LIVELIHOOD AND AVAILABILITY OF SAFE WATER: RURAL SCENARIO AND SUSTAINABLE MANAGEMENT IN BANGLADESH

M. I. Zuberi[*]

ABSTRACT

The availability and management issues related to safe water in the rural areas of Bangladesh has been investigated with data collected from the villages in Shimulia of Dhamrai Upozila. The existing conjunctive use , the prospects and problems regarding an improved strategy for attaining a sustainable supply of water have been discussed. The impacts of climate change on water resources are likely to worsen the water availability scenario due to absence of an efficient water resources management system.

Keywords: Safe water, conjunctive water use, water resource management, Shimulia, Bangladesh

Introduction

Water, the foundation of life, has become a persistent crisis for millions of the world's people – specially in the developing and less developed countries (UN, 2012). This is a crisis that ends up in poor health, impaired livelihoods and endless sufferings. One of the great human challenges of this century, overcoming the water crisis, provision of safe water was the key item in the Millennium Development Goals (MDGs). As stipulated by the MDG 7, target C aims to "reduce by half the proportion of people without sustainable access to safe drinking water" by 2015. Also considered as the central issue in the achievement of the Sustainable Development Goals (SDGs), as over 1 billion people today are without access to safe drinking water and the number of people having a serious water crisis will increase to 3.4 billion by 2025 (UN, 2012). More than two-thirds of the current water use is for food production and agriculture, the demand increasing everyday, the prediction

[*] Department of Environmental Science, Gono Bishwabidyalay, Savar, Dhaka.
E-mail: iqbal.zuberi@gmail.com

is that by 2025 two-thirds of the global population could be living with water scarcity (UN, 2012). Therefore, the availability of safe water became a very important issue.

With other water scarce areas, the availability of safe drinking water, particularly in Bangladesh's hard to reach areas, is expected to worsen with increasing demand, widespread pollution and due to the effects of climate change. According to a World Bank study , about 28 million Bangladeshis, or just over 20% of the population, are living in harsh conditions in the "hard-to-reach areas" that includes about 25% of the country's land, like the char – land, the hilly areas, coastal regions and beels / haors – bowl-shaped wetland areas (WB 2013).

Water : rural situation in Bangladesh

Safe water is an essential requirement for human life and wellbeing. In the rural areas of Bangladesh, water is required mainly for households and agricultural purposes. Information on the water uses pattern of rural settlements is important in developing sustainable water management system for the local people. In rural areas of Bangladesh, more than 97% of the population relies on groundwater for its drinking water supply (WHO, 2017). Due to arsenic contamination, it was estimated that in 2004 only 74% of the population had access to arsenic-free drinking water. Around 26 million people of Bangladesh do not have access to safe drinking water sources, according to an estimate (Unicef and WHO, 2013). In almost all areas, surface water is usually polluted and requires treatment.

The quantity of water required by the households is variable depending on the cultural habit, settlement pattern, type of supply, water source (Keshavarzi et al., 2006). Other factors, like the household size, how water is used, level of maintenance of water supply system, level of education and age of the head of the household are also relevant (Hunnings. 1996). Type of water supply also determines the amount, piped households use on an average almost three times more water than that of un-piped households (Thompson et al., 2001).

In Bangladesh, the mean water consumption was found 83.17 litre per person per day (Lpcd) with standard deviation of 11.93 ; however, this rate varied with income - low consumption households used less than 65 Lpcd, medium 65-90 Lpcd and high more than 90 Lpcd (Al-Amin et al, 2011). Another study, estimated average water consumption per person per day for drinking, cooking and utensil washing, bathing and washing clothes, and sanitary and other purposes were 2 litre, 9 litre, 20 litre, and 8 litre respectively (Ahmed and Smith, 1987). Al-Amin et al (2011) documented slightly higher rates of consumption, which might be due piped water supply system and availability of water in close proximity.

