Farakka Barrage: History, Impact and Solution**

M. Khalequzzaman
Department of Geology
University of Delaware
Newark, DE 19716

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Present address: Dept. of Geology & Physics,
Lock Haven University, Lock Haven, PA 17745

Abstract:

Bangladesh is a small part of the hydrodynamic system that includes the countries of Bhutan, China, India, and Nepal. Bangladesh lies at the receiving end of this hydrodynamic system. The Ganges-Brahmaputra delta, of which Bangladesh is a part, has been created by deposition of river-borne sediments. Ganges water and sediment have been diverted through a barrage (dam) at Farakka in India. This has adversely affected agriculture, navigation, irrigation, fisheries, forestry, industrial activities, salinity intrusion of coastal rivers, groundwater, riverbed aggradation, sediment influx, coastal erosion and submergence in Bangladesh.

An immediate long term solution to the water sharing problem between India and Bangladesh is imperative in order to mitigate the environmental and economic problems caused by India's diversion of the Ganges flow. Implementation of the water rights prescribed by the Helsinki Rule of 1966 can help develop an integrated water resources management plan for the common rivers of the Indian subcontinent.

Key words: Bangladesh, Ganges, Farakka, consequences, solution, and Helsinki Rule.

Introduction:

Bangladesh lies at the receiving end of the tributaries of the Ganges and Brahmaputra rivers. Ninety percent of the watershed of both rivers lies outside the territory of Bangladesh, within the countries of India, Nepal, Bhutan, and China (Er-rashid, 1978). Adequate flow of these rivers during the summer months is vital for such basic functions as irrigation and navigation as well as to preserve fisheries and other components of Bangladesh's ecosystem. The Ganges-Brahmaputra delta, of which Bangladesh is a part, has been created by deposition of river-borne sediments (Morgan and McIntire, 1959; Stoddart and John, 1984; Bird and Schwartz, 1987; Singh, 1987a). A delta can only grow seaward and upward against a rising sea level when river-borne sediment influx is adequate (Smith and Abdel-Kader, 1988). Two-thirds of the sediment supply to Bangladesh is carried by the Ganges and its tributaries (Holeman, 1968; Milliman and Meade, 1983). The water and sediment carried by the Ganges is therefore vital to the existence of the country.

The Farakka Barrage: Impact on Bangladesh:

In 1974 India built a barrage on the Ganges at Farakka in order to divert water for its own use (Figure 1). The water is diverted to the Hoogley River via a 26-mile long feeder canal. During the last 19 years only between 1977 and 1982 has there been an agreement between Bangladesh and India to address water sharing during the summer months (Singh, 1987b). The unilateral and disproportionate diversion of the Ganges since that time has caused a dangerous reduction in the amount of sediment and water flow of the Ganges in Bangladesh. Now Bangladesh's delta receives less sediment and inadequate water flow for navigation and irrigation during the summer months.

The lack of a workable management plan for water allocation to Bangladesh has created a situation where irrigation of crops and navigation are both impossible during the summer months. The summer of 1993 was characterized by almost completely dry riverbeds across the country as reported by all major newspapers in Bangladesh. Groundwater also dropped below the level of existing pumping capacity. Such conditions lead to significant decreases in food production and curtailment of industrial activities. As a result of a lack of adequate freshwater inflow, the coastal rivers experienced saltwater intrusion 100 miles farther inland than normal during the summer months, affecting drinking water in these areas (Zaman, 1983).

The reduction in sediment supply to Bangladesh caused by the dam at Farakka has curtailed delta growth and has led to increased coastal erosion. At the present time the rates of sediment accumulation in the coastal areas are not sufficient to keep pace with the rate of relative sea level rise in the Bay of Bengal (Khalequzzaman, 1989). While the average sedimentation rates range between 4 and 5mm/year, the rate of sea level rise is 7mm/year (Emery and Aubrey, 1989). In addition, the reduced summer flows allow sediment to be deposited on the riverbeds downstream of the dam, resulting in decreased water carrying capacity during the rainy seasons (Alexander, 1989). This reduction in carrying capacity due to river bed aggradation has increased the frequency of severe floods over the last decade, causing enormous property damage and loss of life. If the amount of sediment influx in the coastal areas is further reduced by damming the rivers, then a relative sea level rise in the Bay of Bengal by 1 meter will severely curtail the delta growth, resulting submergence of about one-third of Bangladesh (Broadus and others, 1986; Milliman and others, 1989).

According to the Helsinki Rule signed in 1966 regarding water rights to international rivers, all basin states of an international river have the right to access an equitable and reasonable share of the water flow (Hayton, 1983). There have been many examples of integrated management plans to address water resources of international rivers around the world such as for the Colorado, Rhine, Danube and the Amazon Rivers (Abbas, 1983; Biswas, 1983). Over the last two decades, Bangladesh has tried unsuccessfully to come to agreement with India and the

other co-riparian nations on a acceptable plan for water allocation rights. Since Bangladesh is a small part of a bigger hydrodynamic system that comprises several countries in the region, mutual understanding and cooperation among the co-riparian countries will be necessary in order to formulate any long-term and permanent solution to the problem. For Bangladesh, a developing country, it is important to get the assistance of the international community, without whose support the negotiation of a viable agreement appears impossible and continued loss of human life and resources is expected in the future.

