Water Wealth

A Briefing Paper on the State of Groundwater Management in Bangladesh

Sushmita Sengupta, Amandeep Kang, Nitya Jacob, September 2012

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1. Introduction:

Urban Bangladesh faces a huge water crisis. Groundwater tables are falling rapidly, centuries-old urban water bodies have disappeared or severely polluted and urban floods are a regular occurrence in the rainy season in many cities. In addition to water scarcity, water quality of major rivers and canals is under threat. Groundwater pollution is also a threat to the society. The main cause of water shortage in urban Bangladesh is because the urban water paradigm grossly interferes with the natural hydrological principles. Rain is led away from cities and does not recharge the groundwater, which is being mined extensively.

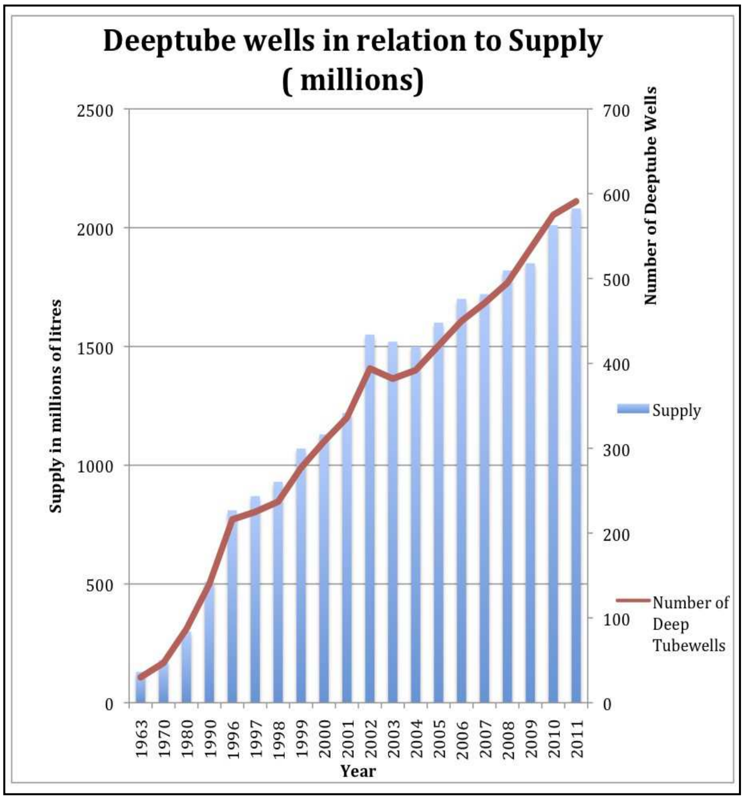


Chart showing the increase in number of deep tubewells with increase in supply in Dhaka, Source: DWASA

Surface water bodies in most cities have become the receptacles for the city's sewage. Urban water bodies, which were the sole source of drinking water in many cities, have been systematically destroyed. In 1960, the built up area was the second lowest land cover type in the city (landfill areas were the lowest and the waterbodies were the highest land cover types). In 2008, the situation completely changed--the built up area became the highest land cover type. The built up area increased more than 385 per cent in comparison to 1960. There was a loss of 32.57 per cent of waterbodies. The land filling and encroachment were the main causes for the loss of wetlands in the city of Dhaka [1].

The increase in the amount of surface water pollution in Bangladesh across the years has forced the citizens to depend more and more on groundwater. The cities like Khulna, Chittagong, Borisal depend heavily on groundwater. In Dhaka about 87 per cent of city supply depends on groundwater[2]. A research by Bangladesh Agricultural Development Corporation (BADC), said that Dhaka's groundwater level had dropped to 52 metres below mean sea level in 2011, compared with 46 metres in 2004. The excessive withdrawal caused vacuum underground creating possibility of subsidence. The over dependence on groundwater is resulting in the groundwater level to fall by one metre per year in the metropolitan areas. The fast depletion of groundwater will also cause saline intrusion in the groundwater reservoir. This will pose a threat to the availability of fresh water in the near future in the metropolitan areas.

According to the Dhaka Water and Sewerage Authority (WASA), the groundwater table was at 11.3 m below the ground level (mbgl) in the 1970s and at 20 mbgl in the 1980s. However, water level has drastically fallen since 1996 (see graph). According to a study by the Institute of Water Modelling (IWM) in Dhaka in 2009, groundwater in the city is going down three metres every year. The researchers of BADC and IWM blamed the decline on low groundwater recharge rates.

While cities reel from water scarcity every summer due to the plunging of groundwater levels, when the rain comes, city like Dhaka is flooded. Urban flooding has become a regular occurrence in the larger cities of Bangladesh. The Coastal City Flood Vulnerability Index (CCFVI) developed by British and Dutch scientists in 2012 shows that Dhaka is the second most vulnerable city to serious flooding after Shanghai. With water mixing with dirt and sewage overflows, every city reels under severe health problems in the aftermath of floods. Over the years, the natural drainage channels of cities have been encroached upon and urban water bodies, which were the main recharge bodies to soak up the monsoon rainwater, have been filled up and built upon. Drainage systems in many of the towns were built many years ago and have not been expanded to keep up with the population. Worse, existing drains are not maintained and desilted.

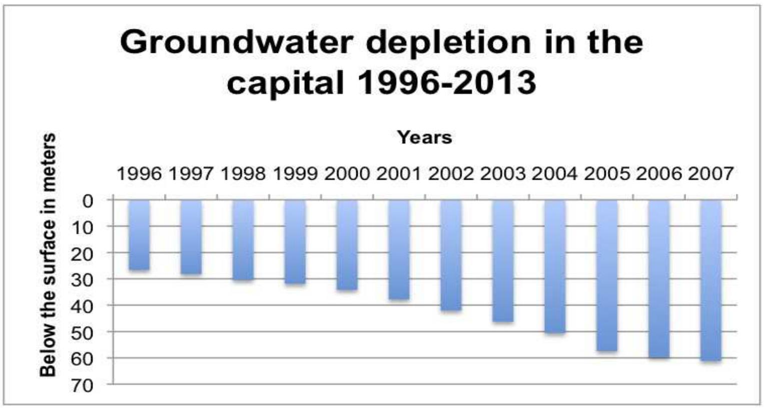


Figure 1: Chart showing decline of groundwater level in Dhaka (1996-2006)

