



Adaptation Strategies for Safe Drinking Water Supply in the Low Lying Coastal Regions in Bangladesh

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This paper examines the current problematic situation and existing management system for safe water supply in the low lying coastal region of Bangladesh. Based on field survey and community consultations through Focus Group Discussions (FGDs), this study identifies a range of factors that influence the shortage of safe water supply in the coastal region in Bangladesh. These include: salinity intrusion (from both human and natural causes), the local hydro-geological condition, poor implementation of water supply management, reduction of upstream sourced flow of water, and lack of adequate policy and research initiatives for technological innovation and implementation. This study suggests possible adaptation strategies that can help improve the safe water supply in the coastal region in Bangladesh.

Keywords: Climate change adaptation, Water supply, Coastal region, Bangladesh.

1. Introduction

Water management in Bangladesh is a critical issue owing to growing demand for the resource and poor infrastructure, particularly in the country's low lying coastal regions that border the Bay of Bengal.⁷ The country is located at the lower end of three large rivers (i.e., the Ganges, the Brahmaputra and the Meghna) and lies at the head of the Bay of Bengal. About 93% of the freshwater streams that flow through Bangladesh originates in the upsterram and located outside the country.¹⁵ This means that Bangladesh's water supply is highly dependent on external water sources and vulnerable to upstream activities, stressors and climate change impacts on these river systems.⁷ The Stern Review on the Economics of Climate Change indicates that even a moderate rise in temperature could have serious implications for the environment of the South Asian region, and particularly in Bangladesh. Reports also suggest that over the past 30 years the East Himalayas have experienced a drop in snow and ice cover by around 30%, and there is a

real risk that these glaciers might disappear within few decades.¹² Bangladesh's reliance on these glaciers to fuel its major rivers and streams means that the implications of the diminished East Himalayan Glaciers would be severe and will cause drought, and therefore a lack of fresh water for irrigation and domestic purposes. Bangladesh is also highly vulnerable to sea level rise due to its geographical location and topographic characteristics. Sea level rise may also promote the landward ingression of salinity, particularly when combined with reduced stream flow from upstream sources, such as, the Himalayan glaciers and during drought periods. The recent Copenhagen Summit in 2009 has identified Bangladesh as one of the most vulnerable countries to the impacts of climate change, accordingly, climate change has become one of the most important considerations for water management in Bangladesh. This is for this reason it is important to find effective adaptation strategies for safe drinking water in the vulnerable coastal areas in Bangladesh.

The existing methods of water supply in Bangladesh remain very traditional. For instance, about 97% of the people in Bangladesh uses aquifers and hand pumped shallow tube wells as the main sources of drinking water. However, the coastal region of Bangladesh that comprises over 32% of the country's land mass but is inhabited by more than one fourth (28%) of the total population has limited fresh-water availability due to increased levels of salinity.³ Furthermore, land use changes (e.g. shrimp farming, salt production) and natural disasters (e.g. river erosion and heavy rainfall induced waterlogging, cyclones and tidal surges) have an impact on the availability of freshwater supply in the coastal region. Thus, scarcity of safe drinking water is one of the key challenges faced by the coastal communities in Bangladesh.²³ The situation becomes worst during the dry season, as areas up to 240 km inland are exposed to saline water due to decreased flows from upstream and increased tide heights associated with sea level rise.²² The 2008 ALPCC Position Paper outlines that Bangladesh has been experiencing increased irregularity of rainfall in recent years and this has led to severe water shortages during the dry season, which stretches between mid March to mid June. Surface water reservoirs (i.e. ponds) have become increasingly prone to drying out entirely or becoming polluted due to reduced water levels and stagnation.¹⁸ Moreover, the drying out and pollution of ponds, which have traditionally been relied upon for drinking water supplies has resulted in an increased demand for groundwater supplies in the coastal region. This also places an emphasis on the issue of increasing groundwater salinity levels, the urgent need for practical solutions and adaptation to the impacts of climate change. There are also problems related to the level of arsenic in the groundwater in Bangladesh. According to British Geological Survey (BGS), out of 64 districts in Bangladesh, 47 to 61 districts have arsenic content above the WHO recommended maximum permissible limit of 0.05 mg/L.⁴ The severe problem is in the southern (coastal area) and northeast parts of the country. The Ganges, Megna, and Atri Floodplains, the tidal regions

and the coastal plains are the major physiographic regions vulnerable to arsenic contamination.⁹

