sanitaire voorzieningen voor iedereen te waarborgen. Drinkwaterschaarste is een belangrijk probleem, vooral in ontwikkelingslanden. De hoofdvraag die aan de basis ligt van dit onderzoek is: hoe kunnen duurzame gemeenschapsdrinkwatersystemen succesvol worden bestuurd? Puur publieke, private of zelfbesturingsregelingen leiden niet altijd tot optimale prestaties op het gebied van drinkwatervoorziening in ontwikkelingslanden. Als reactie daarop hebben zowel wetenschappers als mensen uit de praktijk zich gewend tot coproductieregelingen. *Community management plus* (CM+) is één van die benaderingen om drinkwaterproblemen op te lossen, waarbij zowel aan gemeenschappen als aan externe actoren een rol wordt toebedeeld. Deze dissertatie richt zich in het bijzonder op het CM+ model. CM+ impliceert een regeling waarbij de verantwoordelijkheid voor exploitatie en onderhoud wordt gedeeld tussen gemeenschappen van drinkwatersysteemgebruikers en overheidsinstanties of lokale Ngo's. Deze vraag wordt in dit proefschrift in vier stappen - en in vier opeenvolgende hoofdstukken - beantwoord. De zuidwestelijke kustregio van Bangladesh diende als basis voor het empirisch onderzoek.

Eerst zijn de voorkeuren van mensen voor drinkwatersystemen vastgesteld (hoofdstuk 2). Willen drinkwatervoorzieningssystemen blijven werken, dan is de afstemming tussen vraag en aanbod van cruciaal belang. Een goed functionerende markt voor drinkwatervoorziening is echter vaak afwezig in landen in het zogenaamde Mondiale Zuiden. Daarom moeten overheidsinstanties en/of donoren met alternatieve manieren komen om de voorkeuren van huishoudens te achterhalen. Ik heb een keuze-experiment ontworpen dat als zo'n alternatief kan dienen. Door het toe te passen op een steekproef van 882 huishoudens laat ik zien dat huishoudens niet eenvoudigweg het ene drinkwatersysteem verkiezen boven het andere, maar dat zij bepalen wat hun voorkeur heeft op basis van de waarde die zij hechten aan een reeks van verschillende attributen van zo'n systeem. Ook blijken verschillende huishoudens verschillende kenmerken van verschillende drinkwatersystemen verschillend te waarderen.

Ten tweede heb ik het effect bestudeerd van de beschikbaarheid van een reeks alternatieve drinkwatersystemen in een gemeenschap op de waarschijnlijkheid dat een nieuw geïntroduceerd drinkwatersysteem met succes wordt geïntroduceerd (Hoofdstuk 3). In plaats van zich uitsluitend te verbinden tot één drinkwater optie, gebruiken huishoudens in Bangladesh vaak diverse drinkwaterbronnen die op verschillende manieren, en in variërende mate voldoen aan één of meer van de verschillende voorkeuren die zij hebben met betrekking tot hun drinkwater. Wat gebeurt er als een nieuwe optie aan die mix wordt toegevoegd? In 15 gemeenschappen in de zuidwestelijke kustregio van Bangladesh waar recent een nieuwe optie (*managedaquiferrecharge*, of MAR) werd geïntroduceerd, observeer ik variatie in de mate waarin deze bron bijdraagt tot het bevredigen van de drinkwaterbehoeften van de huishoudens. Met behulp van meervoudige lineaire regressie (n=636 huishoudens) vind ik dat waargenomen risico, kosten, smaak, zelfredzaamheid, en vorm en intensiteit van concurrentie met alternatieve drinkwateropties, een significante invloed hebben op variatie in de mate waarin een nieuw drinkwatersysteem geaccepteerd en gebruikt wordt.

Ten derde heb ik mij gerichtop kenmerken van de relatie tussen een gemeenschap van drinkwatersysteemgebruikers enerzijds en overheidsinstanties anderzijds, in mijn poging om de voorwaarden voor succesvol bestuur van drinkwatersystemen onder een CM+ regime beter te begrijpen (Hoofdstuk 4). Op basis van concepten uit de *commons*-literatuur heb ik een lijst opgesteld van voorwaarden voor (i) collectieve actie onder DWS-gebruikers, en (ii) samenwerking tussen drinkwatersysteemgebruikers en een overheidsinstantie. Ik heb deze lijsten toegepast op 30 zogenaamde *pond sand filter* systemen in het zuidwestelijke kustgebied van Bangladesh. Door correlaties te berekenen, heb ik vastgesteld dat groepsgrootte, onderlinge afhankelijkheid, heterogeniteit, afhankelijkheid van het drinkwatersysteem, lokaal ontwikkelde regels en samenwerking tussen drinkwatersysteemgebruikers en het overheidsagentschap significant geassocieerd zijn met het voorkomen van collectieve actie onder drinkwatersysteemgebruikers. Ik concludeer ook dat het laatste (d.w.z. de samenwerking tussen drinkwatersysteemgebruikers en de overheidsinstantie) wordt bevorderd door transparantie en inclusieve besluitvormingsprocedures, maar vooral door een relatie die wordt gekenmerkt door vertrouwen.