The quality of groundwater, which is extensively used as a source of water supply in most cities of Bangladesh, is also deteriorating. Firstly, the groundwater is polluted by sewage and other effluents. Secondly, because of excessive groundwater extraction, there are a variety of quality problems ranging from hardness to arsenic and fluoride contamination. The scientists of Rajshahi University together with Hokkaido University, Research Group for Applied Geology (RGAG) and Asian Arsenic Network (AAN) of Japan suspect that groundwater of about 63 out of 64 district of Bangladesh are seriously contaminated with arsenic. There are 11 Million tube wells in Bangladesh out of which about 5 Million tube wells are highly arsenic contaminated. About 80 Million people of the affected districts are at risk and the total number of patients suffering from Arsenicosis is about 7000 and out of which about 200 persons already died in last few years. Arsenic is majorly spread and contaminating the shallow aquifer in the region and hence eventually those people who drink water from shallow tubewells are most likely to getting affected with arsenic contamination and arsenicosis. In 1998, British Geological Survey (BGS) collected 2022 water samples from 41 arsenic-affected districts. Laboratory tests revealed that 35% of these water samples were found to have arsenic concentrations above 0.05 mg/l. Although arsenic is the major inorganic constituent of health concern, problems in the groundwater also exist with high concentrations of iron and manganese. Boron is problematic in some higher- salinity areas in southern Bangladesh[3].

2. Urban water supply and groundwater dependence

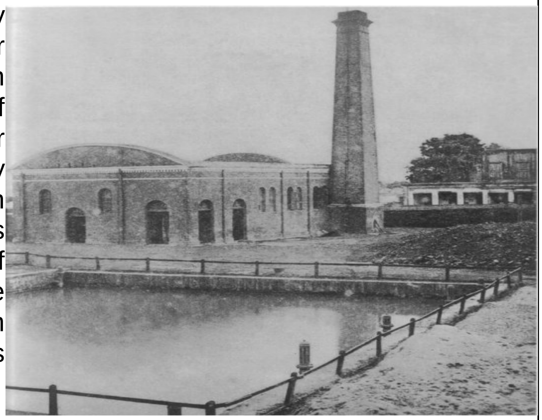
The traditional water sources for many towns were mainly ponds, canals and dugwells (pre-independence: before 1971). Only very few towns had piped water supply. Major piped water supply to many towns started in 1980. Department of Public Health and Engineering (DPHE) was responsible for the supply. Gradually the *paurashavas* became incharge of water service delivery. In order to address the water supply of bigger cities WASAs were established. The four cities where WASA was established were Dhaka, Chittagong, Khulna and Rajshahi. Cities like Dhaka and Chittagong used river water in small proportion to supplement the groundwater. In absence of suitable aquifer, towns like Gopalganj, Sunamganj and Pirojpur use river water. Lake water is also a source for town like Rangamati[4]. 97 per cent of people in Bangladesh have turned to getting their water from underground sources over the past 20-30 years. This started when the Bangladesh government and few organizations tried to stop the problem of diarrhoeal diseases that has been a problem in Bangladesh throughout history. These organizations concluded that the epicentre of the disease was sewage contamination of the surface water, and so they started digging thousands of wells to get to the groundwater[5].

Dhaka, the capital city of the country initially depended on dugwells, rivers, ponds and beels. The treatment plant was first time installed in middle of 1800 and water from Buriganga was treated. In the middle of 1900, the city first time went deep down in the ground for the search of water (see box). About 87 per cent of water supply now depends on groundwater.

The study of the groundwater demand from different parts of the country shows that northwest and north central region depend on groundwater a lot for the supply of the water. Groundwater resources are determined by properties of groundwater storage reservoir and volume of annual recharge. Mainly rainfall, flooding and stream flow in rivers penetrate earth surface and recharge groundwater reservoirs. Although Bangladesh has been considered rich in groundwater resources, the total groundwater storage data is absent. National Water Plan Phase-II estimated average groundwater as 21 cubic kilometres (cu km) in 1991. However, with the increased trend of urbanisation and irregular rainfall behaviour, surface run-off has increased in recent times, which reduces groundwater recharge considerably.

History of Water Supply in Dhaka

Treated water supply began in Dhaka, partly, for the first time in 1878. In 1869, civil surgeon of Dhaka reported that water of all dug wells of the city was contaminated. Even the water from the rivers and canals was full of pathogens. Majority of the people used to drink from dug wells or rivers-canals and pond-beels.



There was a Great Cholera incidence in 1881. One or two members from every family died. Pure, filtered water was first supplied to Dhaka in 1879, following the construction of the water works in the previous year. Before that, the city's water had been supplied from the river Buriganga and a large number of wells and tank sunk into the soil. All these sources bred diseases. Regular outbreaks of cholera were further evidence that the supply of filtered was inadequate, but the great epidemic of 1919 failed to move either the government or the municipality.

However, a second epidemic in 1927-28, when 237 people were recorded as dying in Dhaka, stimulated action. A major project to improve the supply of filtered water was prepared and partially executed by the Public Health Engineering Department during the 1929-30. A tubewell was installed in 1940 in Narinda with the capacity to supply 11,000 gallons water per hour. The number of street hydrants was insufficient, the water pressure was low and queues were large. Water taps were situated far away from many slums. Inevitably, a large number of people still depended on polluted water from wells and canals.

The municipality also blamed the consumers themselves for irresponsibly wasting water. Since water was regarded as nature's bounty, people tended not to feel guilty about leaving water hydrants open till they ran dry, or failing to report burst water mains to the municipality. Although the supply of filtered water in Dhaka was inadequate, it was at least of high quality. The municipality took the water supply more seriously than many other services. Regular bacteriological tests were carried out in the Public Health Laboratory, to maintain the purity of water as far as possible[6].