This study aims to identify the factors that influence the shortage of water supply in the low lying coastal region in Bangladesh. The study also highlights possible solutions and adaptation strategies for low cost water supplies within the vulnerable coastal areas of Bangladesh, in the face of climate change. This study suggests three strategies that may assist in the implementation of technologies which could help to provide a more sustainable set of water supply systems in the coastal region of Bangladesh. These strategies include: the implementation of community based water management systems, formation of community water enterprises, and household water demand management systems. These strategies would need to be implemented by improving existing policy initiatives with a particular focus on community based climate change adaptation, institutional capacity building, and strengthening the initiatives of NGOs and local government institutions. The context for this discussion was based on extensive community consultations and baseline surveys in the affected coastal regions of Bangladesh.

2. Water Supply Situation in the Coastal Areas of Bangladesh

About 74% of the population in the coastal areas of Bangladesh have little or no access to safe drinking water.²⁵ Despite the large number of natural streams, ponds and ample ground water storage, the scarcity of potable water is acute in coastal areas. Most of the time the available river water is highly turbid and saline. The lesser saline pond water can be used for many domestic purposes, but is still unsafe for drinking. The region is also subject to the impacts of land use changes that have occurred since the 1980s such as, the conversion of agricultural land to saline shrimp ponds. These hydrogeological conditions and impacts associated with inappropriate land-use are now becoming more aggravated because of climate change induced sea level rise and the reduction of upstream freshwater flow. As the sea levels continue to rise in the future, the IPCC estimates that increased stress on the fresh water zone by saline sea water will heavily decrease fresh water availability in the coastal zones of Bangladesh over the coming years.¹⁴ The predicted sea level rise in Bangladesh will induce salinity impacts in three key natural water sources surface water, groundwater and soil. Further, freshwater flows from cross-boundary rivers will diminish in the dry season, making this problem even more pronounced. A recent CEGIS report estimates that a 5 parts per thousand (ppt) saline front would penetrate about 40 km inland for a sea level rise of 88 cm.⁶ This penetration will further affect the fresh-water pockets and reservoirs of the country's northern part (Fig. 1).

Unlike other areas of Bangladesh, in the coastal regions of Khulna and Bagerhat, ground water of acceptable quality is not available at shallow depths for easy withdrawal by conventional hand pump tube wells. This means that

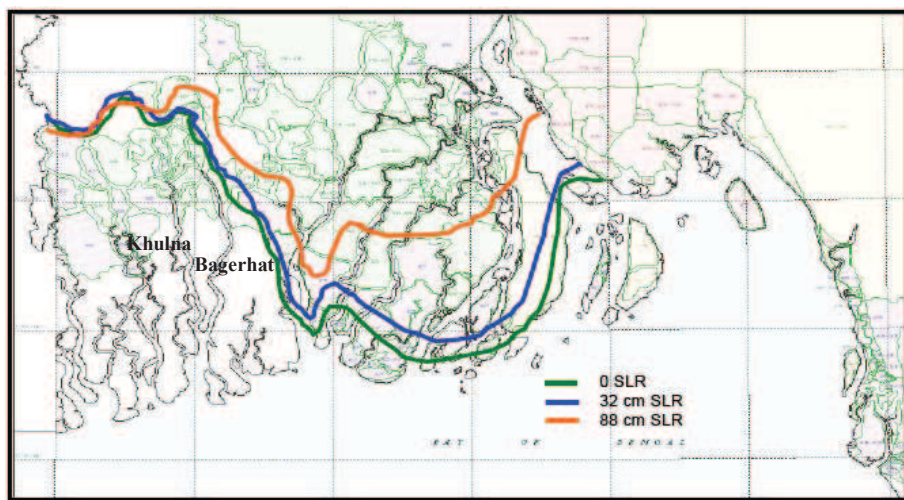


Figure 1 Line of equal salinity (5 ppt) for different sea level rise in dry season.⁶