Ten vierde heb ik de rol van Ngo's bestudeerd in het ondersteunen van drinkwatersysteemgebruikers bij het succesvol besturen van hun gedeelde hulpbron (Hoofdstuk 5). Hoewel het besturen van lokale, gedeelde drinkwatersystemen vereist dat gebruikers collectief handelen, zijn gebruikers zelden succesvol in het volledig op eigen kracht organiseren van dergelijke collectieve actie. Daarom wordt vaak een beroep gedaan op Ngo's om lokale gemeenschappen te ondersteunen bij het opzetten of consolideren van het soort lokale collectieve actie dat nodig is voor het beheer van hun drinkwatersysteem. De doeltreffendheid van dergelijke vormen van Ngo-steun blijft echter onduidelijk. Daarom heb ik de vorm en het effect van dit soort Ngo-steun geëvalueerd. Daartoe heb ik 11 gevallen onderzocht waarin Ngo's hebben samengewerkt met gebruikers van zogenaamde*ManagedAquiferRecharge* (MAR)systemen in Bangladesh. De activiteiten van Ngo's lijken te zijn gebaseerd op het toepassen van standaardbenaderingen voor training en bewustmaking, en minder op het in staat stellen van gebruikers om hun eigen oplossingen te bedenken. Het is moeilijk aan te tonen dat de steun van Ngo's een blijvend effect heeft op een van de behoeften. De resultaten impliceren dat bij pogingen om effectieve en langdurige vormen van collectieve actie te organiseren onder de gebruikers van systemen van gedeelde hulpbronnen, zowel Ngo's als opdrachtgevers van projecten zich meer expliciet moeten bezighouden met het leren wat werkt en wat niet.

De theoretische bijdragen van dit proefschrift hebben betrekking op de conceptualisering en organisatie van benaderingen voor drinkwatervoorziening. Ik heb een economische theorie over consumentenvoorkeuren gebruikt om nuance en details toe te voegen aan wat "voorkeur" en "vraag" betekenen in de specifieke context van drinkwatersystemen. Ik heb theorieën uit de psychologie en sociologie gebruikt over de adoptie van innovaties en bijgedragen aan het begrip van de voorwaarden waaronder CM+ naar verwachting beter werk zalbijdragen aan het oplossen van drinkwaterleveringsproblemen dan zijn voorgangers. Ik heb theorieën over collectieve actie toegepast en aangetoond dat het analytisch zinvol is om drinkwatersystemen te zien als een gedeelde hulpbron, oftewel *commons*. Ik heb institutionele en ontwikkelingstheorieën over Ngo-ondersteuning toegepast om aan te tonen dat Ngo-activiteiten gebaseerd lijken te zijn op het toepassen van standaardbenaderingen van training en bewustmaking, en minder op het in staat stellen van gebruikers om hun eigen oplossingen uit te werken. Toen ik aan mijn onderzoek begon, waren de factoren die leiden tot het succes van CM+ grotendeels onontgonnen terrein. In dit proefschrift heb ik een begin gemaakt met het opvullen van deze kenniskloof. Om de voorwaarden voor het succes van CM+ te verkennen, heb ik in mijn onderzoek gebruik gemaakt van inzichten uit verschillende literatuurbronnen. Theorieën en concepten uit deze literatuur heb ik gebundeld tot een geïntegreerd en samenhangend geheel. Dat is misschien wel de grootste bijdrage aan theorievorming die ik in dit proefschrift lever.

Kortom, hoe kunnen duurzame gemeenschappelijke drinkwatersystemen succesvol worden bestuurd? Het antwoord op deze vraag, gebaseerd op het onderzoek dat in dit proefschrift wordt gepresenteerd, kan als volgt worden samengevat. Ten eerste, de voorkeuren en percepties van mensen zouden het uitgangspunt moeten zijn. Bij gebrek aan een markt voor drinkwateroplossingen kan een keuze-experiment dienen als een substituut om de voorkeuren van huishoudens te bepalen. Inspanningen om vast te stellen wat huishoudens willen en nodig hebben, vereisen aandacht voor de rampbestendigheid en betrouwbaarheid van het systeem, voor de gezondheidsrisico's en de smaak van het drinkwater, en voor een reeks sociaalpsychologische factoren zoals gemeenschapsnormen. Ten tweede, aangezien drinkwatersystemen de kenmerken hebben van een gemeengoed of *commons*, moet ondersteuning (d.w.z. de "+" in "CM+") gericht zijn op de organisatie van collectieve actie (in plaats van (alleen) het overdragen van middelen (d.w.z. geld en materialen) en informatie (d.w.z. bewustzijn en capaciteiten). Overheidsinstanties moeten transparant zijn bij hun contacten met de gemeenschappen en moeten een inclusieve besluitvorming mogelijk maken. Ngo's moeten hun ondersteunende activiteiten richten op *empowerment* en de ontwikkeling van capaciteiten voor zelfbestuur. Ten derde toon ik in deze dissertatie aan dat de context van belang is en dat er geen wondermiddelen bestaan voor de oplossing van drinkwatervoorzieningsproblemen. Dezealgemenevoorwaardenzijn - onderling met elkaarverbonden.

