2. Water Resource Management in Bangladesh

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Abstract

This paper reflects the overall water resource management situation in Bangladesh including water availability, demand, supply and other related phenomena. The competing interests of agriculture, fisheries and navigation have to be resolved. Upstream developments in other co-riparian countries reducing the availability of surface water day-by-day. With supply diminishing and demand intensifying, it is becoming more and more critical to develop a clear management policy.

During the monsoon season, the flood damage from the Brahmaputra, Ganges and Meghna is catastrophic. On the other hand, the annual minimum flow (generally during February) of rivers near the Bay of Bengal is only 5% of the rivers peak monsoon discharge. Negligible rainfall during the same period (December to March) causes drought that adversely affect agriculture and other economic sectors. The incidence of both flood and drought in a yearly cycle profoundly affects river morphology in Bangladesh. Fifty-seven transborder rivers drain a huge amount of water from river basins up north to the Bay of Bengal in the south. The average annual sediment load that passes through the country to the Bay of Bengal is 1.5 to 2.5 billion tons.

Total surface water available for development during the dry period (December to February) is 19,170 million cubic meter (MCM). Available groundwater recharge is 21,088 MCM out of which 8,406 MCM is used in irrigation. Groundwater contributes about 70% of total irrigation and the rest 30% comes from surface source. About 95% of drinking water in Bangladesh is derived from groundwater. Arsenic contamination of this source was first detected in 1993 and now most parts of the country are affected by arsenic poisoning.

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Introduction

Bangladesh is bounded by India on the west, the north, the northeast, Myanmar on the southeast and the Bay of Bengal on the south. It forms the largest delta in the world. The land of Bangladesh is flat, with some uplands in the northeast and the southeast. The great plain lies almost at sea level along the southern part of the country and rises gradually towards the north. Land elevation in the plain varies from 1 to 90 meters above the mean sea level. The maximum elevation is 1230 m at Keocradang Hill in Rangamati Hill district. The population of Bangladesh is 130 million having an area of 147,570 sq.km. and thus making a population density of 880 per sq. km. (BBS, 2002).

Bangladesh is a lower riparian country. Most of it is located within the flood plains of three great rivers-the Ganges, the Brahmaputra, and the Meghna-and their tributaries and distributaries. The river systems drain a total area of about 1.72 million square kilometers in India, China, Nepal, Bhutan and Bangladesh. Only 8 percent of the catchment area lies within Bangladesh. As a result huge inflows (Table-1) of water over which Bangladesh has no control enter the country.

Table 1 Flow (cumec) of Major Rivers, 2000

River	Station	January		February		August		September	
		Max.	Min.	Max.	Min.	Max.	Min.	Max.	Min.
Brahmaputra	Bahadurabad	5490	4660	4710	3410	60400	33600	52400	28500
Ganges	H. Bridge	2070	1760	1930	1340	48900	18800	49100	33800
Gumti	Comilla	7920	7180	7740	7380	11790	8140	9450	7780
Muhuri	Parshuram	10160	10070	10070	10010	13900	10400	11900	10440
Surma	Sylhet	3000	2400	2700	2120	11290	9160	10400	8090

A network of rivers with a total length of about 22,155 km covering the country flow down to the Bay of Bengal. The alluvial soil is thus continuously being enriched by heavy silts deposited by rivers during the rainy season. About 84 percent of the total population live in rural areas and are directly or indirectly engaged in a wide range of agricultural activities.

The water system of Bangladesh comprises the tributaries and distributors of some 230 rivers in the country. Out of them 57 are transboundary rivers - 54 coming from India and 3 from Myanmar. The cross-border flows into the country amount to around 1010 billion cubic meters (BCM), and an additional amount of 325 BCM is generated from local rainfall, averaging 2200 mm.