physical provision of water services alone will not sufficiently improve water supply, as experiences of the past years have demonstrated.²¹ In most of the areas investigated tube wells were found to be unsuccessful in providing access to water, because groundwater is mostly saline to depths of 210–305 m and suitable freshwater aquifers are not available in most of the areas.⁸ Digging deeper tube wells can provide access to relatively low saline water; however, at those depths the water contains high concentrations of sand which makes it undrinkable, without the installation of expensive filtration systems.¹ Although the standard level of salinity in groundwater of Bangladesh's coastal areas is 1 ppt, in some areas that were investigated, salinity levels of up to 10 ppt were recorded.⁸ As a result, in spite of sinking a large number of tube wells, the water supply situation in many coastal areas remains unsatisfactory.

The availability of saline-free pockets in coastal areas is scarce, and even though hydrogeological conditions can vary considerably over relatively short distances¹ the overall the number of salinity affected areas is growing. The Bangladesh Soil Resource Development Institute²³ observed that from 1973 to 2000 the number of salinity affected areas has increased by 22.5%, from 831,950 ha to 1,020,850 ha. The rate of increase becomes even more rapid in the coastal districts (e.g., Satkhira, Khulna, Bagerhat, Bhola and Patuakhali), since these areas are subject to unique hydro-geological factors that contribute to their vulnerability (Fig. 2).

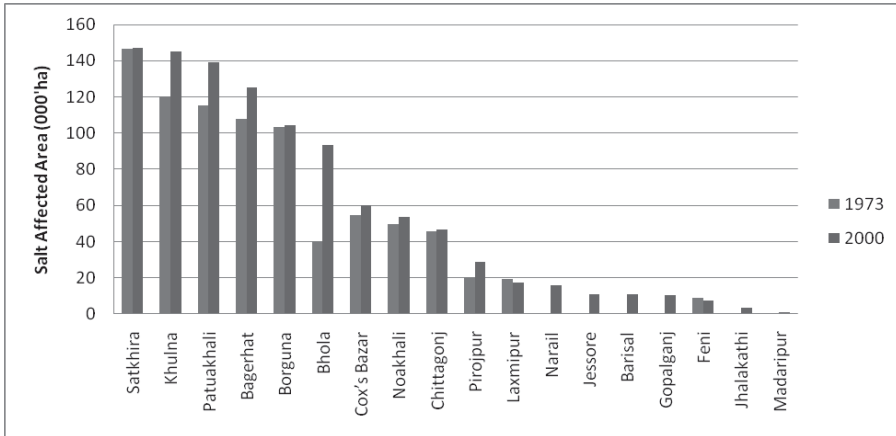


Figure 2 Comparison of salt affected coastal districts between 1973 and 2000.²³

3. Methodology

The research, conducted between January 2008 and July 2008, comprised two streams. Community engagement and feedback via a semi-structured climate impact survey, and a series of focus groups. The survey was distributed in hard copy format to each household in the communities of the study area located in the eight unions of two coastal districts (Khulna and Bagerhat) in Bangladesh (Table 1).

In total 162 individuals, comprising 91 females (56%) and 71 males (44%), participated in the focus groups which were conducted during the period 4th and 8th May 2008. The focus groups were facilitated by the first author (Azam, M.), with a range of stakeholders including school teachers, community leaders, elderly people, journalists, agricultural farmers, fish farmers, housewives and day labourers. The focus groups used a standardised semi-structured questionnaire to discuss

