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IMPACT OF GANGES WATER DIVERSION ON THE SOUTH-WEST PART OF BANGLADESH : A PERCEPTION STUDY

Abstract

Bangladesh has possibly one of the world's largest river systems like the Ganges, Brahmaputra, Meghna and other numerous tributaries and distributaries. Among the rivers, the Ganges supplies water to the south-west region of Bangladesh through one of its distributaries, the Gorai river. The construction of the Farakka Barrage has resulted in the reduction in dry season flows in the Ganges system in Bangladesh and induced various environmental degradation in the south-west part of Bangladesh. Taking this into consideration, this paper attempts to present the perceptions of the local communities based on a questionnaire survey in south-western Bangladesh, about the impact of Farakka Barrage on the region. The prevalent perception is that the problem of low flows in the downstream greatly accentuated socio-economic and environmental problems. In order to ameliorate the situation, most of the respondents urged for constant pursuit of vigorous diplomacy so that the recently signed 30-year treaty is fully implemented. They also suggested the construction of a barrageSs across the Ganges/Padma in Bangladesh.

Introduction

Stream flow is the largest component of the water resource in Bangladesh. Each day, on average, approximately 3400 million cubic meters (Mm^3) of water are discharged into the Bay of Bengal. This is

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about 3.9 times higher than the average daily rainfall over Bangladesh[1]. Among the three major river systems that flow through Bangladesh, the Ganges in many respects, is one of the world's greatest rivers. Its catchment area at Goalundo, where it meets the Brahmaputra, is about 9,75,000 km^2 of which 1,88,000 km^2 is in Nepal and China, 7,81,000 km^2 is in India and only 6,000 km^2 is within Bangladesh[2]. The catchment area of the Ganges is one of the most densely populated areas of the world and majority of the population is dependent on the Ganges for livelihood in one way or another. It is estimated that about 410 million people (1991 figure) are directly or indirectly dependent on the river Ganges[3]. The river has also great importance for the socio-economy of the co-basin countries.

In Bangladesh, a regular water supply from upstream is needed, particularly during dry season (November-May), for agriculture, domestic and industrial purposes, maintaining river depths, sustaining fisheries and forestry, and for stemming inland penetration of sea water from the Bay of Bengal. It is the most vital source for supply of water for irrigation in Kustia, Jessore, Faridpur and Khulna region of south-west Bangladesh during dry season. It is estimated that about 37% land of Bangladesh is dependent on the Ganges system[4].

In 1975, a barrage on the Ganges river at Farakka was commissioned by India. The purpose of the construction of the barrage was to divert 133 m^3 per second of water from the Ganges river to the Bhagirathi-Hooghly river in order to maintain the navigability of Calcutta port[5]. It was also expected that this barrage would control the river for supplying

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1 Master Plan Organization (MPO), *National Water Plan Report*, Bangladesh, Vol. 1, MPO, Dhaka, 1986.

2 Bangladesh Water Development Board, *Hydrology of the Border Rivers*, Vol. 1 (Draft), BWDB, Dhaka, 1986, pp. 2-1.

3 B.G. Verghese and R.R. Iyer, *Converting Water into Wealth: Harnessing the Eastern Himalayan Rivers*, Konark Publishers, New Delhi, 1993.

4 K. Begum, *Tension over the Farakka Barrage: A Techno-political Tangle in South Asia*, University Press Limited, Dhaka, 1987.

5 B.M., Abbas, *The Ganges Water Dispute*, University Press Ltd. Dhaka, 1984.

Ganges water to the Indian states of Uttar Pradesh and Bihar[6]. Moreover, the barrage was perceived to offer to India a political leverage in her dealings with Bangladesh[7].

The diversion of water at Farakka has significantly changed the hydrology of the Ganges river system in Bangladesh. The monsoon discharge in the Ganges has increased, while in the dry season the discharge has decreased significantly[8]. Increased monsoon flow has introduced changes in the annual flooding pattern in Bangladesh. The inadequate supply of water in the Ganges system during dry season has disrupted agriculture, fisheries, forestry, navigation and enhanced salinity intrusion from the coast[9].