Groundwater storage reservoirs are composed of three aquifers in Bangladesh:

1. Upper aquifer or composite aquifer

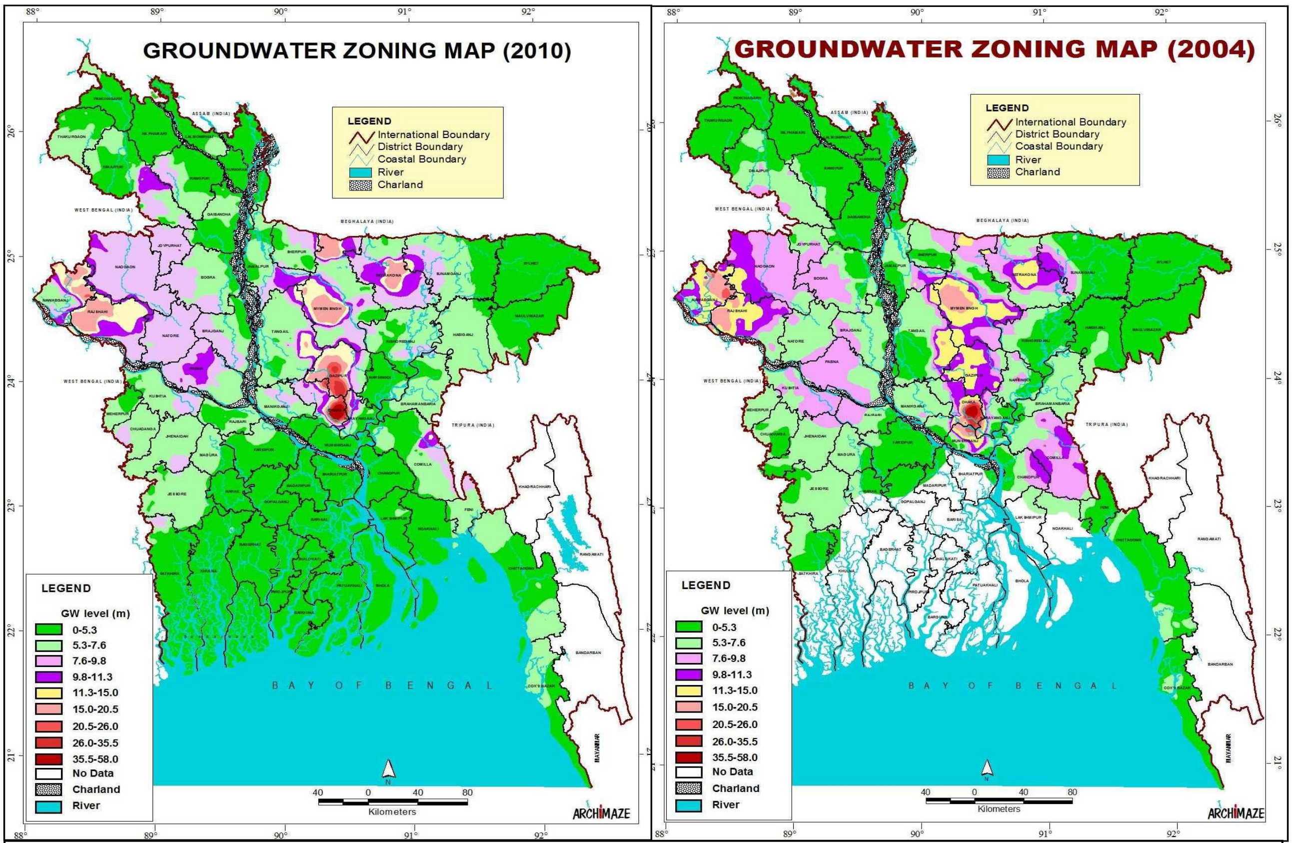


Figure 2.1: Groundwater zoning maps in Bangladesh, 2004 and 2010 (Source: Bangladesh Agriculture Development Corporation, 2011)

2. Main aquifer (it is at depths six meters in north-west and to 83 m in the South) and
3. Deep aquifer

The transmission property of the main aquifer is good to excellent over most of the country but it is deteriorating towards the south and the east. Underlying the main aquifer, there is a deeper water bearing unit separated by one or more clay layers of varied thickness referred as the deep aquifer that has been exploited by tube wells in Dhaka and in the coastal areas. In the areas near the coast the water table is descending due to over extraction or salinity contamination of upper or main aquifer[7]. Strong declining trends (0.5–1 metre/year) in dry-period groundwater levels are observed in the central part of the country surrounding the Dhaka city. Moderately declining trends (0.1–0.5 metre/year) occur in western, northwestern, and northeastern areas. In the northern table land areas and floodplains of the major rivers, magnitudes of declining trends are low (0.01–0.05 m/yr). Stable or slightly rising trends (0–0.1 metre/year) are generally observed from the Meghna estuary to the southern coastal areas in the country. A similar overall pattern is seen during wet periods except in the northern table land areas, southwestern delta plains and southern coastal areas where wet period trends are slightly rising or stable[8].

The researchers say the groundwater resource available is not sufficient to meet the demand of the cities and towns. Excess extraction causes the groundwater level to decline at a rate of more than 2.0 m inside the city of Dhaka and more than 1.0 metre near Buriganga river. As per model study of 1997 the depth of groundwater level was 25.0 metres below ground level (mbgl), by year 2006 it will go to 35.0 mbgl and by the year 2016 it will be lowered to 45.0 mbgl[9]. Due to over extraction of groundwater, land subsidence has been noted in different places of the city. Groundwater has been abstracted for urban and industrial water supplies (mostly in Dhaka, Narayanganj and Gazipur areas). Most rapid and higher rates of decline occur over Dhaka city and adjacent areas where groundwater abstraction is the highest in the country. These aquifers are replenished (known as recharge) each year during the monsoon season when rain and flood water finds its way into the aquifer slowly percolating down through overlying soils and sediments. The rate of recharge varies depending on the property of soil and geology of the area. Unfortunately, the recharge rate over Dhaka city is much slower than that of the adjacent floodplain areas.

