Muniruzzaman , I.K.; Mirza, S.; Islam, K. and Koli, K. 2017.
Viewpoint – Taking a multidimensional approach to small town water supply: The case of Paikgachha.
Water Alternatives 10(2): 562-577

Viewpoint – Taking a Multidimensional Approach to Small Town Water Supply: The Case of Paikgachha

Imrul Kayes Muniruzzaman
Director – Fundraising and Learning, WaterAid Bangladesh, Dhaka, Bangladesh; imrulkayesmuniruzzaman@wateraid.org

Shahrukh Mirza
Strategic Support Specialist, WaterAid Bangladesh, Dhaka, Bangladesh; shahrukhmirza@wateraid.org

Khairul Islam
Country Director, WaterAid Bangladesh, Dhaka, Bangladesh; khairulIslam@wateraid.org

Kolimullah Koli
Independent Consultant; koli713165@gmail.com

ABSTRACT: Ensuring access to safe drinking water in climate-vulnerable southwest Bangladesh is a growing challenge. People living in the coastal municipality town of Paikgachha in Khulna District are suffering from an acute crisis of drinking water due to contamination of groundwater by salinity, iron and arsenic. WaterAid Bangladesh piloted a piped water supply model with a progressive tariff approach that brings residents, especially the poor, safe and affordable water, while ensuring financial sustainability of the model. This paper discusses how the multidimensional approach underlying the development of the piped water system successfully addressed the social and institutional dimensions of water supply in a context involving multiple stressors. The initiative has demonstrated that sustainable service with full cost recovery is possible while addressing equity issues in the challenging circumstances of Bangladesh's coast.

KEYWORDS: Water supply, piped water, small town, progressive tariff, sociotechnical approach, Bangladesh

INTRODUCTION

Bangladesh is a rapidly urbanising nation, with 34% of its population living in urban areas (World Bank 2017). The growth rate of the urban population is much higher than that of the total population – 6 vs 1.3% – and at current trends it will lead to a doubling of the urban population to approximately 74 million by 2035 (IED 2009). As acknowledged in the country's 7th Five Year Plan (Planning Commission, 2015), the urban landscape is marked by rising inequality, and the urban poor, in particular, face limitations in accessing services such as water supply, sanitation and drainage. These trends are percolating beyond cities, affecting municipalities and small towns, which are comparatively even more constrained in terms of resources and capacity. The rapid rate of urbanisation poses significant challenges to infrastructure and services in small towns and municipalities, which are struggling to cope with a persistent increase in rural-urban migration.

About 28 million Bangladeshis, or just over 20% of the population, are living in harsh conditions in the hard-to-reach areas[1] that make up a quarter of the country's landmass (World Bank, 2012). In addition, Bangladesh is facing multiple threats from climate change, coming out on top in a global ranking of climate change vulnerability (Verisk Maplecroft, 2011). The impact of climate change, including rising salinity, erratic rainfall, and more frequent and intense natural disasters, is already being experienced in many parts of the country, and constitutes a significant additional stress on urban infrastructure (ADB, 2009).

The dual pressures of unplanned urbanisation and climate change are compounded by weak local government institutions (LGIs) at the municipality level that generally do not have the human, financial or technical resources to address the multiple risks faced by small towns situated in climate change-vulnerable areas (ADB, 2009). Populations in small towns must, therefore, contend with poor municipal services, including water and sanitation. Low-income groups typically face even more severe restrictions in access compared to the general population given their lack of legal tenure; and low-income urban settlements are often characterised by much lower living standards as a result, including higher rates of morbidity, maternal and child mortality, nutrition and life expectancy (Dodman and Satterthwaite, 2008). According to numerous studies, many of these public health problems are linked to water and sanitation.

Despite these issues, small towns and municipalities are usually neglected in both government and development assistance planning (WaterAid, 2010). Identifying this critical gap, WaterAid has been working to globally push the small town agenda in its country programmes and global advocacy since 2007. As part of this organisational initiative, the WaterAid Bangladesh Country Programme has been working in a small number of municipalities in Bangladesh since 2009. One of its project areas is the town of Paikgachha, located in the southwest district of Khulna. Paikgachha is situated in the highly vulnerable coastal belt, which is subject to frequent tropical storms and cyclones. Besides these, the belt is experiencing rising salinity in groundwater and surface water as a result of unregulated shrimp cultivation as well as climate change. The region is yet to recover from the effects of cyclone 'Sidr' in November 2007 and 'Aila' in May 2009.

WaterAid Bangladesh began a pilot project on Piped Water Supply System (PWSS) in Paikgachha in 2012 to reduce water crisis in the town. The project set up a pre-aeration and filtration type water treatment plant to treat groundwater that provides about a quarter of the people in the town with access to safe drinking water. The PWSS is unique because of its use of a progressive tariff system that enables poor and extreme poor families to buy water at an affordable rate. The case of Paikgachha is presented in this paper as an example of sustainable cost recovery with equitable access and progressive billing in a coastal town under multiple stressors, including urbanisation and climate change.

The paper is prepared as a learning output to share a ground experience of water supply from one of the project areas of WaterAid. Information used in the documentation came from multiple sources including conversations with municipality staff, water user groups, NGO partners; and going through municipality records and WaterAid project documents. Limited secondary data have been used to explain the context and indicate challenges in urban water supply in Bangladesh.

The following sections explore the background to the project in more detail, describing the challenges facing coastal municipalities, including Paikgachha. We then look at the nature of the intervention through a sociotechnical lens, presenting a case for multidimensional approaches to water supply projects in the coastal context. Finally we discuss the potential for replication and key constraints before concluding.

[1] Areas are defined as hard-to-reach, based on six indicators: groundwater table, drinking water coverage, sanitation coverage, hot spots, poverty and child mortality (World Bank, 2012).

BACKGROUND

The challenges of coastal Bangladesh

The coastal region of Bangladesh, comprising 19 districts with a population of over 38 million, faces a unique set of environmental, climatic and socioeconomic challenges. The region has a low-lying topography, intersected by a wide riverine network, and enclosed by polders (man-made islands protected by embankments) as protection against flooding. Despite a number of important economic activities being centred in the region, including fisheries, shrimp cultivation and agriculture (15% of the country's arable land is located within the coastal embankment), the area is characterised by high rates of poverty, with 14 of the 19 districts having poverty rates that are higher than the national average (World Bank, 2014a).