Table 1 Study area

District	Upazila*	Union**	Area (ha)	Population	Persons/km ²
Khulna	Koyra	Koyra Sadar	3339	32499	973
		Uttar Bedkashi	2244	14431	643
	Paikgacha	Garoi khali	4239	22959	541
	Dacope	Kamarkhola	2919	13319	456
		Koilasganj	2919	14750	505
Bagerhat	Mongla	Chila	3015	17029	564
		Chadpai	2055	16242	790
	Sharonkhola	Southkhali	3737	24090	644

Note: *Administrative units of district, **Small administrative units of upazilas
Source: (BBS, 2001)³

existing climate change induced problems and issues in each union associated with a range of issues including non-availability of drinking water, salinity, food insecurity, shrimp cultivation, increasing intensity and frequency of cyclones and tidal surge, river or embankment erosion, lack of employment opportunity and increasing average tide heights.

Baseline surveys were carried out along with the “Alternative Livelihood Programme in the Context of Climate Change (ALPCCC)” project, which was implemented by Prodipan, a local Non-Governmental Organisation (NGO) working towards socio-economic empowerment with the specific target for children, gender, environment and climate change needs. These surveys were distributed amongst 4500 households in the study area. The survey primarily focused on participants’ perceptions regarding a range of issues that relate to supply and availability of safe drinking water. These included: the most likely causes of a continuing scarcity of drinkable water, the effects of salinity, whether they thought salinity was becoming an increasing problem, the sources that members of the community obtained their drinking water from when local water was affected by salinity, or otherwise unavailable, the distance that members of the community would have to travel to obtain drinking water when water in their communities was scarce, effectiveness of the existing water supply management and technological strategies, and any other relevant issues they wished to raise. Outcomes from this stage of the research led to three possible scenarios and strategies that can help facilitate the introduction of effective strategies in the affected communities, with the aim of providing improved access to drinkable water. These strategies include an introduction of a community based water management strategy, community water enterprise, and a household demand based strategy and are discussed in Section 5.

4. Results

In the coastal areas of Bangladesh, ponds are the only source of drinking water in which the level of salinity exists at an acceptable level. However, ponds are not always available in coastal areas, and when they are available, they are often used for aquaculture in order to generate income. This affects other ponds which are located near rivers or saline shrimp ponds and are often affected by increase in salinity due to the penetration of saline water.¹ Accordingly, there are very few ponds located in the study area that are exclusively reserved for drinking water. Further, given the changing rainfall patterns in these districts, some of these ponds remain dry during summer or become polluted by flooding in the wet season. This requires many people in these areas to travel for up to 5 km to collect drinking water (Fig. 3). In most cases, this places an extra burden on women in these areas and promotes gender inequality.

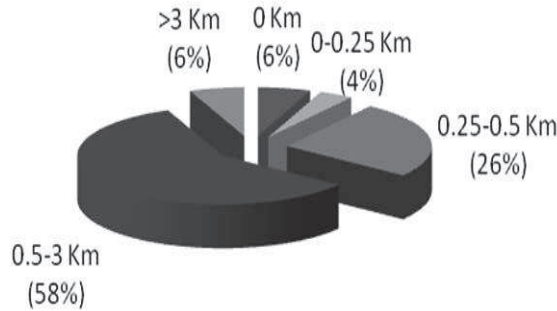


Figure 3 Household Distances travelled for collecting safe drinking water in coastal areas ($N = 4500$).¹⁹

The water supply situation in the coastal communities in Bangladesh is difficult to measure mainly due to lack of reliable statistical data. Hence in this study we have utilized interviews and on-site surveys. The consultation outcomes of the focus groups have formed the basis of the evaluation of community perceptions. This present study finds that the salinity level has increased severely over the last five to ten years. While majority of the people in the study area depended on pond water for their drinking water supply, a significant number of them used wells as their main source of drinking water (Fig. 4).