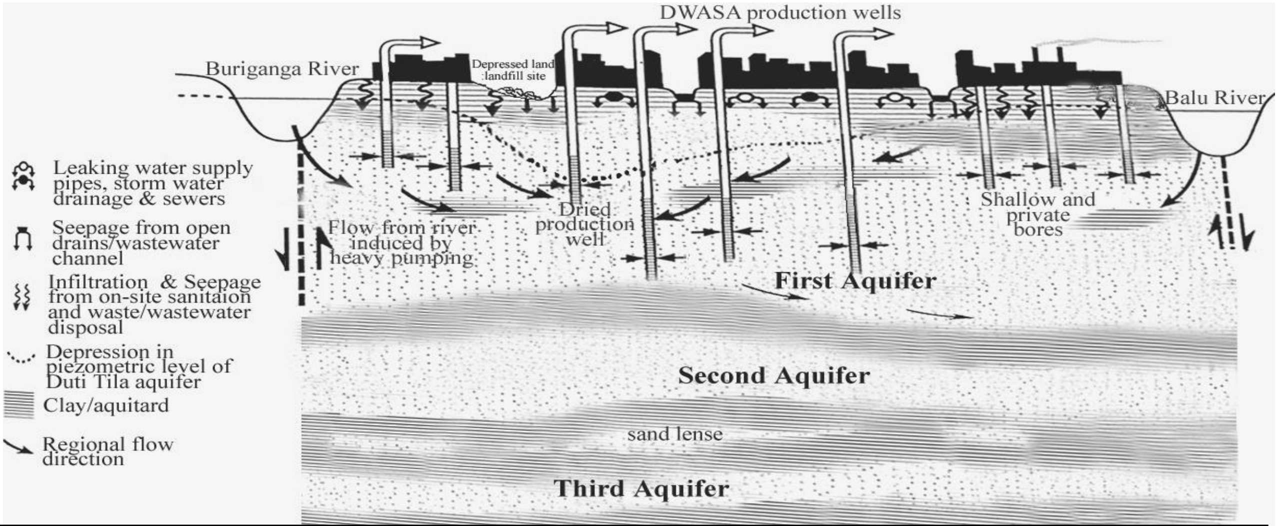


Figure 2.2: Groundwater extraction in the urban areas of Dhaka (Source: Sarmin Sultana. 2009. Hydro geochemistry of the Lower Dupi Tila Aquifer in Dhaka City, Bangladesh. TRITA-LWR degree project

Region	**Gross area (thousand hectares)**	**Usable recharge (mm^3)**	**% of groundwater demand for water supply (mm^3)**
Northwest	3, 016	539	4.7
Northeast	Not available	222	12.7
North-central	3, 569	566	13.2
Southeast	3, 007	232	7.7
South-central	1, 426	179	12.6
Southwest	2, 562	289	11.3
Eastern hills	Not available	181	100

Table 1: Groundwater demand for water supply in different regions (Source: Sector development Plan, FY 2011-25, LGD)

3. Groundwater pollutants and their effects on human health

The causes of pollution of groundwater in Bangladesh are due to: discharge of untreated waste, dumping of industrial effluent, runoff from agricultural fields, industrial growth, urbanisation, leakage from sewage lines and natural occurrence of arsenic. At national level 27 per cent of shallow tubewells are known to be contaminated. At few places more than 90 per cent of shallow tubewells are contaminated[10]. About 54 percent of hand pumped tubewells were found to have faecal contamination, due to poor well head design, faulty construction and management[11]. In Bangladesh, groundwater was always treated as the best source for drinking water unless arsenic was reported in early 1980s. Apart from the arsenic contamination of groundwater, there are problems of faecal contamination. High concentration of iron, fluoride, manganese, boron, phosphorous, salinity, iodine and uranium are also found in different parts of the country. However, these contaminations do not show serious impact on the human health.

More than 60 per cent of the groundwater in Bangladesh contains naturally occurring arsenic, with concentration levels often significantly exceeding World Health Organisation's (WHO) standard of 10μg/litre. Recent data show that around 30-40 percent of the total population in Bangladesh is using arsenic contaminated groundwater for drinking. Since 1970, the Bangladesh government started sourcing groundwater in a full fledged manner. This was done to avoid pathogen contaminated surface water. The government started installing shallow tubewells (less than 150 m depth). In 1983, Department of Public Health Engineering first detected arsenic in groundwater. In 1998, it was found that more than 50 per cent of over 8000 tubwells in the country yielded groundwater contaminated with arsenic. The concentration not only much over WHO's standard but also Bangladesh's standard of 50 μg/L. Sixty out of sixty four districts show high concentration of arsenic (above WHO's standard). The data provided by Bangladesh Geological Survey (BGS) and DPHE show that the shallow aquifers are laden with high concentration of arsenic. According to DPHE, that is the reason why they are going for extraction from deeper wells. Whether these deeper wells will provide a sustainable source is also a question mark for the department. According to the study of eminent scientists shows that if the concentrations of arsenic as reported by BGS and DPHE are projected for future predictions, then there will be 2 million cases of arsenicosis and 125,000 cases of skin cancers, and incidences of several thousand deaths from internal cancers per year[12].

Khulna: Total Dependence of City Supply on Groundwater

The total demand of water for Khulna city is 240 MLD. Khulna WASA is supplying 102 MLD water entirely from ground water source this is because the surface water source is either saline or polluted. The current supply is 42 MLD which is sourced from the underground water through deep tubewells. The water is supplied to 16900 households through pipe network. The remaining 60 MLD of water is extracted from nearly 10000 hand tube wells (4000 deep and 6000 shallow tube wells) installed at various common points in the city area by Khulna City Corporation (KCC). These tubewells are maintained by Khulna WASA. Groundwater is chlorinated before supply. KWASA monitors the groundwater monthly for Arsenic and Iron. The shallow aquifer is either saline or contaminated with arsenic. Hence the citizens as wells as water suprefers deeper tubewells.

A large number of privately owned tube wells are also present in and around the city. As a result, the groundwater table declines significantly during the dry period (March-May), consequently the wells provide limited or no water during the dry period.

Source: KWASA and personal communications with local residents and NGO.

Table 2: Overview of Arsenic Contamination

Safe water coverage	Percentage tubewells with Arsenic contamination				
	<20 %	20-40 %	40-60 %	60-80 %	>80 %
<20 %	189	223	370	535	7204
20-40 %	428	666	935	1034	8888
40-60 %	1885	1890	1213	792	1708
60-80 %	1682	1049	631	1348	509
80-100 %	770	490	148	214	245
> 100 %	418	674	483	274	118
No data	18	8	0	0	0

Source: Sector Development Plan FY 2011-2025.