There is growing evidence of the impact of climate change in the southwest coastal region. Research on hydro-meteorological trends in the region of Khulna indicate rising temperatures and increasing intensity and magnitude of rainfall (Mondal et al., 2013). There is evidence of intrusion of the saline waterfront landward from measurements of soil and water salinity in coastal areas, and predictions of an increase in this phenomenon (World Bank, 2014a; ADB, 2011). These challenges are compounded by human interventions in the shape of the Farraka Barrage, which has created an upstream diversion; and the coastal polders, which have reduced the flood-plain storage areas for tidal waters, impeding drainage and leading to siltation of rivers (Mondal et al., 2013; World Bank, 2014a). Widespread shrimp cultivation in the coastal belt has also contributed to increasing salinity levels (Benneyworth et al., 2016).

One of the primary resources affected by this intersection of environmental and economic challenges is water. Despite significant water resources, Bangladesh is highly vulnerable to water insecurity (Benneyworth et al., 2016; ADB, 2016). The coastal region is particularly vulnerable given its susceptibility to the impacts of climate change, which can detrimentally affect both surface water and groundwater levels. One of the key impacts of a warming climate is rise in sea level, which results in saline intrusion in both shallow and deep aquifers. The situation in the coast is further complicated by intermittent deposits of thick clay, which impedes natural flushing and recharge of groundwater aquifers during the monsoonal season (Benneyworth et al., 2016). Precipitation variability due to climate change also reduces groundwater recharge rates, further affecting the availability of freshwater from groundwater resources (Opel, 2016).

The impact of climate change on surface water is even more immediate and visible. Changes in rainfall pattern and air temperature affect river flow, which ultimately worsens different forms of water pollution, such as sediment, pathogens and pesticides. Besides, rising sea levels and storm surges encroach into surface water bodies, salinising freshwater sources (Opel, 2016). Significant changes in river salinity are expected in the southwest that will lead to acute shortages in drinking water in coastal urban areas, as well as scarcity of irrigation water in the dry season (World Bank, 2014a). Increasing saline intrusion and water pollution threaten water quality, further reducing the already scarce supply of potable water. Water quality is also compromised by poor sanitation practices that lead to faecal contamination, and the use of fertilisers and pesticides in fish cultivation and agriculture – major economic activities in the region. While groundwater is considered safer from a bacteriological point of view, the presence of arsenic, chlorides, and iron in excessive amounts compromise the quality of freshwater from groundwater sources (Khan et al., 2013; Benneyworth et al., 2016).

The knock-on impact of growing water scarcity and poor water quality are considerable. In terms of health, studies have shown that people in coastal areas in Bangladesh are consuming higher than average intakes of salt due to greater exposure to salinity in food and drinking water (Rasheed at al.; 2014), while there is a significant association between salinity in drinking water and increased risk of (pre)eclampsia and gestational hypertension in coastal populations (Khan et al., 2014). In terms of

wider socioeconomic impacts, there is evidence which suggests that the lack of safe water is one of the factors driving out-migration from the coastal region. In the district of Khulna, the rural subdistricts closest to the coast and affected most severely by saline intrusion in surface water and groundwater show the highest rates of depopulation (Opel, 2016).

The rest of this paper will focus on the case of Paikgachha, a small municipality located in the wider Paikgachha *upazila* (subdistrict) in the district of Khulna. The municipality presents a highly relevant case for examination of water scarcity in a small-town context in coastal Bangladesh.

Overview of Paikgachha, a coastal municipality

Municipality authorities (Pourashavas) are local governments of secondary towns, with population sizes ranging from around 10,000 to 600,000 (IED, 2009). Bangladesh has 325 Pouroshavas or municipalities which have been divided into three categories, A, B and C, depending on their population and annual revenues. District headquarters and larger towns fall in the A category, which typically display better social and physical services compared to B and C categories, which are medium and small towns, which usually remain unfunded and underserved (WaterAid, 2013).

The Pourashava or municipality authority itself is a body of elected councils and chairmen responsible for management of towns based on the Local Government (Pourashava) Act 2009. The act fully authorises a Pourashava to produce and supply water and render related services to its citizens. The mandated responsibilities of the Pourashava) include sanitation, water supply and sewage, amongst wider town planning and development, and public infrastructure. However, in practice, municipality authorities rarely have the institutional capacity needed to raise adequate revenue or recruit the necessary technical and human resources needed to carry out their mandate (ADB, 2009). Municipal authorities in remote small towns are the biggest victims of capacity gaps. In Paikgachha, for example, a baseline conducted in 2012 found that 55% of the 75 posts sanctioned for the municipality were vacant (PMID, 2012).

These constraints gain more significance in cases where municipalities are faced with wider socioeconomic and environmental challenges. The case of Paikgachha demonstrates some of these tensions. Established in February 1997, the town has a population of about 19,765 living in an area of 2.52 km^2, with over 40% of the population living below the poverty line (PMID, 2012).

The larger sub-district of Paikgachha shows a declining population growth rate despite growing urbanisation, going from 0.98 percent in 2001 to -0.01 percent in 2011 despite growing urbanisation (Opel 2016). High levels of salinity affect both surface water and groundwater in the subdistrict, as seen in the figure below. Besides, high levels of arsenic and iron contamination in the shallow aquifer in Paikgachha have worsened the crisis of potable water, with only three wards out of ten in Paikgachha municipality having some access to freshwater. Most people who can afford to buy water from vendors at an average price of approximately USD1.00/100 litres. This is roughly 100 times the subsidised rate for government supply in big cities.

Calculations show that an average family in Paikgachha municipality spends over 9% of their monthly income on meeting the basic requirement of drinking water considered necessary in an emergency (3 litres per person per day). If considering the WHO standard of 20 litres per person per day, this figure goes up to 62% of the average monthly household income (Opel, 2016). Poor families that cannot afford these expenses are often forced to use contaminated surface water without any proper treatment, or travel long distances to collect water from other wards. During the monsoon, most households practice rainwater harvesting as an alternative, but generally this can only serve a household for a month or two beyond the rainy season (WaterAid, 2013). The poor and the women are the major victims, as the poor cannot afford to buy water from private vendors, and women and children face social, physical and physiological problems in carrying out their socially and culturally

Figure 1. Map of Khulna District and Paikgachha.