State of rural water supply: a case study

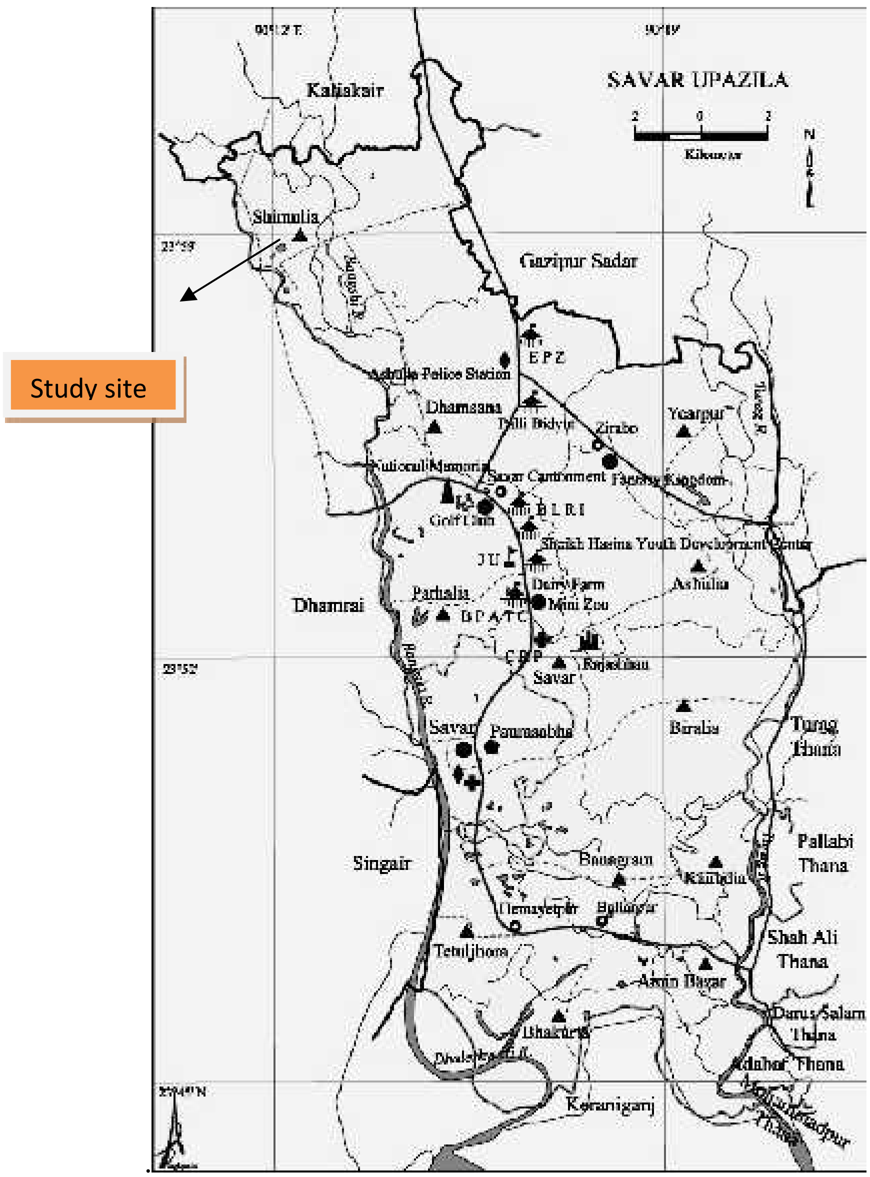
Dhamrai Upazila enjoys the same climatic condition as other parts of Bangladesh, the tropical monsoon zone and is endowed with different aquatic habitats including ponds, tanks, beels and other low-lying areas filled with seasonal water. The research sites in the village Shimulia (Fig. 1) were chosen to be representative of typical social and natural resource conditions: primarily agrarian communities around the beels where most farmland is annually flooded but cropping during the dry season is irrigation dependent. Rice-based cropping (monsoon rice – fallow – irrigated rice) dominates on the seasonally flooded Gleysols that occupy most of the shallow alluvial basins. Vegetable cash crops such as aubergine, chilli, onions, rapeseed are grown on better-drained soils occupying floodplain ridges. For six months in a year (July-December) miles of paddy fields, roads and homes are flooded with water. Three months later, water is in short supply as villagers combat water scarcity, affecting everyday life and crop yields. Demand of water for irrigation is widely varying, depending on water availability, crop type, season and economic condition. In the area, the sources of drinking water is hand tube wells (Table 1), motorized devices for drinking, domestic and irrigation are used, mostly by shallow tube well (STW) with well length of less than 30 m (100 ft), several deep tube wells (DTW) with well length of 60-90 m (200-300 ft) have been installed during last ten years.