Photo 3.1: Groundwater contaminated due to poor sanitation. Source: Sushmita Sengupta, Water team, CSE

The port city of Bangladesh, Chittagong, which is also the second largest city of the country, depends heavily on groundwater. Two-thirds of the city's population i.e. 5.5 million people depend on groundwater. According to the water utility (Chittagong WASA), the supply reaches almost to forty per cent of the population. To avoid arsenic, CWASA extracts water from deep aquifers. As digging deeper tubewells and borewells is expensive, the poor and slum dwellers have to rely on shallow aquifers. The arsenic contamination levels are thus taking a toll on the unprivileged. Seven of the 41 wards under the jurisdiction of the city corporation have high arsenic contamination, according to a study by Chittagong University of Engineering and Technology (CUET) in association with Chittagong Engineers Institute and the Bangladesh Environment Forum.

Photograph 3.2: The skin disorders, called keratosis and spotted melanosis, are the initial symptoms of arsenic poisoning (left), Volunteers have painted red some of the tubewells that pump arsenic-contaminated water (right) Source: Down to Earth, Web special, November 2012

Rajshahi and Rangpur: More groundwater mining

The total population of Rajshai city is around 10 Lakh with around 48000 households. The total demand of water for Rajshahi city is 10.3 crore liters per day. Rajshahi WASA which is responsible for supplying water to the city, supplies only 7.3 crore liters per day. The supply is extracted mainly from the underground water source. Only 20 per cent of the supply depends on surface water which comes from Padma river flowing very near to the city. The supply coverage is only 69 per cent. Hence there are large number of private tubewells. There are approximately 6000 tube wells in the city of Rajshahi, this includes the illegal tube wells as well. The groundwater level reaches almost 7 feet bgl during the lean period. Round the year, the groundwater level stays at a shallow level of 2 feet bgl.
(*Source: Dr. Alam, Deputy Managing Director, Rajshahi WASA)*

Rangpur on the table land area of north Bangladesh also shows a heavy dependence on groundwater. The city corporation which supplies water to the city depends entirely on groundwater for its water supply. The official water extraction rate is 6000 cubic meter per day. This includes both shallow and deep tubewells. Out of a population of eight lakhs, the city supply reaches only 5-10 per cent of the population. The rest of its population own private tubewells. The city is planning for a surface water supply from the Tista river. According to the city corporation, this project will face some problems, as the river dries up during the lean period. Some wards of the city have iron contamination in their groundwater. That is why the city authority has gone deeper in search of contamination free water. The authority has already reached 550 feet bgl for this.
(Source: Mir Tuparzan Hossain, Water Superintendent Rangpur City Corporation)

Coastal city like Khulna faces acute salinity problems specifically during non-monsoon period. The groundwater totally becomes non potable during this season. There are problems of hard groundwater also in this area which makes the groundwater unfit for drinking[13].

4. Estimation of recharge potential

Both small and large towns/cities of Bangladesh depend heavily on groundwater. To recharge this groundwater, the best source is rainwater[14]. This is because the country receives up to between 1429 to 4338 mm of rainfall on an average. Long term mean annual rainfall in Bangladesh is 1492 mm in northwest and 4097 mm in southeast. Since the early 1970s, using different methods and datasets there have been several efforts to estimate groundwater recharge to shallow aquifers in Bangladesh. As per a study conducted by Master Plan Organisation (MPO 1987) the high potential areas in Bangladesh for recharging are Brahmaputra and Meghna river basins and eastern parts of Bangladesh[15]. In a more comprehensive study of recharging potential in Bangladesh by UNDP, it was found that majority of recharge (more than 90 per cent) to unconfined shallow aquifers occurs during monsoon season (UNDP 1982)[16].

Studies shows that the net recharge is higher with 5 to 15 mm per year in northwest and western parts of Bangladesh compared to eastern parts except Comilla district. The magnitude of groundwater recharge varies between pre developed ground water fed irrigation (1975-1980) and post developed ground water fed irrigation periods (2002-2007) periods (*see the map: Groundwater Recharge Estimates*). However, the biggest constraint for ground water recharge is that the shallow aquifers get filled up by the monsoon, leaving no space for further recharging.

Groundwater Recharge Potentiality of Barind Tract

Recent research conducted by university of Rajshahi using remote sensing and GIS aimed to explore the recharge potential of Barind area of Rajshahi has found that only 8.6 per cent of the total precipitated water (1685 mm) percolates into the ground and recharge the groundwater reservoirs. The study found that up to 15 per cent of the total area of Rajshahi Barind tract has moderate recharge potential. On the similar lines, another research by the University of Rajshahi found that in the high Barind area, as there are high irrigation demands and rainfall is not sufficient to compensate for extraction, hence buffer water management can be applied to help in increase recharge. It has also been estimated that 56 per cent of surface water can be used for recharging the groundwater by buffer water management practices. *(Source: Personal communication with Prof. C.S. Jahan, Department of Geology and Mining, Rajshahi University and M. Phil Thesis of Arefin Md. Raiad[17])*