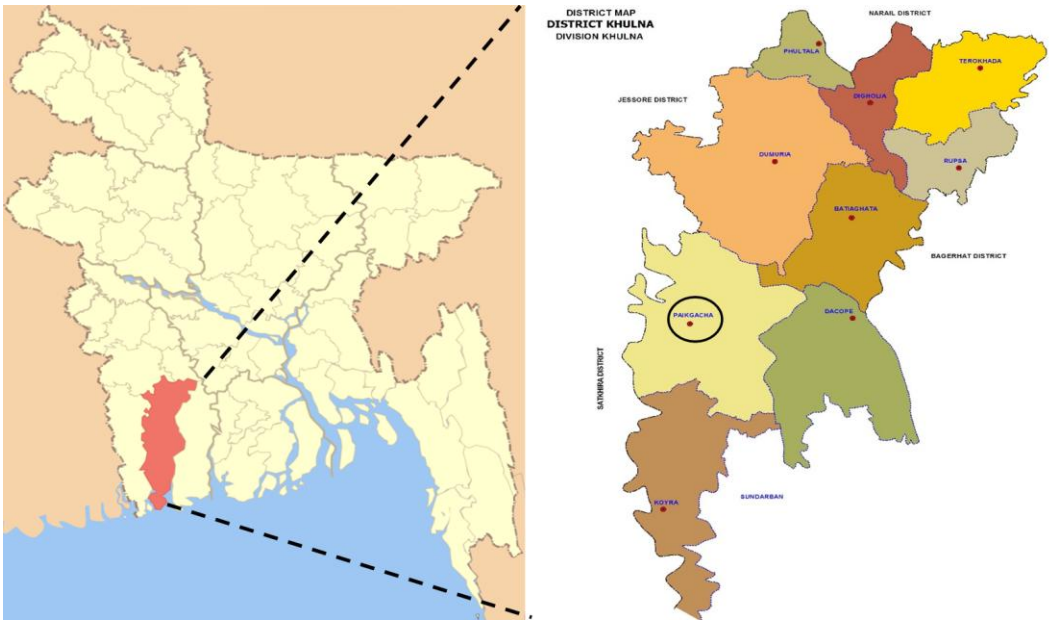
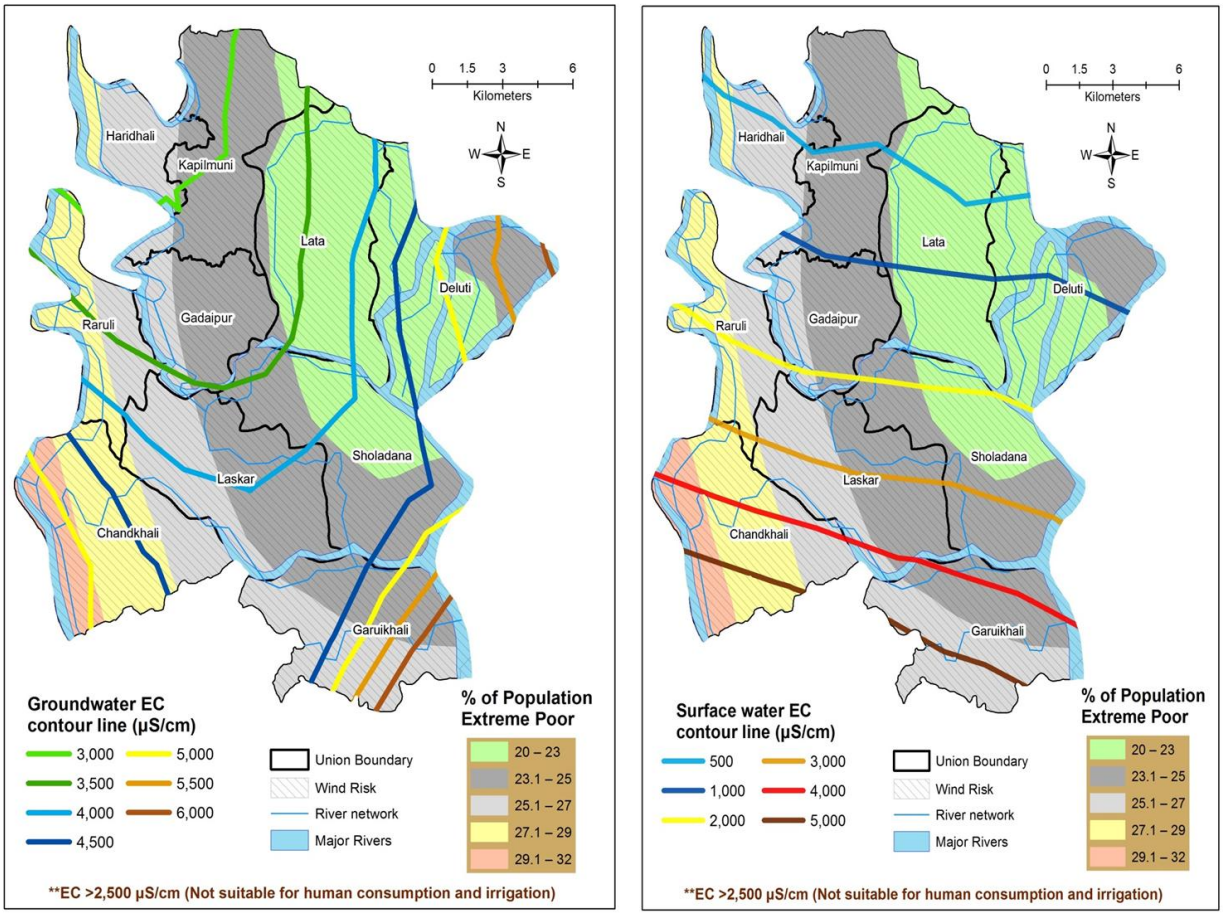


Figure 2. Salinity levels in Paikgachha (map collected from International Centre for Climate Change and Development (ICCCAD) by authors, based on data from Bangladesh Water Development Board (BWDB), 2013.



assigned task of collecting water for the family (Faisal and Kabir, 2005; Khan et al., 2013). While there are plans for constructing climate-resilient infrastructure and addressing lowering freshwater supplies, these have so far remained limited to core urban areas (Khulna City), with no clear indications of how water insecurity in peri-urban areas in the region will be addressed (Khan et al., 2013). In this context, the role of both local government and communities in managing services that can adapt to these impacts will be critical to the overall resilience of local communities, particularly low-income groups that face more barriers to access compared to wealthier counterparts.

ANALYSIS OF THE PIPED WATER SUPPLY SYSTEM (PWSS) IN PAIKGACHHA

WaterAid Bangladesh began its work in Paikgachha in 2009 as part of its Small Town programme. The intervention was scaled up in 2011 with funding from Thames Water. The intervention had four distinct components: i) construction of a water treatment plant; ii) construction of a pipe network and water points; iii) development and application of a pro-poor tariff system; and iv) capacity development of the municipality. WaterAid engaged a local partner NGO, Nabolok,[2] to deliver the outputs on the ground with technical inputs from the WaterAid team. The focus of the intervention was equally on developing and strengthening community mechanisms needed for sustaining the operation, as much as on the technology. This necessitated working on multiple dimensions, including technology, local government and community mobilisation. The interplay of human and technical aspects presents the opportunity to analyse the project with a sociotechnical lens to understand the value of a holistic approach in designing small town water supply projects under conditions of multiple stressors, including climate change, water scarcity and high rates of poverty.