It is an irony of nature that in winter when the climate is favourable for agricultural production, the vast quantity of water that inundated the country a few months earlier, seems to disappear and winter crops are severely hampered by the scarcity of available surface water. Fortunately, the country has got a rich aquifer with reasonably good transmission and storage properties.

Large surface water irrigation project having command area of 10,000 ha or more administered by the Bangladesh Water Development Board (BWDB) known as "major irrigation project" covers only 8% of the total irrigated area. The "minor irrigation system" consisting of Shallow Tubewells (STWs), Deep Tubewells (DTWs) and Low Lift Pumps (LLPs), having a command area of 35 ha or less covers about 86% of the irrigated area.

Arsenic is an element, which is concerned from both points of view i.e. environment and human health. Arsenic contamination of ground waters in Bangladesh was first confirmed in 1993 (Jahiruddin, 2002). At the moment, arsenic poisoning in Bangladesh appears to be the largest mass poisoning in the world. Eighty million people are now exposed to arsenic poisoning and 10,000 people have already shown the symptoms of arsenicosis (Chowdhury, 2001).

Supply and Demand of Surface and Ground Water

A. Surface Water Supply

In 1991 National Water Plan Phase-2 (NWP2) assessed the availability of surface water from the water balance model for 173 catchments, translated into 60 planning areas and then 5 regional areas (northeast, northwest, southeast, southwest, and southcentral). Total water outflow was considered the potential available for developing irrigation, fisheries, and navigation, and for meeting environmental needs.

Water balance studies show that even in the dry month of March, when diversion is maximized and base flow minimized, net diversion from the entire river system is only 5 percent of inflow. The total picture, considering such factors as surface inflow, rainfall, evapotranspiration, percolation to groundwater aquifers, diversion for irrigation, infiltration, and return flow is given by a hydrologic simulation of the water balance model. This model estimated the runoff remaining after existing uses in 1990 for the five regions (Table-2). Water availability during the minimum dry period was 3,710 million cubic meters in February 1990; during the maximum wet period; 111,250 million cubic meters in August 1990.

Table 2 Regional Surface Water available for Development(MCM), 1990

	Dry months							Wet months				
Region	Nov	Dec	Jan	Feb	Mar	Apr	May	Jun	Jul	Aug	Sep	Oct
NW	2970	1840	1160	780	780	920	2210	5360	13950	13520	13540	6470
NE	5090	1710	710	130	230	2480	9680	22290	40840	39800	28860	16350
SE	820	950	750	640	650	630	1090	3170	6450	5480	3190	19800
SC	8250	4400	3050	2020	2320	3760	7680	14300	35370	44230	40050	20960
SW	1180	580	270	140	120	100	230	1080	4440	8220	7280	3050
Total	18310	9480	5940	3710	4100	7890	20890	46200	101050	111250	92920	66630

B. Groundwater Supply

Phase 2 of the National Water Plan in 1991 suggested that the available recharged ground water in the five regions was 21,088 million cubic meters, and that the agricultural industry used 8,856 million cubic meters (Table-3). It estimated the groundwater-resource potential for agricultural use beyond 1991 at 9,447 million cubic meters, of which about 8,501 million cubic meters was likely to be exploited by 2010. The balance of 946 million cubic meters was bot economically exploitable by available technology but remained a potential for the future. Also according to Phase 2 of the plan, most future groundwater for agricultural use has to come from deep tubewells.

Table 3 The Groundwater Balance (MCM) Derived by NWP2, 1991

Resource potential	NW	NE	SE	SC	SW	Total
Available recharge	9786	6594	1498	1249	1961	21088
Present agricultural use	3943	2831	630	165	1287	8856
Domestic and industrial reserve up to 2010	554	1276	638	257	466	3191
Surplus to agriculture	1026	-	-	-	-	1026
Future agriculture development potential	4313	2853	626	977	678	9447
Future agricultural use up to 2010						
Deep-set shallow tubewells	2160	0	0	0	270	2430
Deep tubewells	1575	2757	373	965	401	6071
Total	3735	2757	373	965	671	8501
Balance beyond 2010	578	96	253	12	7	946

C. Surface and Ground Water Demand

The NWP2 predicted on the basis of anticipated irrigation projects the demand for irrigation in March 2018 to be 14,290 million cubic meters (Table-4). This was determined by an investment analysis model whose input was estimated surface and groundwater availability from the water balance model described earlier. Thus the future demand for irrigation water was based on its projected availability.