Another issue in the coastal areas of Bangladesh is the intrusion of saline water into the shallow aquifers, which are often used for tube wells. The study shows that access to fresh groundwater through tube wells is getting harder due to saline

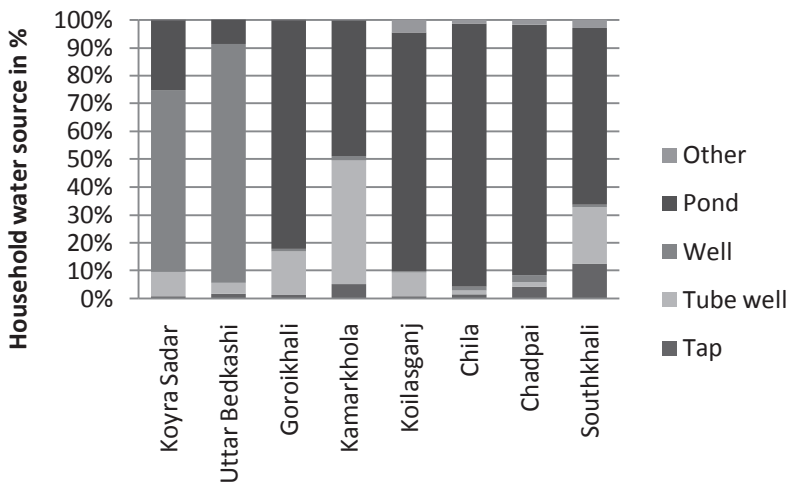


Figure 4 Household sources of drinking water (Pradipan, 2008b).

water intrusion into shallow aquifers which forces people to use pond water in addition to seasonal rainwater (Prodipan 2008). Further, the situation for these people is worsening because of the deterioration of water quality in most of the surface water sources, which makes it unsuitable for drinking purposes.

Although additional technological options for safe water supply in coastal areas are very limited, people may be able to overcome some of these problems by harnessing water using different technologies. Some alternative options that could be adopted include: shallow shrouded tube wells, pond sand filters, household filters, infiltration wells or galleries, rain water harvesting, solar desalination and surface water treatment plants.² In recent years, some small scale reverse osmosis desalination plants have been implemented by NGOs aided by, active community participation. For example, Prodipan have installed four desalination plants and is selling water at a price of 0.5 Tk./litre.²⁰

According to the National Policy for Water Supply and Sanitation 1998, the Department of Public Health Engineering (DPHE) acts as the lead agency (along with stakeholders from NGOs and private sectors) in providing coordinated inputs into the rural water supply projects.¹⁷ Despite DPHE's impressive network offices at the Sub-district and District levels, there is some consensus that it is too hopelessly subjected to inefficiency, bureaucracy and corruption, to be effective. More importantly, the DPHE lacks the adequate programmes and tools, such as, monitoring, onsite support, financing mechanisms, and training, to implement its projects.⁵ Moreover, DPHE has a centralized administrative structure with little decision making power at the local level. This creates a lack of responsibility for maintaining the water technologies in the government's, or NGOs projects, and creates a barrier to sustainable water supply in the rural areas. Another player is the Bangladesh Water Development Board (BWDB), which is involved in surface water resources management and responsible for managing water resources in polders of coastal areas. Although NGOs have been involved in implementing programs such as, the installation of water options using a cost sharing approach, in most of the cases they did not play a role in capacity-building to develop self-sustaining mechanisms for the rural poor to obtain access to safe water, and to accelerate the technology dissemination process. One of the major causes of this problem is the weak institutional framework and inadequate financial resources.

5. Adaptation Strategies for Building Resilience in the Water Sector

The discussion in the previous sections, and the results of this study, reveal that searching for alternative options for safe water supply in coastal areas is crucial. In that respect, the following three key aspects should be taken into consideration: the institutional environment, technology, and the user community.² Thus, implementation of these options will not only depend on the geological condition and

site specifics but also on the income level of the people and strength of authorities. For example, about 54% of the affected families in the coastal areas are functionally landless with an income level of less than 1-2 US\$/day.³ Considering these social factors, pond sand filters, rain water harvesting, surface water treatment plants and household filters would be preferable for the majority of the population, if provided with adequate institutional support in terms of technical and financial assistance through appropriate credit facilities. Solar desalination can be an alternative option for higher income people. To ensure that the level of service is sustained over time, the management capacity at the local level must match the operation and maintenance needs of the system. The system should require only a minimum of support from the government, or NGOs. Good management is only feasible if a monitoring system is in place and being used. Further, any technology used should be easy to manage, and users in the community should be made aware of the most efficient use of this technology.² From experiences in many developing countries, even technologically very good water agencies cannot successfully operate and maintain a network of widely dispersed water systems without the full involvement and commitment of the users.¹⁶ To achieve this, the study suggests three model management approaches that could be used to minimize the water stressed condition to some extent at community level.