Sociotechnical analyses of water management and water systems emphasise the complexity of technological change, acknowledging the interrelationship between technological and social dimensions, and studying the role of multiple actors (Abdullaev and Mollinga, 2010; Nilsson and Nyanchaga, 2012; Ahlborg and Sjöstedt, 2015). As argued by Pahl-Wostl (2007) in the case of river basin management, uncertainties caused by changes in climate and socioeconomic conditions mean more attention has to be given to understanding environmental, economic and institutional dimensions of water systems, making the sociotechnical perspective particularly relevant to understanding water issues in the dynamic context of Bangladesh's coastal municipalities.

In order to explore this angle further, this section will utilise the research framework, adapted from Abdullaev and Mollinga's 2010 study on water management in Uzbekistan to analyse the PWSS intervention. The system will be considered under each of the dimensions separately, before being brought together under an overarching analysis of the interlinkages between the three.

Table 1. Research framework for sociotechnical analyses of Paikgachha's piped water supply system (adapted from Abdullaev and Mollinga, 2010: 86).

Dimensions	Research object
Physical (technical)	Physical shape, type and state of technology
Organisational (managerial)	Institutions, organisations, and management
Socioeconomic and political	Social and governance structures

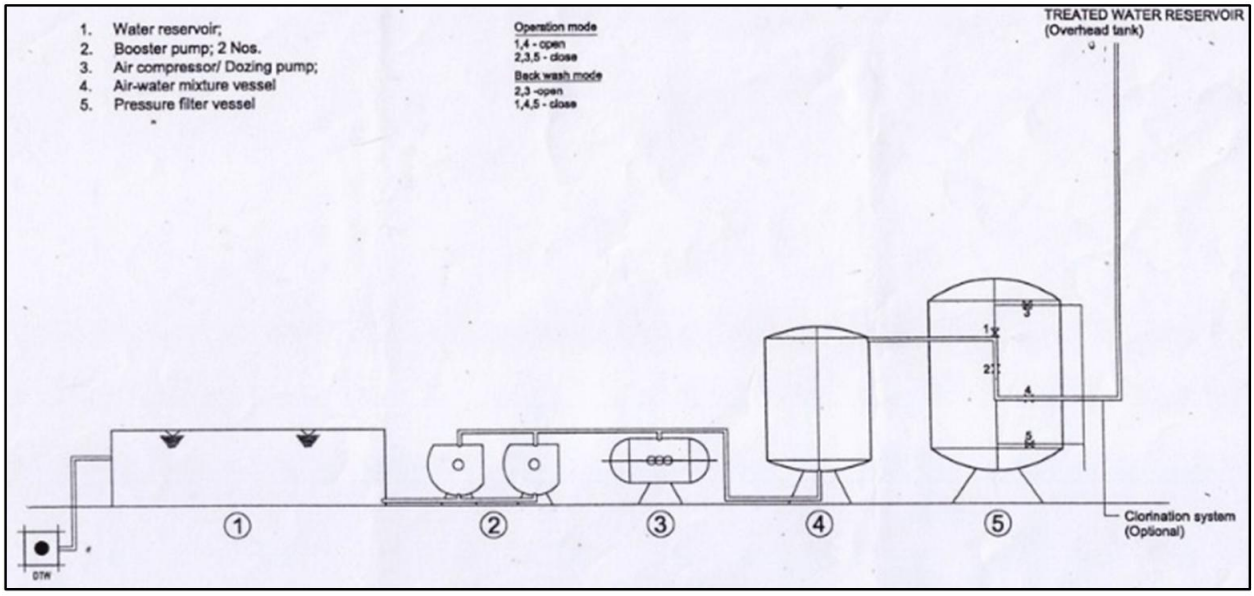
[2] Nabolok (new folk) is the name of a regionally focused national NGO in Bangladesh. WaterAid has been partnering with this NGO for more than a decade.

Physical: The piped water supply system (PWSS)

WaterAid supported Paikgachha municipality to build a piped water supply system (PWSS) in partnership with Nabolok and Rural Development Academy (RDA). RDA is an autonomous government institution specialising in training, research and action research on rural issues. RDA, WaterAid and the municipality jointly provided the financing for the system, while WaterAid and Nabolok provided technical expertise related to the design of the system and management of its construction.

The physical infrastructure of the PWSS consists of a treatment unit, an overhead tank, an underground tank and a pipe network. Construction of the plant took about 1.5 years, and was completed in 2015. The treatment plant consists of three production wells (each of two has a capacity of 10,000 litres/hr and the third one has a capacity of 30,000 litres/hr), an iron cascade type pre-treatment unit, two water reservoirs with a combined capacity of 250,000 litres, and two filter vessels.

Figure 3. Layout of the water treatment plant.



Regular water quality tests have been conducted since the plant began operating, testing whether all parameters are within acceptable limits both after treatment at the plant, and at the user end. These tests show whether the water quality has consistently met the national standards. Key features of the system are as follows:

Table 2. Key features of the system.

Key features	Quantity
Total production capacity	50,000 litres/hour
Total water supply capacity	50,000 litres/hour
Overhead tank capacity	50,000 litres
Underground tank capacity	250,000 litres
Daily water supply	2 times/day

Organisational: The progressive tariff structure

In the context of communities where most households are low-income, pro-poor and progressive water tariffs can play an important role in assuring access to all. In Paikgachha, five different user categories have been identified, that are charged different rates based on their ability, with payment rising progressively with increasing use.

Based on the community consultations, the tariff rates have been set as follows:

Table 3. Differential pricing based on connection.

User category	Price /1000 litres (up to 7000 l /month) (US$)	Price /1000 litres (over 7000 l/month) (US$)
Community connection for poor[3]	0.62	0.62
Institutions and offices	1.00	1.25
Commercial connection	1.50	1.87
Temporary and others	1.87	2.50

For up to 7000 litre consumption per month, poor families pay BDT 50/1000 litres, while non-poor categories pay more. The tariff rises progressively with increasing consumption of more than 7000 litres per month. However, poor families pay the same flat rate of BDT 50 in consideration of affordability.

Additionally, community water point installations are charged reduced connection fees. This is important as large connection costs can be a bottleneck to expanding piped water access amongst the poor, while finding ways to lower connection costs substantially improves connection ratios amongst low-income groups (ADB, 2012). Altogether, 1355 families (64% are poor); eight educational institutions and two restaurants have been connected to safe drinking water through 382 metered connections (up to May 2016).

All connections are metered, and a member from the water supply department of the municipality visits the houses/meters every month to take the meter reading. Monthly bills are then produced and sent to the owner of the meter. The municipality also follows a water-quality guideline to ensure drinking water quality. This includes regular testing of water at specific intervals against different parameters in government laboratories, and regular reviewing of water-quality reports.