Table 4 Projected Water Supply and Demand, March 2018

	Water requirements			Water supplies	
	Amount (MCM)	Percent		Amount (MCM)	Percent
Agriculture	14290	58.6	Main rivers	11740	50
Navigation Environment and Fisheries	9910	40.7	Regional rivers	6390	27
Domestic uses and industry	170	0.7	Groundwater	5360	23
Total	24370	100	Total	23490	100

Water Management in the Wet Season

Floods are a recurring phenomenon in Bangladesh. Each year about 22 percent of the country is flooded. The intensity and timing of floods vary from place to place and year to year. Flooding in Bangladesh is the result of a complex series of factors. These include a huge inflow of water from upstream catchment areas coinciding with heavy monsoon rainfall, a low floodplain gradient, and congested drainage channels.

A. Efforts at Flood Management

Since the floods of 1954 flood control and drainage projects have played an important role in water resource management in Bangladesh. In fact, they account for about half of the funds spent on water development since 1962. For a clearer perspective, past efforts at flood controls in Bangladesh are divided into two periods: initiatives taken until the big floods of 1987-1988, some of which are continuing and initiatives since 1988.

i) Efforts Before the Big Floods of 1987-1988

Most flood control and drainage projects prior to 1988 were implemented for a number of reasons, including protection from main river floods and flash floods in the east, saline intrusion in the lower deltaic area, and the need to improve drainage. These projects included polders/embankments for prevention and movement of floodwater inland and for draining runoffs from rainfall.

Projects divided into three categories-major, medium, and small-were implemented. Major undertakings include the coastal embankment (949,000 Ha), Manu River (22,500 Ha), Teesta barrage (540,000 Ha), the Ganges-Kobadak (141,000 Ha), Brahmaputra right bank (226,000 Ha), Chandpur Irrigation (54,000 Ha), and Chalan Beel (53,000 Ha) projects (World Bank, 1998). They involved extensive embankment and water control structures, and in the case of the Meghna-Dhonagoda, Manu, Muhuri, and Ganges-Kobadak projects, gravity irrigation covers about 185,000 hectares in addition to flood protection. In Bhola, Chandpur, and Karnafuli low-lift pump irrigation was made available along with flood control for 140,000 hectares of moderately to deeply flooded area.

Medium-scale projects typically involved flood control and drainage with limited irrigation development. Small-scale projects benefited (FCDI) areas ranging from 1000 to 10,000 hectares.

ii) Efforts After 1988

The severity of the floods of 1987 and 1988 led the government of Bangladesh to look for a long-term plan that would provide a comprehensive solution to the recurrent problem of flooding. Several major studies were undertaken in 1989. Notable among them were studies sponsored by the French, Japanese, and a United States team and a United Nations Development Programme (UNDP)-supported flood policy study.

Water Management in the Dry Season

A. Water Availability in the Dry Season

i) Surface Water

For many years, Bangladesh and India have exchanged sharp accusations over shared river resources (Iyer, 1999). In 1993, tensions between India and Bangladesh boiled over when the dry-season flow of the Ganges river reached severely low levels, and resulted in crop losses in Bangladesh (Hossain et al., 2003). India's establishment of the "Farrakka Barrage" (2250 m long, 109 gates, 76,500 cumec discharge capacity) in 1975 on the Ganges only 18 km from the Bangladesh border has sparked conflict and disagreement between the two nations. India's purpose in building the barrage was to divert water to the Calcutta port, but such diversion has resulted in falling water tables and greater water salinity downstream for Bangladesh (Shahjahan, 1993). However, after a long dialogue and discussion with India, an Indo-Bangladesh Treaty (for 30 years) on sharing the Ganges' water has been signed in 1996.

ii) Ground Water

The amount of ground water that can be extracted is limited by cost. In fact, economics of irrigation will dictate what source of water (ground water or surface water), how much of ground water and which method of extraction will be used for irrigation.