Table 1 : Sources of water in ten villages of Shimulia, Savar from household data collected in 2016

Item	Sources	Number of households (hh)	Comments
Drinking water	Tube well	96	Tube well water drying (24 hh)
Water for washing	Tube well	81	Tube well water drying (24 hh)
	Pond	11	Pond water drying (Jul - Aug)
Water for irrigation	Deep TW	6	
	Shallow TW	76	TW water drying (Sept - Oct)
	Canal /pond	21	Canal / ponds drying (Aug - Sept)

All the households use tube well water for drinking, country wide 97% of the rural population actually had access to an improved source of water supply (Ahmed 2005). Again, demand for irrigation water is also met mostly from the ground water, only 21 households reported using canal/pond water. Country wide, only 20% of irrigation demand met by low lift pumps and traditional bucket-lift methods whereas 70% was covered by groundwater irrigation (Ahmed 2005).

Fig 1. Location of the study site of Shimulia in Dhamrai



The villagers complained about water shortage affecting their livelihood (Table 2), about one third facing no water scarcity but the remaining two thirds reported water shortage beginning in the month of July. Many ponds and canals begin drying out by the end of April while some hand tube wells dry up at the middle of the dry season (September), villagers reported that this has been a trend for last few years and because of more water is taken out than coming in by the natural recharge.

Table 2 : Villagers from Shimulia reporting water scarcity and quality

Item	Number of households
Water availability: No water scarcity	30
Late season water shortage (November – March)	30
Mid season water shortage (September)	24
Early season water shortage (July)	12
Water quality: No complain	58
Foul smell in STW water during dry season	17
Fouls smell and taste in STW water	10
Pond/canal water: Too dirty to use	66
Used for three months	19

Many of the villagers have ponds beside or behind their homesteads but about 90% of the ponds were observed to be too polluted to be used, pollution mostly from the drains and waste water from homesteads. The villagers reported the issues of wastewater management and water quality as a major environmental problem and blamed the lack of initiatives to address these. About one third of the village households complained about foul smell and taste of STW water during lean season. At national level 27% of STWs are known to be contaminated while at few places more than 90% of the STWs are contaminated. About 54 percent of hand pumped tubewells were found to have faecal contamination (Hakeem, 2010). Another set of issues we need to address is waste water and the pollution of our depleting fresh water sources in the rivers, beels, haors and canals. Of all waste water generated in the nearby industrial areas and households is discharged with its full load of liquid wastes destroying the surface and ground water resources. Water pollution not only puts the health and well being of people at risk, it also contaminating all the ecosystems killing the flora, fauna and affecting the long term economic future of many communities. For example, ground water in many parts of India is totally unsafe for drinking and irrigation due to continuous contamination from pesticide used for agriculture, industrial disposal, arsenic exposure (Akash Vashishtha, 2015). It has also been acknowledged that wastewater management clearly plays a role in achieving future water security in a world where water stress will increase (OECD, 2012).