5.1. Community based management strategy

This approach can be described as a 'bottom-up' approach, in which the need for a management strategy is expressed and devised by the community. Once the specifications for the management system have been identified, the community may seek to gain financial assistance or advice from the government, NGOs or other funding institutions. In most instances the funding institution would remain the majority owner of facilities. Technologies such as, pond sand filters, large rain water reservoirs and surface water treatment plants can be installed based on the demand of the community and the suitability of area. For this strategy to be effective it is important to foster a sense of community ownership, this can be achieved by part-sharing the cost of technology and infrastructure (10–20%). Previous experiences have shown that most of the options implemented without cost sharing failed after the project period. The precise amount of the cost share can be fixed in negotiations with the community. An organized Village Committee should be made responsible for managing the facilities, recovery of the costs, operation and maintenance of the equipment. A selected person, trained by DPHE, would be employed to work as caretaker. However, monitoring by funding institutions, even after the project period has been completed, should be mandatory. The need for appropriate monitoring by funding institutions has been indicated where this model has been implemented previously and failures have occurred due to improper monitoring (Fig. 5).

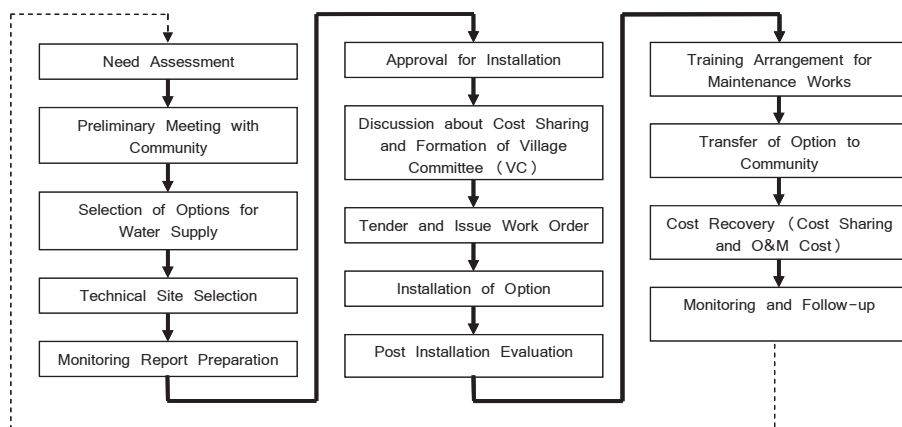


Figure 5 Implementation process of community based water supply system.

5.2. Community water enterprise

This is a relatively new approach and has not yet been implemented anywhere. Under this model, a selected group of people within a poor community would have full ownership of the system. They would be responsible for the installation, operation, maintenance and management of the system. Unlike the community based management strategy model, under a community based water market, external organizations would only provide the financial means (credit facilities), technical support, and monitoring, to enable a water business enterprise to be set up within the community. This community based water market would be a self-sustainable approach, as the cost of water would be within the purchasing power of consumers, and the loan taken to pay for this capital intensive technology would be recovered from selling water to the people. Once the payback period is over, the poor people involved in the business would own the technology involved. If the price is not affordable, then other funding methods such as tax reductions, subsidies, rebates, or loan extensions could be considered.⁵ By contrast, in other cost sharing approaches, government and NGOs often play a dominant role in the community and community level decision making, which can subsequently lead to problems within the community. Under the proposed model, the community based water market strategy allows the affected community to have full ownership of the system. This means that communities would be more responsible for managing their own systems, giving them more autonomy and a sense of ownership. This could be a successful strategy in coastal areas on Bangladesh and might be able to overcome the drawbacks associated with traditional cost sharing approaches.