[3] The project uses the definition of the National Water Supply and Sanitation Cost Sharing Strategy 2012, which defines the urban hardcore poor as meeting any of the following criteria: (a) landless households, (b) pavement/slum dwellers/homeless, (c) main earning person or head of family is day labourer, owning less than 100 decimals of cultivable and homestead land or residing in a rented premise lesser than 200 square feet, and having no fixed source of income, (d) households headed by disabled or females or old-aged (65+) persons, (e) monthly household income not exceeding Taka 3999. The urban poor are defined as meeting any of the following criteria: (a) landless, living in poor quality (i.e. semi-pucca or tin-roofed) house or in a rented premise lesser than 500 square feet, (b) having single income source of the household, not exceeding monthly income of Taka 4999, (c) having 3 (three) months' food deficit per calendar year, both men and women sell labour occasionally, (d) having limited access to educational facilities of their children. The non-poor are defined as anyone other than the poor and hardcore poor (PSU, 2012).

Table 4. Type of connections (up to May 2016).

Type of connection	Type of consumers	No. of connections	No. of families	No. of users
Community connections	Community tap stand	54	309	1183
	Community water point	31	523	1551
Household connection	Single family	201	201	1012
	Multiple family	86	312	1600
Commercial connection	Restaurant	2	2	108
Institutional and others	School, college and madasha[4]	8	8	4686
Total connections		382	1355	10,140

Management and operations and maintenance (O&M)

Backing this tariff regime is a full financial and O&M system strengthened as part of the project's work. Before the PWSS installation, there was no separate wing in Pourashava to deal with water. After PWSS installation, Pourashava authority realised that a separate division was needed to operate the water supply system, and manage connections, bill collection and troubleshooting. A team of eight members was recruited for the Pani Shakha (water wing), of which seven are funded by the Pourashava itself, and one position is supported by the project. These team members were involved in the establishment of the plant, and are well-oriented on the pro-poor aspects of the system.

The Pani Shakha uses a customised software system developed with support from project funding to track the usages of every meter and generate monthly bills. A separate bank account has been opened to collect the payments, and the meter owners deposit their payments in the account against individual meter numbers. Every month, the Pani Shakha checks the bank statement and deposit slips to identify the defaulters, and sends notices to the defaulting meter owners. There is a step-by-step guideline to collect default bills or close the line of major defaulters. To date, no illegal or bypass connections have been found. The incidence of corruption has also been low, although in one case, it was found that the poor families who enjoyed progressive tariff facilities sold water to local hotels. This case was settled through deliberation between the household in question and the Pourashava, and there have been no such incidents since.

A ward-wise water management committee has also been formed with seven members, nominated from both users and ward councillors. The committee is required to have at least two members, one male and one female, from poor or extreme poor families, to represent the views of marginalised households. This committee provides support to the municipality for monitoring tariff collection and ensuring smooth operation overall. A central user committee has also been formed at the municipality level, in order to ensure that the system continues to be customer-friendly and pro-poor, with both male and female representation from lower-income groups, civil society, the private sector, and other notable figures in the community.

[4] Educational institution providing religious education following public exam and government approved curriculum. The degrees are compatible with the degrees of mainstream education and the system is governed by a separate Board of Education under the Ministry of Education

Additionally, the Pourashava and project staff worked together to develop a guideline for the PWSS, setting out all aspects of operating the system such as the formation of the water management committees, the roles and responsibilities of staff and customers, definitions of different categories of users, connection fees, etc. The development of the manual was, in itself, an extensive exercise that built the capacity of local government stakeholders to understand how to organise their activities in an open and transparent manner, with checks and balances built in for greater accountability, such as an annual general meeting for the Pani Shakha with representation from the community.

Socioeconomic and political: Building community and political ownership

The key innovation of the Paikgachha piped water supply system lies in its adoption of a tariff structure that increases progressively, and has been developed so that even the poorest families are assured a minimum level of safe water supply. However, this element is the result of a wider set of activities targeted towards creating an enabling social and political environment needed to realise the idea of progressive tariffs. This section describes these activities as the final element in the PWSS development.

Sensitising and capacity-building of municipality and community

The Nabolok NGO worked with the Pourashava on sensitisation and capacity-building activities for close to two years prior to the PWSS agreement. As a result of this long-term engagement, a more capable and strategic duty-bearer emerged. Capacity-building included training to Pourshava councillors and staff on water and sanitation as a human right. The trainings included an explicit pro-poor focus, emphasising that the municipality had a responsibility in fulfilling this human right. Another important part of capacity-building of local government was exposure visits to other water-scarce municipalities. This has been cited by the mayor and councillors in key informant interviews as a key resource for the Paikgachha PWSS, acting both as a source for ideas and an igniter for change. The exposure visits to other small towns facing similar challenges, such as Mongla, Faridpur and Kushtia, showed the municipality authorities that despite the severity of the water shortage, solutions existed and could be realised with political will and well-designed O&M systems.

A major barrier to realising any plans was funding, which was not forthcoming from government sources. The Pourashava was then encouraged and oriented by Nabolok and WaterAid Bangladesh to approach different institutions like Rural Development Academy[5] and HYSAWA.[6] This kind of guidance was missing from the Pourashava's previous attempts to provide water, restricting them to small-scale solutions such as intermittent provision of tube wells and water reservoirs that could not reach those most in need.

Alongside working with the municipality authority, the intervention also included sensitisation activities in the communities. In order to understand the local context and community demands, community groups were formed at the ward level,[7] ensuring representation of poor and extremely poor households, and with a majority of female membership. These groups participated in a number of participatory rural appraisal (PRA) exercises to identify priority issues, of which water was the foremost given the Paikgachha's severely water-stressed status. These groups were then oriented on their right to water, sanitation and hygiene (WASH), as well as local governance and administration procedures such as the annual open budget meetings of the municipality. Along with many of the community group members were also members of the government-mandated ward-level coordination committees

[5] Training and Research Agency of the Government under the Ministry of Local Government, Rural Development & Cooperatives.

[6] An autonomous government project on water, sanitation and hygiene under local government ministry in partnership with multiple bilateral aid agencies

[7] The lowest administrative boundary within a municipal area and is represented by one elected councilor.

(WLCCs), a platform that includes community representatives from each ward as well as the elected representative (ward councillor). The community groups and WLCCs therefore both acted as pressure groups to advocate with municipal authorities for water supply in open budget meetings and ward *shabhas* (meetings). The mutually reinforcing components of sensitising duty bearers, and supporting communities to raise their voice on a long-standing crisis, led to the political momentum needed in the municipality to explore a long-term solution that could work at scale.