Problems of water availability

Out of the two major sources of irrigation water in Bangladesh - surface water and groundwater – the availability of surface water is very low especially during the dry season, so groundwater is extensively used for irrigation. It may be noted that the contribution of surface water was more than that of groundwater in the past, during 1985-86 the contribution from the two sources was almost equal but during the last two decades, the area irrigated by groundwater increased significantly (BADC, 2003). According to BADC, in the boro season of 2004, the total irrigated area was 4,043,859 hectares, of which about 75% was irrigated by groundwater and about 25% was irrigated by surface water. A 'Tube well (irrigation well) Sitting Regulation' was in place that required obtaining government permission for sinking irrigation wells but in 1992 the responsibility of procurement, storing and selling of STW were handed over to the private sector. As a result, the number of STW has increased three folds and the lowering of groundwater table, in many areas of the country STWs becoming inoperative during the peak irrigation season of March-April, which is also the peak dry season in Bangladesh. As reported by Alam (2006) about 60% suffered from tubewell failure due to lowering of groundwater level; over 80% of these farmers reported reduced crop yield and financial loss due to lowering of groundwater level. Since 1986, DPHE [www.cseindia.org/userfiles/groundwater_management_bangladesh.pdf] has been monitoring the fluctuations of groundwater table using a measuring network having one tube well in each union of the country. The data indicates the area where the water table has fallen beyond the suction limit has increased from 12% in 1986 to 20% in 1990. As a result a large number of tube wells fitted with no 6 suction pump become non-functioning during dry season. During 1992-95 an in depth study had been carried out to predict the area of the country where the water table would be beyond the suction limit in the year 2010. Findings on water table monitoring showed that water table has fallen beyond suction limit in about 27% tube wells in 2004 (BWDB, 2005). A more recent report (Rahman et al, 2016) indicated that the average ground water table has been lowered by about 2.5 meters in Bangladesh during 2006-2014.

Conjunctive use of surface water and ground water

Conjunctive use of water relates to the combined use of ground and surface water which is a better strategy as two water sources used provide a higher water reliability (Dudley and Fulton, 2005). Conjunctive use therefore functions as a buffer for periods of water scarcity. The idea of this management approach is to use surface water when the water table is high and change to groundwater when the water table is low. This technique might be especially important as a buffer function for mitigating impacts of climate change, such as increased heat and drought (Foster et al. 2010). Conjunctive use of surface water and ground water is a complex water management strategy that involves management of surface water and groundwater as one resource under diverse geological, hydro-geological, hydrology and geophysical setting (Evans et al 2011; Foster et al, 2010). As there exists a natural hydrologic connection between groundwater and surface water, conjunctive water use readily improves water reliability and can become particularly important for mitigating problems related to climate change, such as increased drought or overexploitation and decreases in groundwater availability. Two main usage phases of conjunctive use are differentiated: (a) Recharge: when the water table is high, the use of surface water is to be maximised. The recharge of groundwater can be enhanced artificially by surface water recharge and subsurface water recharge and (b) Recovery: during the dry season, water is drawn from ground-water resources.

Careful management should keep recharge and recovery in balance which needs a combined management, as there are usually several farmers withdrawing from the same water source, uncontrolled individual use may lead to overexploitation of groundwater. This is a widespread problem, because conjunctive use often occurs unplanned and by default. To enhance the benefits of this practice a better and scientific coordination between the users is needed through a 'conjunctive water management' (World Bank 2006). Currently, the use of ground water is not regulated and landowners can extract as much water as they wish, as a result the water table is sinking – and at an alarming rate many of the aquifer may be drying up. But without a government agency closely monitoring the levels, this would be incredibly hard to achieve.

At the general level the benefits attributed to optimising conjunctive use of surface and groundwater have been investigated over many years through theoretical modelling and studies of physical systems (Xin Wu et al, 2016). These benefits take the form of :

• Economic gains • Increases in productivity • Energy savings • Increased capacity to irrigate via larger areas • Water resource efficiency • Infrastructure optimization

There are actual socio-economic benefits that can be attributed to the implementation of conjunctive use management, for example, Bredehoeft and Young (1983) predicted a twofold increase in net benefit arising from conjunctive management; Agriculture and Rural Development Group of the World Bank (2006) reported a 26 % increase in net farmer income, substantial energy savings, increased irrigation and substantial increase in irrigated crop. More recently, Foster and Steenbergen (2011) emphasized that spontaneous conjunctive use of shallow aquifers possesses the capacity for groundwater to buffer the variability of surface water availability enabling :

• Increased water supply security; • Better timing for irrigation; • Larger water yield than one source; • Reduced environmental impact; • Avoidance of excessive surface water or groundwater depletion.