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CURRICULAM VITAE

Muhammad Badrul Hasan was born on the 1st of January 1983 in Kishoreganj district in Bangladesh. He spent his sweet boyhood in the Kishoreganj with his family until he was 20. He completed his Secondary School Certificate (SSC) and Higher Secondary Certificate (HSC) in 1998 and 2000 from the Hafez Abdur Razzak Pilot High School and Bajitpur Degree College respectively. Having found his alma mater in the University of Dhaka, he obtained his Bachelor degree and Masters' degree in the Department of Political Science. He achieved outstanding results in both of those examinations for which he received different prestigious awards including Social Science Dean's Award. During this time, Badrul also got involved in different social and voluntary organizations, for example, Rotareact club in University of Dhaka, Association of English Learners at Mohsin Hall, University of Dhaka, Prothom Alo Bandhusova and so on.

After his graduation, Badrul started working first as an Executive Officer at the Women for Women: a research and study group– the first women non-government organization in Bangladesh, and then as a faculty at the Department of Political Science in Bangladesh Open University- a public university till 2013. Then, he joined as a faculty at the Department of Political Science in the University of Dhaka and continued working until the early 2016.

In January 2016, Badrul started working on his PhD at the Department of Environmental Governance at the Utrecht University. This PhD was part of Delta-MAR project and focused on assessing the governance guidelines for the successful implementation of Managed Aquifer Recharge in the South-western coastal Bangladesh. During his PhD, Badrul remained motivated to make science contribute to the society, hence participated in different international conferences and symposiums such as***e***-conference on "Access to Drinking Water Webinar: co-creation in Africa #SDG6 (November 2020) in TU Delft University,International Conference on Earth and Environmental Sciences & Technology for Sustainable Development (ICEEST) (January 2020) in Dhaka, 10th International Symposium on Managed Aquifer Recharge (May 2019) in Madrid, LANDac Annual International Conference, (July, 2019) in Utrecht, and symposium on the Earth System Governance (July 2018) in Geneva. The final outcomes of his PhD research are presented in this dissertation.

Currently, Badrul works as a faculty at the Department of Political Science in the University of Dhaka, Bangladesh. He lives in Dhaka – the capital city of Bangladesh.

PUBLICATIONS

- **Hasan, MB.**, van Rijnsoever, Driessen, P.P., Zoomers, A., and van Laerhoven (2021) Elucidating households' preferences for drinking water supply systems in Bangladesh: A choice experiment (Submited for publication at Water International Journal).
- **Hasan, M. B.**, Driessen, P., Zoomers, A., & Van Laerhoven, F. (2020). How can NGOs support collective action among the users of rural drinking water systems? A case study of Managed Aquifer Recharge (MAR) systems in Bangladesh. *World Development*, *126*, 104710.
- **Hasan, M. B.**, Driessen, P. P., Majumder, S., Zoomers, A., & van Laerhoven, F. (2020). A Community Management Plus Model for the Governance of Rural Drinking Water Systems: A Comparative Case Study of Pond Sand Filter Systems in Bangladesh. *International Journal of the Commons*, *14*(1).
- **Hasan, M. B.**, Driessen, P. P., Majumder, S., Zoomers, A., & van Laerhoven, F. (2019). Factors affecting consumption of water from a newly introduced safe drinking water system: the case of managed aquifer recharge (MAR) systems in Bangladesh. *Water*, *11*(12), 2459.
- **Hasan, M. B.** (2013). State of Governance in Bangladesh: A Critical Assessment from Institutional Perspective. *Journal of Dhaka University Studies*, Bangladesh, Volume 70, Number 1
- **Hasan, M. B.** (2008). PRGF Programme in Bangladesh: An Assessment. *BIISS Journal*, Bangladesh, Volume 29 Number 1

In coastal Bangladesh, community drinking water systems (DWS) seem to perform sub-optimally. This may be largely attributed to the crisis of governance arrangement. Until the 80's, pure public or private governance arrangement had been adopted, but failed to produce the optimal performance of community DWS. Then, since the international drinking water supply and sanitation decade (1981-90), community management (CM) approach has been promoted as a better alternative. However, in the recent times, the CM approach has been reaching its limits producing sub-optimal performance of DWS. Community people frequently faces dilemma (i.e., appropriation dilemma and provision dilemma) to devise their own institutions, thus they need support from external entities. Many of scholars termed this arrangement as community management plus (CM+). The national policies of Bangladesh guiding operation and maintenance of DWS also stipulates the CM+ approach. However, there is still lacking the pre-conditions under which the CM+ model can succeed in case of community DWS. This dissertation describes the research that explores the prerequisites for the success of CM+and thereby helps to promote optimal performance of community DWS in coastal Bangladesh.