Community consultations

The project design included extensive consultations regarding the tariff structure to be adopted for the piped water system. A series of eight consultations took place in 2013 and 2014. These consultations took the form of community meetings led by the Pourashava, with facilitation support from Nabolok. The Pourashava extended invitations to WLCCs, community groups, local committees including associations of business owners, wholesale fish traders, and transport workers, civil society including representatives of different non-governmental organisations (NGOs), and local elites such as teachers and religious leaders. Tariffs were proposed based on initial ideas from the Pourashava based on their experiences from the exposure trips, and were then discussed and debated by different groups until a consensus was reached. This intensive process led to the emergence of multiple viewpoints, including the fundamental question of flat rates versus progressive tariffs.

The meetings provided the space and time for the concept of progressive tariffs to be understood, debated and internalised by participants, and subsequently allowed people to collectively determine the tariff bands applicable to different categories of users. While initially the concept of progressive tariffs was debated, the sensitisation activities described above meant that both municipality authorities and many of the community members participating in the consultations understood the importance of equity in water services. Many of the representatives from poorer communities had been active in the community groups and WLCCs Nabolok worked with, and were vocal regarding their right to water and limited ability to pay in the meetings. There was thus a momentum amongst many of the citizens and duty-bearers to ensure equitable access, based on the series of capacity-building and sensitisation activities carried out prior to the actual event of the consultations.

These consultations were crucial not only to accurately gauge people's ability and willingness to pay, but also to establish common agreement on the different rates through a series of deliberations, where people from all walks of life participated and expressed their views. The initial tariff system set following public meetings was then checked by an external expert, in order to review its alignment with the requirements of a solid business model that would see the system remaining functional in the long term. In conducting this external review, carried out in August 2014, an independent consultant carried out a detailed financial analysis along with factoring in the socioeconomic and financial condition of the citizens of the municipality, the technical and hydrogeological condition of the water supply system, the required O&M cost of the system, the arrangement of annual depreciation and the uses of efficient fund management. Considering these factors, the consultant estimated that over an assumed 12 years of operation, an average of 593 connections per year (first year, 324 and 12th year, 611 connections) would make the PWSS attain breakeven, whereas the estimated average number of connections over the same period stood at 1566, indicating good revenue strength and financial viability of the system (PMID, 2014).

Working across multiple dimensions: A sociotechnical intervention

In Bangladesh, challenges related to urban infrastructure include insufficient capital investment due not only to lack of financial resources, and weak planning and implementation but also to inadequate O&M funds (ADB, 2009). Municipalities and water utilities are meant to fund O&M through water charges, but tariffs are usually too low to ensure proper maintenance, while the issue is considered to be too

unpopular for elected local governments to pursue. At the same time, poor households that are beyond the reach of official supply networks end up buying water from private vendors at exorbitant prices. These challenges reflect similar constraints faced by small towns and municipalities in many parts of the world (WaterAid, 2009). However, the challenges gain a new dimension in Bangladesh's coastal region, where the threat of climate change is already manifesting itself, and high rates of poverty and urbanisation are placing additional stress on water resources.

The Paikgachha PWSS was about developing a technologically sound system within this challenging context with participation of the communities to be served, capacitated staff and local government, informed consumers, and proper management methods. It represents WaterAid Bangladesh's attempt at a way of working that considers the physical environment, socioeconomic characteristics and institutional capacities before technology-driven 'hardware' solutions.

At the heart of this multidimensional approach is the participation and inclusion of members of the community in the tariff-setting exercises. This is in line with WaterAid's own programmatic approach, as well as international best practice on designing services for the urban poor (World Bank, 2009). Both project staff and service providers often end up working on mistaken assumptions about what the poor want and their willingness to pay, leading to supply-driven projects that eventually fail (ibid). Giving them a voice in design and planning services with their meaningful participation does two things: it establishes the poor as legitimate, bill-paying customers, and it leads to improved, realistic designs that are more likely to sustain. The technical viability of the project is therefore intrinsically linked with the social and cultural aspects of how people perceive water and their willingness to pay for it.

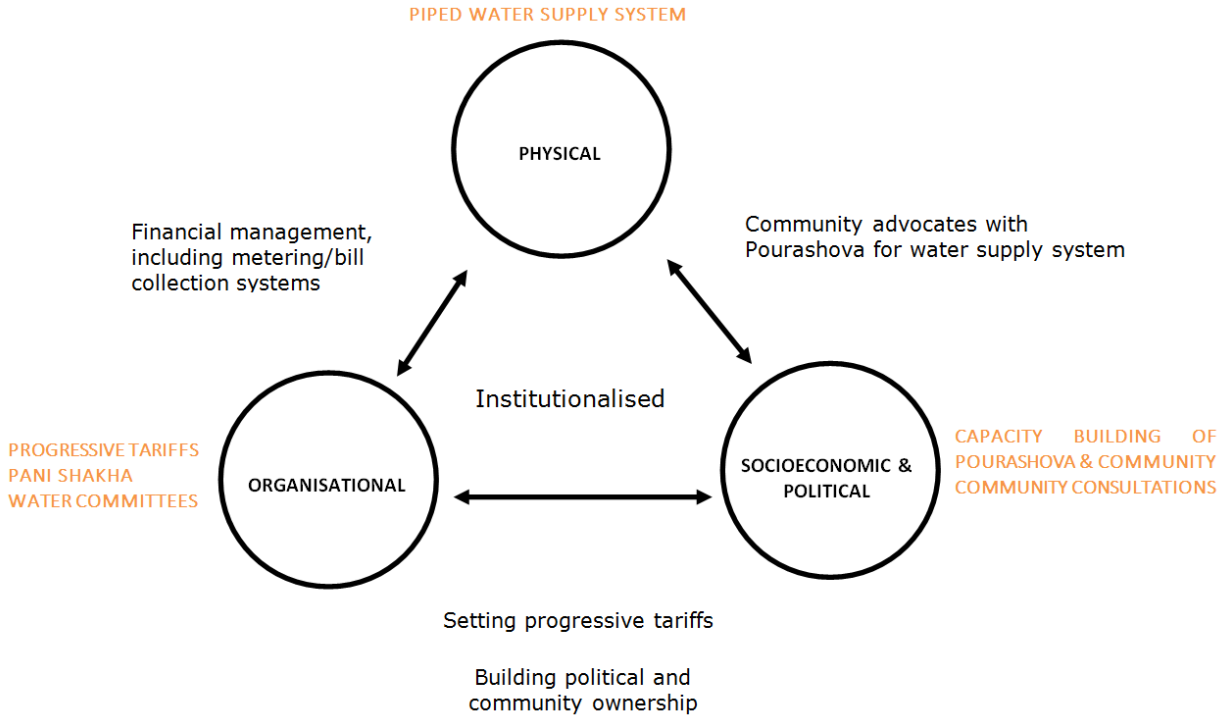
Equally, the long-term sustainability of the system requires sound financial and O&M structures that are embedded in the local political and social context. This required building the capacity and ownership of water management authorities, and developing pro-poor sensitivities in the Pourashava as well as in the wider community in order to build a system based on progressive tariffs rather than on flat rates. The bottom-up approach towards tariff setting was a critical element in building joint ownership of the technology with even the poorest families understanding and accepting the rate they would have to pay. Moreover, the consultations brought the municipality in closer contact with the communities they are meant to serve, opening up spaces for dialogue and creating a sense of mutual endeavour, in line with experiences of small-scale infrastructure projects elsewhere (Ahlborg and Sjöstedt, 2015).