Climate change and water availability in rural areas

The impacts of climate change on water resources are evident. With climate change, all countries of the Indian Subcontinent are likely to face increased frequency and severity of droughts and floods (Chopra, 2009). Ironically Bangladesh experiences two water extremes - while some parts suffer from flooding, others suffering from water shortage. Also many regions are reaching a critical stage where there will be not enough water and are or will be close to reaching the threshold, and likely to suffer short-term water insecurity because of climate change induced droughts and floods (Mirza, 2011). A need to make the water resource management carefully developed, more adaptive and responsive to unforeseen and rapidly changing situations has been indicated. Water conservation and increased efficiency of water use would increase resilience, but active measures such as better watershed management, introduction of water recharge dams, large scale to communal water storage facilities and rainwater harvesting, would go a long way to make the rural communities more resilient to climate change (Shamsuddin Shahid, 2010).

The quality of water in the river basins is vital to human and environmental health. Whether water quality improves or deteriorates under a changing climate depends on multiple variables including water temperature; the rate, volume, and timing of runoff; and the physical characteristics of the watershed. Over the long term, groundwater supplies are sustainable only to the extent that aquifer recharge remains in approximate long-term balance with groundwater extraction. Climate change has the potential to affect this balance by altering the rate and/or the pathways of groundwater recharge associated with shifts in precipitation patterns, increased temperature, and other drivers of vegetative evapo-transpiration and changes in stream flow.

Climate change is expected to bring changes in the frequency and severity of weather events such as precipitation, flooding and cyclones, which can impact human health (Easterling et al. 2000). Waterborne disease outbreaks are preceded by heavy precipitation events (Nichols et al. 2010), and extreme precipitation was linked to waterborne infections (Chen et al. 2012). So, on the health ground, too, management of water resources is important.

Policy and management issues

Conjunctive use of surface water and ground water is a complex water management strategy that involves management of surface water and groundwater as one resource under diverse geological, hydro-geological, hydrology and geophysical setting. India has adopted this concept as management strategy since 1970s, but the progress of the same hasn't been encouraging (Harsha, 2016). The strategy has been a setback in Indian context, despite prioritizing 40 years ago, due to the limitations and lacunae of research and institutions. As the water problems in Bangladesh are increasing and information useful for decision makers within the water sector and related to the water sector are scarce, unreliable and fragmented, immediate steps are necessary to avoid the long term stalemates. Solving water problems requires information from many disciplines, and the physical accounts (describing sources and uses of water) are the most important foundation. The current hydrological data democracy does not provide all required data necessary for a proper water consumer communication, which hampers the development of good water stewardship. A long term program aiming at developing an information and data base regarding the current knowledge and experience concerning key economic, policy, institutional, environmental and technical aspects of groundwater management is needed. A 'Framework for Action' consisting of a set of policy and institutional guidelines, recommendations and best practices designed to improve groundwater management at local/regional/country levels has to be developed.

Energy and water are interlinked in two ways, first, water is used in the production of nearly all types of energy (coal, geothermal, hydro, oil and gas, nuclear), and second, energy is the dominant cost factor in the provision of water and wastewater services (extracting and conveying water, treating water, distributing water, using water and collecting and treating wastewater). In fact, energy can account for up to 30% of total operating costs of water and wastewater utilities: in some developing countries this can be as high as 40% of the total operating cost. Meanwhile, on average 15% of the world's total water withdrawals are used for energy production.