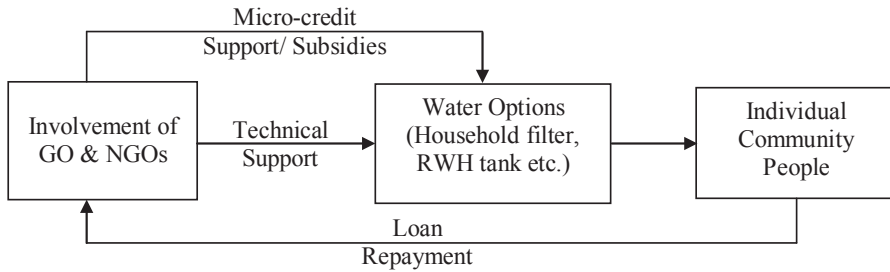


Figure 6 Implementation process of household demand based strategy.

5.3. Household demand based strategy

Figure 6 illustrates the household demand based strategy. In this approach or model, both household filter and rainwater harvesting tanks (RWHT) can be implemented to form a combined water supply strategy at the individual/household level. Under this model, GOs or NGOs can make necessary arrangements to provide the technology to interested people, who repay the loan as easy installation to micro-credit organizations (Fig. 6).

It is crucial that these government and NGOs work with micro-credit organizations to facilitate the necessary loans, subsidies and technical support. The success of the household demand based strategy also depends on the income level of the community, as well as their willingness to participate in the scheme. The community's willingness to participate in the scheme might be facilitated by a RWHT demonstration or model conducted by different NGOs (a RWHT with 1000–1500 litre capacity is presently available in the market). For the long-term sustainability of the system, any household filters installed should be easy to maintain and parts should be made readily available. At present, RWHT system can provide at least four to six months water support (depending on the suitability of the catchment area and the capacity of the storage reservoir). For the rest of the year it is hoped that people will be able to filter water from nearby ponds and other sources. This combined strategy will help to ensure drinking water supply to household for the entire year.

6. Conclusions

Coastal communities in Bangladesh suffer from severe problems involving the coverage, quality, and quantity of drinking water supplies. Ground water is a dependable source for water supply in many other regions of Bangladesh, but in the coastal area, the salinity distributions in ground water, caused by rising sea levels, and low rainfall, render this ground water undrinkable, on top of this there are limited water supply alternatives in these coastal regions. Further,

replenishment of water in deep and shallow aquifers is regulated by complex hydrogeological processes. These coastal regions are particularly affected by such processes, and this greatly contributes to the water shortage in the region. Current initiatives that have been taken to resolve these problems through the introduction of alternative options for supplying water have failed until now, due to a lack of strong implementation strategies, weak management systems, and a lack of adequate policy strategies. Therefore, new and innovative approaches for water management in extremely poor communities and water scarce areas must be initiated. Based on the above findings, this study suggests and develops three strategies - community based management, community water enterprise and household demand based management to help resolve these problems and to reduce communities' vulnerability to water scarcity. Unlike current initiatives, all three strategies proposed in this paper can create strong communities and user involvement by giving either a sense of ownership or operational responsibility of the water supply facilities to the community.

Furthermore, policy making should incorporate a uniform initiative that promotes community driven initiatives that are facilitated by government and NGOs. This will help water management institutions to handover their responsibilities for some water supply activities (on an area basis) to the community, thus strengthening their capacity to aid in other activities. The three models outlined in this paper have different aspects and justifications based on community demand and capacity and would therefore be easy to implement, operate and maintain. Fair and transparent negotiations between parties are a very important consideration for successful implementation and communities would need to be able to clearly see the benefits associated with suggested strategies. Mainstreaming the ideas suggested in this paper through pilot programmes, practical demonstrations and information delivery to policy makers and water experts should also be an important consideration in order to update existing systems and to implement the suggested models.

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