B. Irrigation by Methods

In 1999-2000, a total of 4.20 million hectares of land was irrigated in Bangladesh; 3.70 million hectares by minor irrigation projects, 0.29 million hectares by public-sector-operated major irrigation schemes and the rest 0.21 million hectares by traditional methods (Table-5). The economics of irrigation in Bangladesh indicates that low lift pumps (LLP) are the most cost-effective of all minor irrigation technologies in the country. Major irrigation projects, which account for less than 10 percent of irrigated land in the country, appear to be the least viable of all modes of irrigation. However, they have multiple objectives, such as flood control, drainage, environmental protection and fisheries development, which have got intangible benefits.

Table 5 Irrigation by Methods in 1999-2000

Method	Area (Ha)	% of Total
LLP	742000	18
Tubewell	2956000	70
Major	293000	7
Traditional	209000	5
Total	4200000	100

Improving Water Management through Institutional Development

Institutions and the way they are set up determine the long-term ability of a nation to manage its water resources. One of the important goals of institutional development in the water sector is to make the system responsive to people's needs. The structure of public water organizations in Bangladesh is shown below:

Function	***Organization***
Policy and planning	Water Resource Planning Organization
Research	River Research Institute, Environmental and Geographical Information System, Hydrology Department
Development	Bangladesh Water Development Board, Local Government Engineering Department
Regulation	Bangladesh Water Development Board, Bangladesh Inland Water Transport Authority. Water and Sewage Authority (WASA), Land Ministry, Zila Parishad, Municipalities

Arsenic Problem

There are 20 countries including Bangladesh where arsenic contamination of ground water has been reported (Jahiruddin, 2002). It is generally agreed that the source of arsenic contamination in ground water of Bangladesh is geological (BGS report, 1999). The maximum permissible level (MPL) of arsenic in drinking water is 0.01 mg/l as set by the World Health Organization (WHO). This level as suggested by the United States Environmental Protection Agency (USEPA) is 0.02. The Canadian standard is also the same. However the Bangladesh drinking water standard is 0.05 mg/l.

The Government of Bangladesh (GOB) with the aid of World Bank has launched a big project to detect and mitigate arsenic contamination in ground water. This is a 15 year (from 1996) project entitled as, Bangladesh Arsenic Mitigation Water Supply Project (BAMWSP), being executed by the Department of Public Health Engineering (DPHE). They test water samples (tubewells) directly in the field by using arsenic testing kit and confirm the results of the suspected (unsafe) samples by testing them in the zonal laboratories using spectrophotometry. The tubewells that are yielding water with arsenic concentration beyond the MPL (0.05 mg/l) are being marked red.

Conclusion and Recommendation

a) It is necessary to strengthen and promote the involvement of public and private research organizations and universities to develop and disseminate appropriate technologies for conjunctive use of rain water, ground water and surface water.

b) To resolve conflict on the international rivers like the Ganges-Brahmaputra, all the countries that share the watersheds should make integrated plan for the best possible utilization of water resources.

c) The annual minimum flow of rivers near the Bay of Bengal is only 5 percent of the rivers' peak monsoon discharge.

d) Parts of Bangladesh suffer from droughts during the year that adversely affect agriculture and other economic sectors.

e) Environmental degradation caused by the intrusion of saline water is a major problem in the southwestern region of Bangladesh.

f) Integrated flood management program should be undertaken.

g) The supply of dependable drinking water for a growing population should be ensured.

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