Solutions:

An immediate long term solution to the environmental and economic problems caused by India's diversion of the Ganges flow is imperative. India would prefer to keep the negotiation of water sharing of the international rivers bilateral with its neighbors, but to this date there have over 80 meetings between Bangladesh and India at various levels which have all been unsuccessful. India prefers to negotiate water sharing of the international rivers with its neighbors bilaterally. India has signed separate treaties, agreements and memorandums with Nepal, Bhutan, and Pakistan on water sharing of the Ganges, Brahmaputra and Indus rivers respectively (Prasad, 1993; Singh, 1987a). Bangladesh would prefer the involvement of all the co-riparian nations in the designing of a regional water resources development plan (Craw, 1981).

The governments of India and Bangladesh have put forward different schemes to augment water flow in the Ganges during the summer months. India has suggested the excavation of a 209-mile link canal (Figure 1) through which 100,000 cusec (cubic feet per second) of water would be diverted from the Brahmaputra to the Ganges during the summer months (Zaman, 1983). The proposed canal would be about the width of the River Thames of England. Indian engineers want to build three dams on the Brahmaputra in Assam to regulate water flow of the river (Craw, 1981). Bangladesh is reluctant to allow India to build more dams on the common river for various reasons. Building of the canal and dams on the Brahmaputra will make Bangladesh more dependent on India for its share of water. Further disruption of water flow will be devastating for the economy of Bangladesh. Diversion of water from the Brahmaputra will jeopardize irrigation, navigation, and other components of ecosystem in the Brahmaputra valley. Besides, about 20,000 acres of lands will be lost in Bangladesh to the canal. Bangladesh being one of the most populous countries in the world cannot afford to lose more land that supports thousands of its people. The concept of a link canal as proposed by the Indian government is technically and economically not feasible for Bangladesh (Zaman, 1983).

If the summer flow of the Ganges has to be augmented by digging a link canal, then such a canal can be dug within the territory of Bangladesh. An artificial canal connecting the Ganges and Barhmaputra between Sirajganj and Bheramara in Kushtia district would serve the same purpose for Bangladesh as the 209-

mile link canal proposed by India. The length of the proposed Sirajganj-Bheramara link canal would only be 60 miles (Figure 1). The city of Sirajganj and many other parts of Sirajganj district are experiencing very high rates of riverbank erosion (Hossain, 1993; Haque, 1989). The diversion of surplus flow of the Brahmaputra at Sirajganj will help reduce the water flow velocity. This reduction in flow velocity would reduce riverbank erosion downstream from Sirajganj. Comparison between the proposed Indian Link Canal and the canal proposed by this author is shown in Table 1 below.

Table 1. Comparison of various parametrs that will have to be taken into account should the Link Canal proposed by the Indian Government or by this study has to be implemented. This parametrs are calculated by this author based on the available information.

Indian Link Canal	Canal Proposed in This Study
Location: Jogigopa	Sirajganj-Bheramara
Dimension: 209 mi*0.5 mi*30 ft	60 mi*300 ft*20 ft
Volume: 87,398,784,000 ft^3	1,900,800,000 ft^3
Acres lost: 66,880	1454 (1/15 of Indian)
Acres in Bd: 22,293	1454
Discharge: 100,000 cusec	24,000 cusec
Velocity: 1.9 miles/hour	2.72 miles/hour
Distance travelled: 300 miles	60 miles
Brahmaputra flow: 25,000 cusec	100,000 cusec in winter
Topography: Against slope	Follow natural slope
Relocation: A large number	Relatively small number
Navigation: Will be affected	Will not be affected in Bd.
Brahmaputra basin env.: Affected	Will not be affected
Earth work: 7 Suez Canals	1/6 of the Suez Canal
Sediment load: Will be removed	Will stay within Bd. delta
Rivers intercepted: 14 rivers	3 rivers

The Government of Bangladesh proposes to augment the Ganges flow by building of numerous storage reservoirs in India, Bhutan, and Nepal to store water during rainy seasons which can be released in summer months (Figure 1). This proposal identifies 51 potential reservoir sites (Craw, 1981; Chowdhury and Khan, 1983). The technical and environmental feasibility study of building reservoirs have to be carried out before such a proposal can be accepted for implementation. The potential for electric power that can be generated from such project is more than the electricity consumed by North America alone (Prasad, 1993). If Bangladesh's calculations are correct, the Ganges flow can be augmented by 88,000 to 181,000 cusec during the summer months. India's calculations show that only an increase of 50,000 cusec would be possible (Craw, 1981; Chowdhury and Khan, 1983). Since neither India's nor Bangladesh's proposals are acceptable to each other, it will be hard to come to a consensus. India, being the upstream country has yet to show its genuine desire to solve the water sharing problem between itself and Bangladesh. There are some alternatives to these two government proposals.