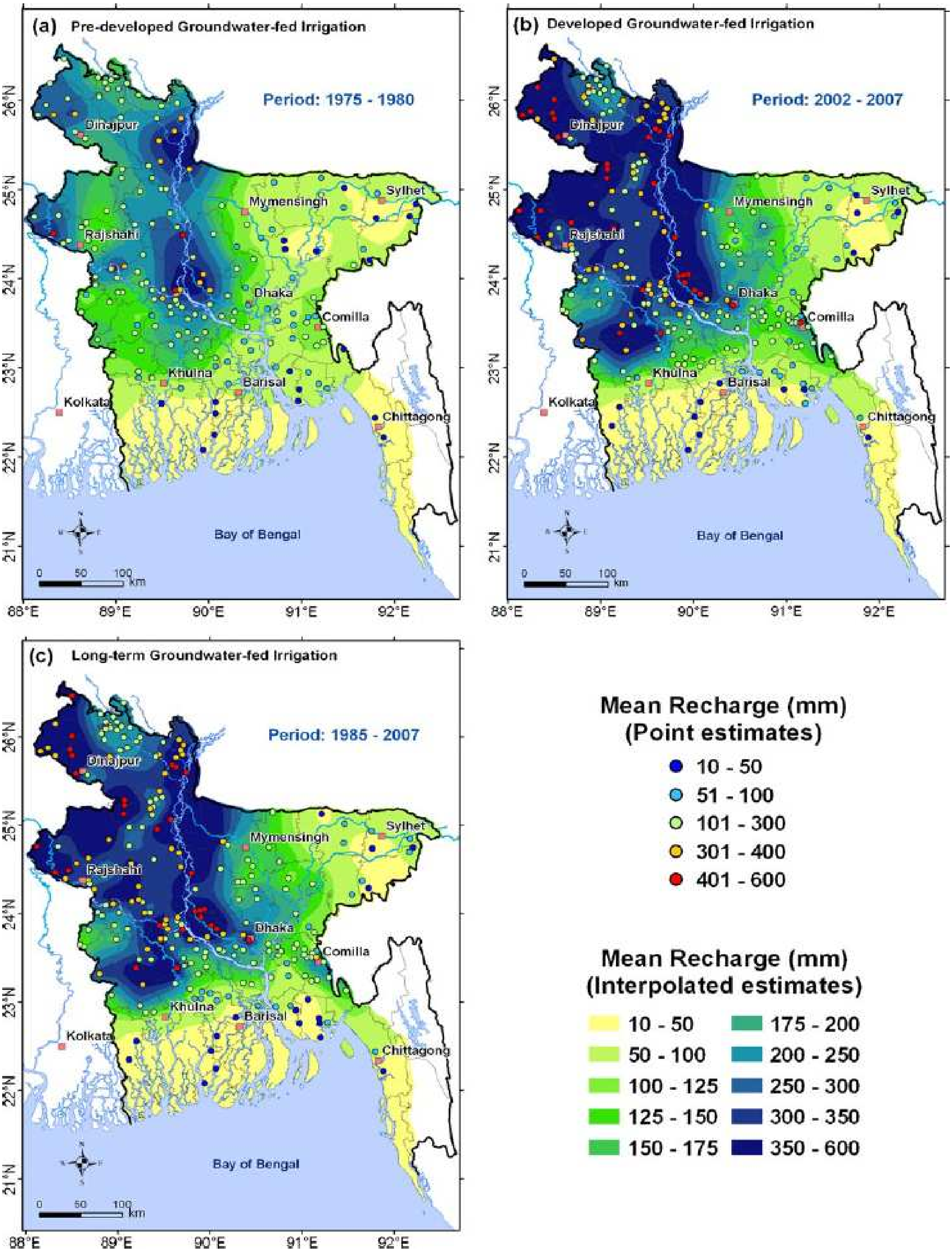


Figure 4.1: Ground water recharge estimates. Source: Groundwater Recharge (Shamsudduha et al., 2009)

5. Importance of the preservation of waterbodies

Due to rapid urbanisation and negligence of the authorities, the groundwater of different cities of the country including the capital city is falling at an alarming rate. According to Dhaka WASA, the groundwater level in the city is declining at the rate of 8-10 m. The groundwater level was recorded as shallow as 10 mbgl in Dhaka during early seventies. It has already reached 68 mbgl in different parts of the capital like Motijheel, Mohammadpur, Mirpur, Tejgaon, Malibagh, Rampura, Ramna, Shahbagh and Dhanmondi areas says WASA source. According to the architects of Dhaka, the present building bylaws of Dhaka, which came into force in 2008, are not enough to ensure natural recharge of groundwater. Almost 65 per cent of the city is paved according to the Department of Urban and Regional Planning (URP), Bangladesh University of Engineering and Technology (BUET). The remaining area does not ensure natural recharge of aquifers because top soil at most places is clayey. Just during the time, the country attained its freedom; there was influx of people in the capital city. As the population increased—it has grown 13 times since 1963—developers and the government targeted the channels. By the time the Wetland Protection Act came into force in 2000, residential buildings, industrial units and numerous slums and squatters had constricted the channels and fragmented them into lake according to Bangladesh Poribesh Andolon - the leading activist group of the country. According to researchers of the Department of URP, BUET, the wetlands covered around 28 per cent of the total area in 1989 which reduced to almost 17 per cent in 2005. The loss of wetlands increased from about 502.4 hectare/year to 1922 hectare/year[18]. These activities reduced natural recharge to a great extent in the city. Not only this, the encroachment blocked the flood flow retention zones. This caused extreme flood events in the city.

> Major Food Events and Stormwater Management in the City of Dhaka
>
> - Major floods in 1954, 1955, 1970, 1974, 1980, 1987, 1988, 1998 and 2004.
> - There were also events of floods in 2006, 2007
> - 1988 flood inundated about 85% of the city (depth .3 to 4.5 metres). In 1998 flood, 64 affected wards of Dhaka City had estimated total damage of Taka 2.0 billion or $US 41.0 million
> - 2004 flood inundated 50% of the city
> - WASA sources said the drains can deal with only 10 millimetres (mm) of rain an hour. The city has 150 square kilometres of storm drains, whereas it needs at least 260 sq kms to collect runoff from heavy shower
> - Following the flood of 1987 and 1998, National Flood Action Plan (FAP) was formulated to provide a relatively flood free living environment within the framework of a long term flood protection program for Dhaka
> - Proposals include: construction of embankment, improvement of khal (canal), construction of pumping station and acquiring land for retention pond. (*Source: Personal communications with URP, BUET, local residents and NGO*)