Energy is required for two components of water provision: pumping and treatment (before and after use). Electricity costs are estimated at 5% to 30%

of the total operating cost of water and wastewater utilities, but in some developing countries such as India and Bangladesh, it is as high as 40% of the total operating cost.

What can be done?

In the circumstances, prevention is the only answer to environmental degradation occurring due to indiscriminate exploitation of ground water. This prevention depends on making farmers responsible for the water they use by rationing through regulation, and in the case of gravity flow irrigation by stopping free distribution. It demands education as wells as services and training at the community level to encourage sustainable irrigation systems and to manage them properly once they are in place.

By 2003 the country has sunk 30,632 DTWs, 8,87,988 STWs and over one million manually operated tubewells throughout the country (CSISA. 2004). The over-exploitation of ground water, particularly through rapid expansion of STWs/DTWs in the aftermath of the suspension of Ground Water Rules, has already caused draw down effects in some parts of the country. For instance, in 15 Barind upazilas of Northern Bangladesh 6893 STWs bought by BRDB cooperatives on bank loan failed to operate during the peak irrigation season due to high draw down caused by DTWs there (Shamsudduha, 2011).

Naturally, in order to develop its full irrigation potential, it is necessary to use and store a good portion of the surface water lost during the wet season for subsequent irrigation use. Several possible ways to store water from the monsoon underground which include:

- increasing infiltration by spreading water in parts of the Ganges basin and constructing bunds at right angles to the flow in uncultivated lands;
- providing space for more groundwater storage by pumping groundwater during the dry season in the vicinity of natural drains, which carry water during the monsoon and along certain tributaries of the Ganges;
- increasing seepage from irrigation canals during the monsoon by extending their network, and subsequently pumping out this seeped water during the dry season, and some others.

As climate change makes seasonal precipitation and surface flows increasingly erratic, the need for improved storage techniques has become more acute than ever. Experts agree storing water underground is far more efficient than storing water in surface reservoirs. This is because storing water underground minimizes evaporation, which is a major cause of water loss in surface reservoirs. Underground storage can accommodate far greater variability in demand from farmers, particularly during drought or the dry season when irrigation water may be needed most.

Most developing countries have long since established laws and formal governmental structures to address their serious environmental problems, but few have been successful in alleviating those problems. The development banks, which control resources desperately needed by the developing countries, are promoting the use of economic incentives and other market-based strategies as the key to more effective environmental protection. However, the donors have rarely asked whether the approaches they are urging, which have recently had some success in Europe and the United States, can be implemented effectively in developing countries with limited resources and little experience with market-based policies of any kind.

Saving water: water smart agriculture

In Bangaldseh, water has become a contentious issue due to rise in demand, climate change and continued mismanagement. With erratic rainfall and recurring droughts in 2012, 2015 and 2016, "water saving" has become a high priority for the governments. As the agriculture sector consumes 80% of freshwater in the country, micro-irrigation – drip and sprinkler irrigation – has been catapulted as a policy priority because drip and sprinkler irrigation deliver water to farms in lesser quantities in contrast to conventional gravity flow irrigation.

Increasing yield per unit of water used will be critical for agricultural adaptation (FAO, 2016). New efficient irrigation technologies, like drip and sprinkler irrigation, are already showing much promise. For example, experience from Asia has shown that – when used in conjunction with high-yielding crop varieties and good soil management practices – yields and water savings have increased by 40% (Sadras and Angus, 2006). Many hand dug wells dry up at the end of the dry season, because more water is taken out than is coming in by the natural recharge. Reasons of limited groundwater recharge are heavy rainfall in short time, (climate change) compact topsoil layers, erosion because of loss of vegetation, etc. Options to increase the recharge of ground water are above or underground dams, the planting of trees and plants such as vetivar grass, making contour canals etc.

Research and activities designed to raise awareness of the importance of groundwater resources is important and there is a need to identify and promote best practices in the governance and management of conjunctive water use as a way to achieve the Sustainable Development Goals.

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