Without regional cooperation between the co-riparian nations any major interbasin development activity is almost impossible (Ahmed et al., 1994). However, a better physical control of the supply, accumulation, and dispersal of sediment and water can ensure growth of the delta. Annual dredging of rivers and dispersion of the dredged sediments on the flood plains and delta plains will increase the water carrying capacity of the rivers, and reduce flooding propensity. The amount of sediment presently available is still sufficient for the delta growth if managed correctly. Dredging of the sediment available on the riverbeds and dispersion of dredged sediment on adjacent land can augment the delta growth at a rate that will be enough to keep pace with sea level rise. Calculations of sediment budget and accumulation show that 30% of the present suspended sediment influx of 1.6 billion tons/year in the coastal areas is capable of aggrading an area of 30,000 sq. km (the area of all coastal districts of Bangladesh) when sea level rises at a rate of 1 cm/year. The same amount of sediment dispersed over a 150,000 sq. km area (greater than the size of Bangladesh) is capable of aggrading at a vertical rate of 0.3 cm/year, which would be enough to keep pace with the present rate of local relative sea level rise (Khalequzzaman, in press).

Re-excavation and re-occupation of abandoned distributaries of the major rivers would re-establish the already disrupted equilibrium of the hydrodynamic system due to upstream diversion of the Ganges. This approach is feasible both economically and logistically for Bangladesh. There is a large pool of available labor for such an ongoing project. The excavation of dry channels is already a common practice in rural areas of Bangladesh.

An integrated management plan for both surface and groundwater is necessary for Bangladesh to reduce the economic hardship that is being caused by the diversion of the Ganges (Ahmed et al., 1994). Agriculture, irrigation, navigation, and the ecology of the region have all suffered. Many measures can be taken within the territory of Bangladesh to mitigate the economic and environmental degradation that has resulted from India's unilateral diversion of the Ganges at Farakka: (a) conjunctive (surface water-induced groundwater flow) and planned seasonal use of groundwater and surface water can enhance the supply of water needed for domestic use, irrigation, and industrial activities (Bredehoeft and Young, 1983); (b) recycling of surface water and groundwater can reduce the water scarcity during the summer months; (c) forceful injection of surface water into the groundwater system during rainy seasons can reduce the overflow of rivers and can augment water supply for irrigation during the summer months. Such a forceful injection of fresh water in the coastal region can help prevent salt water intrusion into pumping wells (Brashears, 1946); (d) artificial recharge of the aquifers that are located along the major rivers and their tributaries in Bangladesh can be enhanced during rainy seasons by pumping the groundwater out of those aquifers during summer months that preceed rainy seasons in Bangladesh (Revelle and Laksminarayana, 1975); (e) locating pumping wells along riverbanks and on the riverbeds during summer months can increase

the supply of grounwater to the wells. Since most of the riverbeds are areas of ground water discharge, it will guarentee a relatively steady supply of water to the pumping wells that are located along the riverbanks; (f) use of sluice gates on the tributary rivers and channels during the rainy seasons can store water to use for irrigation in summer months; (g) adaptation of micro-irrigation can reduce the loss of water though evaporation (la Riviere, 1990). Micro-irrigation injects water directly into the soil where it is needed the most for the plants; and (h) changing the crop pattern can cut down on the need for excessive use of irrigation. For example, wheat cultivation requires much less water than rice crops.

Due to the decrease in water flow, riverbeds of the tributaries of the Ganges, along with the main river have aggradated substantially. Most of the tributaries of the Ganges now become dry during the summer months. The sand deposited on the riverbeds can be used as construction material to develop the infrastructure of the country. The large pool of available labor can be used to excavate and transport the sand deposits to places where they can be used as construction material for developing roads and buildings.

The facts clearly show that for Bangladesh, an agreement is urgently needed. The international community including such organizations as the UNO, UNEP, UNDP, ESCAP, G-7, and SAARC can come forward to help solve the water sharing problem between Bangladesh and India by mediating negotiations (Abbas, 1983). International involvement is needed to implement a management plan that will protect the water rights of Bangladesh on the Ganges and other common rivers prescribed by the Helsinki Rule of 1966. This issue is of tremendous economic and humanitarian concern to Bangladesh.

Conclusions:

The unilateral diversion of the Ganges water by India at Farakka Barrage has caused a series of adverse environmental and ecological problems in Bangladesh. A long-term solution to water sharing problems between Bangladesh and India is imperative. Without regional cooperation between the co-riparian nations, any major interbasin development activity is almost impossible. However, a better physical control of the supply, accumulation, and dispersal of sediment and water can be applied to mitigate environmental and ecological degradation resulting from this unilateral diversion of the Ganges water. Increased use of groundwater can reduce the scarcity of water available for irrigation in Bangladesh as long as it is managed properly. International involvement can help implement a management plan which will protect the water rights of Bangladesh to the Ganges and other common rivers prescribed by the Helsinki Rule of 1966.

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