Grounding the tariff and overall management system is an institutional setup spanning both the municipality and the community, maintaining a strong community focus with representatives from poorer segments of the town's population. The institutional interlinkages between the community and municipality have created established channels for the social and political dialogue needed between citizens and duty-bearers to maintain a complex technology with a pro-poor focus in the long run. This has also been seen in WaterAid Bangladesh's work in urban slums in the big cities of Dhaka, where slum residents have gained the right to legal water connections after years of advocacy with Dhaka Water and Sewerage Authority (DWASA), and continue to interact and advocate with the Low Income Community (LIC) unit of DWASA through community-based organisations (WaterAid, 2016).

The above analysis of the case of Paikgachha demonstrates the strengths of a multidimensional approach to the diverse challenges faced by many water-scarce small towns and municipalities in coastal Bangladesh. The system has been functioning well since implementation, and the tariff collection rate after one and a half years of operation stood at 99.57% (up to July 2016). The number of connections is over 1000, leading to a surplus of USD 2250 after covering all operational expenditure (authors' communication with Paikgachha Pourashava). However, the journey is not yet finished. Only one-third of the population in Paikgachha are served as of December 2016. The Pourashava continues to expand coverage to new clients with technical support from Nabolok and WaterAid Bangladesh, and is working to mobilise further resources from annual government budget allocations to extend the

pipeline. Since the beginning of the project, the Pourashava has contributed BDT 5,155,000, or over USD 64,400 to the PWSS from its own resources (data collected from Paikgachha Pourashava).

Figure 3. Schematic representation of the intervention.



POTENTIAL FOR REPLICATION AND CHALLENGES

While the success of Paikgachha as an individual case establishes the possibility of water services that are both pro-poor and financially viable in the long term, there are questions of scale-up and larger impact that are as yet unknowns. However, a number of aspects of the approach are reflected in best practices for sustainable cost recovery examined elsewhere (Brikké and Rojas, 2001), indicating the potential of the intervention as a model for sustainable water supply in the context of coastal small towns in Bangladesh. These include aiming for equity in cost recovery; an examination of the willingness to pay through community consultations; setting up an adequate institutional framework; and accompanying the intervention with capacity-building measures (Brikké and Rojas, 2001). At the same time, Pourashavas have a degree of autonomy as per the Pourashava Water Supply By-Law of 1999, which places the responsibility of setting tariffs on Pourashavas (World Bank, 2014b), which is conducive to replication of this approach.

There are also indications of wider interest in the sector and from other municipalities. Other Pourashavas, including Kalaroa, Nowapara, and Chalna have visited the system. The Asian Development Bank's sector assessment study identifies careful tariff setting and financial management as vital to the sustainability of projects (ADB, 2009), which implies that development partners would also recognise the importance of wider scale-up of the lessons of Paikgachha. This scope needs to be explored further through encouraging horizontal learning with other municipalities and advocating with key decision-makers such as the Municipal Association of Bangladesh (MAB), and multilateral institutions working on urban issues in Bangladesh.

However, this paper also recognises the formidable challenges of further replication and scale-up, given that this was a grant-financed project running over many years. Even in the context of a

development project, the investment in time and resources required to understand and plan according to local realities, and ensure meaningful participation of community members and local authorities, is often not possible given the usual constraints of donor funding. Even more complicated questions of wider take-up and replication against a backdrop of structural challenges remain to be addressed. There are structural weaknesses related to water supply for the urban poor that cannot be addressed within the water sector alone (WaterAid, 2009). In the case of Bangladesh, weak decentralisation and low levels of funding at the local level, fragmented responsibilities for urban development, lack of monitoring of national policies and lack of regulation all contribute to pervasive shortcomings in municipal environments. These are beyond the scope of any one organisation or intervention, but are all factors that need to be considered in projects that seek to reach the urban poor with the basic infrastructure and services that are their right.

CONCLUSION

There are still many pockets of water crisis in the coastal south of Bangladesh. Water supply solutions in most cases become dysfunctional not because of technical reasons, but because of gaps in source protection and community engagement in O&M of the system (WaterAid, 2014). Overall, there is a strong case to consider the social, economic and institutional dimensions of water supply projects, especially in circumstances of wider environmental and human challenges. This is especially pertinent in the case of coastal districts of Bangladesh, where climate vulnerability and pervasive poverty pose complex and interrelated challenges to management of water resources. The case of Paikgachha demonstrates how a holistic approach with effective community engagement in public service delivery can lead to functional and equitable water supply systems that take these challenges into account.

In particular, the tariff-setting approach in the case of Paikgachha was a crucial exercise that brought social and political consensus around the case for progressive tariffs, which played a pivotal role in establishing the urban poor of Paikgachha municipality as viable customers of a piped water supply system. The process of sensitising both local government and citizens was critical to building the momentum needed for a pro-poor initiative at scale. This was backed by building municipality-management capacity and grounding the entire system in a sound business model, with requisite administrative mechanisms such as a water wing and an operations manual developed. The grant financing by a donor for physical infrastructure development made a critical value addition.

While the experience of Paikgachha offers a promising case for multi-actor collaboration in public service delivery in the coastal region, there are significant challenges in replication and scaling up. However, the principles of sustainability embodied in the multidimensional nature of the project offer a promising start for planning of small town water supply projects in hard-to-reach areas, and can offer a model for other coastal municipalities.

REFERENCES

Abdullaev, I. and Mollinga, P.P. 2010. The socio-technical aspects of water management: emerging trends at grass roots level in Uzbekistan. *Water* 2: 85-100.

Ahlborg, H. and Sjöstedt, M. 2015. Small-scale hydropower in Africa: Socio-technical designs for renewable energy in Tanzanian villages. *Energy Research & Social Science* 5: 20-33.