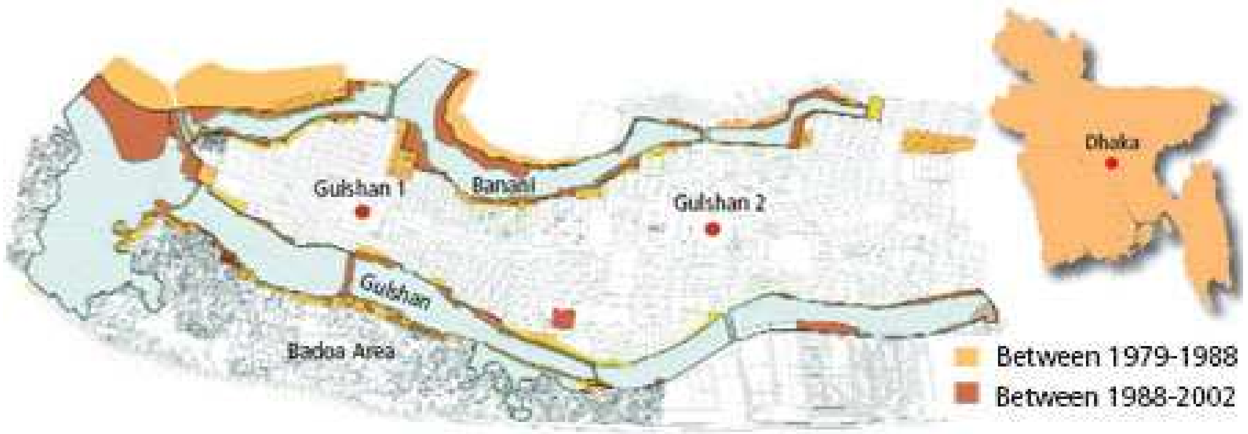


Figure 5.1: Encroached Gulshan Baridhara canal system. Source Down to Earth, January 31, 2011

In other cities like the coastal city of Khulna or hilly city of Chittagong, there is absence of any man made underground stormwater drainage system. The cities are intersected by natural khals (canals) which carry the stormwater and wastewater. The canals are connected to major rivers in the areas. Unplanned development in these areas causes encroachment of these canals. Apart from this, the practise of quarrying in the hills increase the silt load in the canals of the hilly cities like Chittagong. Thus the filling of the canals and waterbodies of these cities lead to frequent flooding in these areas[19].

Figure 5.3: Encroached and polluted river Buriganga, Dhaka. Source: Sushmita Sengupta, Water team, CSE

6. Existing Laws and Policies for Groundwater Management and Rainwater Harvesting in Bangladesh

Historically, like in many under developed countries, the issues such as rights and ownership concerning ground water have never been viewed seriously in Bangladesh. Over the last four decades, substantial amounts of ground water have been withdrawn to meet the burgeoning needs of agriculture and the urban sector.

Institutions concerning management of water sector

Overall, the National Water Resources Council (NWRC) chaired by the Prime Minister formulates policies concerning the water sector and oversees their implementation. The Water Resources Planning Organization (WARPO) under the Ministry of Water Resources acts as Secretariat of the Executive Committee. At micro level a number of ministries and intuitions are involved in the management of the water sector in Bangladesh. The Ministry of Local Government, Rural Development and Cooperatives have overall responsibility for monitoring and governing the sector, including policy formulation through its Local Government Division.

Within the Divisions, except for the three largest urban areas, Dhaka, Khulna and Chittagong and Rajshahi the Department of Public Health Engineering (DPHE) assists municipalities and communities in relation to water supply and management. In Dhaka, Khulna, Chittagong and Rajshahi Water Supply & Sewerage Authority (WASA) is responsible for the water management and supply. Other ministries such as Education, Health and Family Welfare; Water

Groundwater Management Ordinance 1985 - Salient Features

For the purpose of implementation of the ordinance it was recommended that upzilla Irrigation Committees will be constituted, who will be responsible for the management of groundwater at upzilla level. Under this ordinance it was stated that:

- No tube well shall be installed in any place without a license granted by the upzilla parishad.
- No application shall be entertained by the upzilla parishad unless it is accompanied by such fee as may be prescribed.
- On receipt of an application for licence, the upzila parishad shall direct the committee to hold a local enquiry and submit a report on:
  a) the aquifer conditions of the soil where the tubewell is to be installed.
  b) the distance of the nearest existing tubewells
  c) the area likely to be benefitted by the tubewells
  d) the likely effect on the existing tubewells and
  e) the sustainability of the site for installation of the tube wells.

For the existing tubewells, it was proposed that the tube wells operating before the commencement of the ordinance should not operate without licence after the six months of the commencement of the ordinance.

Resources; Environment and Forests; the Planning Commission also influence the sector. The National Water Management Plan (NWMP) in 2004 listed 13 ministries involved in the sector.

Existing policies and acts concerning ground water management

The first effort towards the management of groundwater in Bangladesh came in the form of 'Groundwater Management Ordinance 1985'. The ordinance was basically for the management of ground water used for the purpose of irrigation.

Figure 5.4: Mayur river in Khulna encroached and polluted. Source: Nitya Jacob, Water team, CSE

Bangladesh adopted its first National Water Policy in 1999. One of the main objectives addressed in this policy concerning the management of ground water was the use and development of groundwater in an efficient and equitable way. The policy also recommended a legal and regulatory framework which encourages decentralization, consideration of environmental impacts, and private sector investment for the management of both the ground and surface water. To compliment the national water policy, in 2004, WARPO developed a National Water Management Plan (NWMP), which was approved by NWRC. The objective of this plan was to implement the National Water Policy within next 25 years. In 2004 it also adopted a National Policy for Arsenic Mitigation. This policy emphasized on alternative safe water supply, particularly preferred surface water over groundwater for drinking water supply. Recently Water Act 2013 is published. The act is based on the National Water Policy, and designed for integrated development, management, extraction, distribution, usage, protection and conservation of water resources in Bangladesh. As per water act 2013 all forms of water in Bangladesh belong to the government. As per the act a permit or a license is required for any large scale withdrawal of water by individuals and organizations beyond domestic use. However, the maximum amount of groundwater that can be withdrawn by any individual or organization is not mentioned in the Act. Acknowledging the increasing water needs both in the irrigation and urban areas, the act also stressed on rainwater harvesting, especially to sustain the drinking water supply. To strengthen the implementation, the Act also provides provision for punishment and financial penalty for non-compliance with the Act. The maximum penalty for violations is five years of imprisonment and/or a monetary penalty of Taka10000.