ADB (Asian Development Bank). 2009. Sector assessment (summary): Water supply and other municipal infrastructure services. Based on the Asian Development Bank (ADB). 2009. Final Report of Project Preparatory Technical Assistance, Preparing the Khulna Water Supply Project. Manila: Asian Development Bank.

ADB. 2011. *Adapting to climate change: Strengthening the climate resilience of the water sector infrastructure in Khulna, Bangladesh.* Mandaluyong City, Philippines: ADB.

ADB. 2012. *Willingness to pay and inclusive tariff designs for improved water supply services in Khulna, Bangladesh.* South Asia Working Paper Series No. 9. Mandaluyong City, Philippines: ADB.

ADB. 2016. *Asian water development outlook 2016: Strengthening water security in Asia and the Pacific.* Mandaluyong City, Philippines: ADB.

Bangladesh Water Development Board (BWDB) 2013. Mathematical Modelling Study (Groundwater and Surface water) to Assess Upazila Wise Surface Water and Groundwater Resources and Changes in Groundwater Level due to Withdrawal of Groundwater in the Study Areas (Package-1). Final Report, November. Ministry of Water Resources, Government of Bangladesh. Dhaka: Bangladesh.

Benneyworth, L.; Gilligan, J.; Ayers, J.C.; Goodbred, S.; George, G. et al., 2016. Drinking water insecurity: Water quality and access in coastal south-western Bangladesh. *International Journal of Environmental Health Research* DOI: 10.1080/09603123.2016.1194383.

Brikké, F. and Rojas, J. 2001. *Key factors for sustainable cost recovery in the context of community-managed water supply.* Occasional Paper Series 32-E. Delft: IRC International Water and Sanitation Centre.

Dodman, D. and Satterthwaite, D. 2008. Institutional capacity, climate change adaptation and the urban poor. *IDS Bulletin* 39(4): 67-74.

Faisal, I.M. and Kabir, M.R. 2005. An analysis of gender-water nexus in rural Bangladesh. *Journal of Developing Societies* 211): 175-194.

Independent Evaluation Department (IED). 2009. *Urban sector and water supply and sanitation in Bangladesh: An exploratory evaluation of the programs of ADB and other aid agencies.* Manila: Asian Development Bank

Khan, A.E.; Scheelbeek, P.F.D.; Shilpi, A.B.; Chan, Q.; Mojumder, S.K.; Rahman, A.; Haines, A. and Vineis, P. 2014. Salinity in drinking water and the risk of (pre)eclampsia and gestational hypertension in coastal Bangladesh: A case-control study. *PLoS ONE* 9(9): e108715. doi: 10.1371/journal.pone.0108715.

Khan, M.S.A.; Mondal, M.S.; Kumar, U.; Rahman, R.; Huq, H. and Dutta, D.K. 2013. Climate change, salinity intrusion and water insecurity in peri-urban Khulna, Bangladesh. In Prakash, A. and Singh, S. (Eds), *Chapter in Water Security in Peri-urban South Asia: Adapting to Climate Change and Urbanisation*. India: SaciWATERs, South Asia Consortium for Interdisciplinary Water Resources Studies (SaciWATERs).

Mondal, M.S.; Jalal, M.R.; Khan, M.S.A.; Kumar, U.; Rahman, R. and Huq, H. 2013. Hydro-meteorological trends in Southwest Coastal Bangladesh: Perspectives of climate change and human interventions. *American Journal of Climate Change* 2: 62-70.

Nilsson, D. and Nyanchaga, E.N. 2012. Pipes and politics: A century of change and continuity in Kenyan urban water supply. *The Journal of Modern African Studies* 46(1): 133-158.

Opel, A. 2016. Climate change and water scarcity: Implications for the urban poor in coastal Bangladesh. In Roy, M.; Cawood, S.; Hordijk, M. and Hulme, D. (Eds), *Chapter in urban poverty and climate change: Life in the slums of Asia, Africa and Latin America,* Chapter 10. London: Routledge.

Pahl-Wostl, C. 2007. Transitions towards adaptive management of water facing climate and global change. *Water Resources Management* 21(1): 49-62.

Planning Commission. 2015. *Seventh Five-Year Plan FY2016-FY2020: Accelerating growth, empowering citizens.* Dhaka: General Economics Division (GED), Planning Commission, Government of the People's Republic of Bangladesh.

Participatory Management Initiative for Development (PMID). 2012. *Baseline study to understand service providers' accountability for provision of WaSH services in selected Pourashavas.* Study conducted for WaterAid Bangladesh. Dhaka: PMID.

PMID. 2014. *Fixing water tariff and developing a business model of pipe water supply system for Paikgachha Municipality, Khulna.* Dhaka: PMID. March 2014.

PSU (Policy Support Unit). 2012. National cost sharing strategy for water supply and sanitation in Bangladesh 2012. Progress Report.

Rasheed, S.; Jahan, S.; Sharmin, T.; Hoque, S.; Khanam, M.A. et al., Land, M.A.; Iqbal, M.; Hanifi, S.M.A, Khatun, F.; Siddique, A.K.; Bhuiyya, A. 2014. How much salt do adults consume in climate vulnerable coastal Bangladesh? *BMC Public Health* 14: 584. www.biomedcentral.com/1471-2458/14/584

Verisk Maplecroft. 2011. *Climate change vulnerability index. Climate change risk atlas 2011.* United Kingdom: Verisk Maplecroft.

WaterAid. 2009. *Access for the poor and excluded: Tariffs and subsidies for urban water supply.* Discussion Paper. London: WaterAid.

WaterAid. 2010. *Small town water and sanitation delivery: Taking a wider view.* Report. London: WaterAid.

WaterAid. 2013. *Small town learning review: The synthesis report of a four country study.* London: WaterAid.

WaterAid. 2016. Low income customer support units. Case study: Bangladesh. New York: WaterAid America.

World Bank. 2009. *Guidance notes on services for the urban poor: A practical guide for improving water and sanitation services, water and sanitation program.* Washington, DC: World Bank Group.

World Bank. 2012. *Hard-to-reach areas: Providing water supply and sanitation services to all.* Water and Sanitation Program Guidance Note, November. Dhaka: Water and Sanitation Program.

World Bank. 2014a. *River salinity and climate change: Evidence from coastal Bangladesh.* Policy Research Working Paper No. WPS 6817. Washington, DC: World Bank Group.

World Bank. 2014b. Water and sanitation report; Benchmarking to improve urban water supply delivery in Bangladesh; Targeting the urban poor and improving services in small towns. Dhaka: Water and Sanitation Program. www.ib-net.org/docs/Bangladesh_Report.pdf

World Bank. 2017. Urban population as percentage of total population. http: //data.worldbank.org/indicator/SP.URB.TOTL.IN.ZS