Bangladesh has already proposed to make

Box: Detailed Area Plan for Sustainable Water Management

Rajdhani Unnayan Katripakha (RAJUK) developed a detailed area plan (DAP) for the Dhaka city. It provides more detailed planning proposals for specific sub-areas compliant with the Structure Plan and the Urban Area Plan under Dhaka Metropolitan Development Plan (DMDP) . DAP, a part of DMDP, was initiated in 2004. In 2010, the final DAP was published in official gazette after two reviews. The plan was supposed to be implemented over an area of 1528 sq. km. Under this plan one-third of the master plan area has been marked as flood flow zones, water retention ponds and water bodies. All these were planned for the management of the stormwater, flood and waterbodies apart from other land use features like roads, open spaces etc. DAP is valid till 2015. The success of this plan would have culminated to a sustainable groundwater management. Real estate developers have filled up nearly 83 percent of designated wetlands and flood flow zones of the capital. The destruction of the water sensitive structures cause water logging, reduction of groundwater recharge and related food crisis and health hazards in the city. While the existing DAP is nowhere implemented and already under controversy, the government is planning for anew DAP for the capital city. (*Source: RAJUK, NGOs and URP, BUET)* rainwater harvesting compulsory in the new Water Act 2012. Dhaka City Development Authority (Rajdhani Unnayan Katripakha) proposed few new rules as Dhaka City Building Rules 2011, where rainwater harvesting and groundwater recharge have been made mandatory for buildings having roof area more than 200 square metre (sq.m.). Bangladesh National Building Code is under revision. A separate chapter on Rainwater Management has been incorporated in the draft version. There is a plan to include the provision of "Rainwater Harvesting and Groundwater Recharging" in Dhaka Mahanagar Building (Construction, Development, Protection and Removal) Rule" enacted in 2008. This will be done once the National Building code is amended.

Ponds, lakes and waterbodies which are bigger recharging systems in urban areas, are protected under Water Body Conservation Act 2000 and Bangladesh Environment Conservation Act 1995

7. Way forward: Groundwater management and stormwater management to move towards rain cities

Against the background of the envisaged economic growth and the resulting population growth, the water needs of the small and large towns/cities of Bangladesh will grow at an explosive rate. But water availability will not grow in parallel leading to water stress and resultant conflicts. Most of the major cities and towns in Bangladesh tap deep confined aquifers to source safe water. A confined aquifer can only be recharged naturally in places where it is exposed to the surface. In these towns there is no provision to recharge these aquifers. Wherever shallow aquifers are tapped, unplanned concretisation and destruction of waterbodies make the recharge very difficult. To ensure long-term sustainability of water sources for the city, rainwater harvesting is a simple and effective solution. It can be done using roads, roundabouts, parks, rooftops, paved areas – almost the entire city.

City of Dhaka during 2007 flood. Source: Prof. Ishrat Islam, Department URP, BUET

To undertake rainwater harvesting in the cities and towns of Bangladesh two major ways are possible:

1. Recharge of deep confined aquifers
2. By storing water in tanks or ponds and water bodies

There is a need to put in place a number of measures to create awareness among the people about the importance of water and incentivise them to use water carefully and wisely. These will include policy measures (legal, financial), research, capacity building and education measures. The first step is to create a central authority to coordinate all water conservation and augmentation measures (Rainwater Harvesting or Water Conservation Cell). The next step is defining clear and definite short-term and long-term measures and targets, identify funding sources and secure adequate funding. Bulk users and institutional buildings must be targeted first.

Short-term measures: This will include legal, administrative and financial measures on the one hand, and awareness creation and capacity building on the other. They go hand in hand and must be initiated together. To catalyse citizens and public institutions to become water-wise, legal and administrative measures can be put in place. These include amendment of bylaws to make water conservation measures mandatory, financial and administrative incentives such as rebates on water bills, property taxes, award programmes etc. Pricing of water is a key instrument to ensure that consumers use water carefully.

Long-term measures: A focussed programme to encourage research on such issues as hydrogeological and rainfall mapping, filters, technological tools must be instituted. Detailed maps of each zone can be created for recharge zones, flood-prone areas, water quality and water bodies that can be revived etc. Detailed studies can be initiated using GIS, satellite imageries.

Before exhorting the public to use water wisely, the Administration must lead by example by instituting measures for wise use of water in its own buildings. Rainwater harvesting must be implemented in all government buildings and public spaces such as parks, stadia etc. The cities should go for Water Sensitive Urban Designs (WSUD). For this, building bules and codes are to reflect WSUD principles based around maximising on-property stormwater use where feasible. The city corporations should have infrastructure proposals in accordance with the relevant adopted stormwater management plan. The city engineers should work with the builders and the developers to agree on suitable stormwater management strategies. They should work in such a way so as not to overload any previously adequate downstream system.

As many cities of Bangladesh are favourable for construction of waterbodies, the city authorities must plan for waterbodies in the open areas. Waterbodies (including small ponds) should be conserved and restored. The abandoned channels near the rivers can be used effectively in coastal areas as potential sites of large scale rainwater harvesting. Natural floodwater or treated industrial/domestic wastewater may be stored in infiltration ponds to facilitate natural recharge of groundwater. Due to climate change, there will be intense spell of rains for shorter duration. Either the capacity of stormwater drains in the cities to tackle the rain is limited or the drains are absent. Sufficient amount of retention area and flood flow zones are required to accommodate the excess water. Hence an adaptive measure is necessary to undertake management tools to save the remaining waterbodies. Bigger cities like Rajshahi, Syhlet and Borisal should go for increased use of surface water.

Apart from rainwater harvesting, the cities should also recycle and reuse the wastewater. This water can be used in horticulture and non potable purposes. This will serve to reduce the cost of supplying centrally treated water. Indirectly this will also save the groundwater as most of the cities depend mostly on underground water. The cities should also go for water efficient fixtures. There is an increasing trend the world over to reduce the use of water by designing water efficient fixtures. In countries like Australia, Canada and the US, laws have been brought in to make it mandatory to replace old fixtures that use more water with water-efficient fixtures. Therefore, atleast the medium and large towns/cities should have policy initiatives to facilitate the change over to the use of water- efficient fixtures. These can include labelling of water efficient fixtures, rebates on the fixtures, rebates on water bills. In addition, the Administration can go in for a focussed replacement programme of all older, water guzzling fixtures. The most common water efficient fixture is the flush toilet and in India, low-flush or dual flush toilets are already being used widely. Water taps, washing machines are other fixtures where efficiency can be brought in.

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