Much of the techno-political debate over the impact of the Farakka Barrage on Bangladesh is based on general observations and anecdotal evidence rather than sound analysis of relevant data. Of course, a number of studies regarding assessment of the impact of Ganges water diversion have been conducted under the aegis by the Bangladesh government, UN agencies and independent researchers. But field study on the impact of Ganges water diversion in the affected areas is very scanty. The paper aims to fill the gap. The objective of this paper is to study the perception of local community about the impact of the Ganges water diversion as well as the recently completed Ganges water treaty on south-west part of Bangladesh. The present study was conducted in 1997 when two neighbouring countries had just signed a 30-year treaty for sharing of the Ganges water during lean season. The paper describes the 1997 and 1998 lean season water sharing scenario in Bangladesh after addressing people's

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6 *Ibid.*

7 N. Islam, "The Ganges Water dispute: Environmental and Related Impacts on Bangladesh" *BIISS Journal*, Vol.12., No.3, 1991, pp.263-292.

8 M. Asafuddowla, "Farakka Issue", paper presented at a seminar at the Columbia University, New York, October 10, 1993.

9 Ministry of Environment and Forest (MOEF), *National Environment Management Plan*, Main Report, Dhaka, 1995, p. 167.

perception. Before presenting the findings of the study, a short description of the Ganges basin, the Farakka Barrage and mean monthly discharge of the Ganges at Hardinge Bridge is in order.

The Ganges Basin

The Ganges is one of the largest river systems in the world. It originates from the south of the Himalayan and is divided near Gangotri (elevation 4500 m) in Uttar Pradesh, India[10]. On its way towards the sea, numerous tributaries join the Ganges river in India and Nepal. The river divides itself into two channels below Farakka. The right arm continues to flow south in West Bengal as the Bhagirathi-Hooghly river on which Calcutta port is situated. The left arm enters Bangladesh, 18 km below Farakka and joins the Brahmaputra river at Goalundo. In Bangladesh, the Gorai river is the main distributary, which leaves the Ganges river about 65 km above the confluence of the Ganges and Brahmaputra rivers. The spatial pattern of precipitation in the Ganges basin is varied. Mean annual precipitation in the basin in India varies from 460 mm at the western end to about 900 mm along the middle course and to 1150-2000 mm near the Delta. Mean annual precipitation in Nepal is estimated to be 1800 mm[11].Bangladesh is located at the tail of the Ganges basin. The mean annual runoff of the Ganges at Farakka in India and at Hardinge Bridge in Bangladesh is 410 mm and 357 mm, respectively. Monsoon flow alone constitutes about 83% of the average annual flow[12]. Nepal contributes a significant 71% of the natural dry season flow and 41% of the total annual flow of the Ganges river[13]. The remaining flow basically comes from India.

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10 K. Begum, *op. cit*

11 M.Q. Mirza, "Hydrological changes in the Ganges System in Bangladesh in the post-Farakka period". *Hydrological Sciences*, Oct. 1997, Vol. 42; No. 5, pp. 613-631.

12 *Ibid.*

13 Bangladesh-Nepal Task Force on Flood Control, *Report on Flood Mitigation Measures and Multipurpose use of Water Resources*, Dhaka, 1990.

The Farakka Barrage and Withdrawal of Water

The Farakka Barrage project is comprised of the Jangipur Barrage across the Bhagirathi-Hooghly and a feeder canal taking off from the Ganges upstream of the Farakka Barrage and discharging into the Bhagirathi-Hooghly downstream of the Jangipur Barrage. In April 1975, the Farakka Barrage went on test operation for 41 days (21 April- 31 May) with the diversion of 312- 454 m^3 /second of water under a temporary agreement between India and Bangladesh. After the expiry of the agreement, India unilaterally continued withdrawal from June 1975 to November 1977[14]. A five-year agreement on the sharing of the Ganges water was signed in November 1977. The agreement expired in 1982, but the sharing arrangement was renewed twice under the title "Memorandum of Understanding (MOU)" with some modifications. The second MOU expired in 1988 and for 1988-96, there was no sharing arrangement between two countries. India continued to withdraw waters from the Ganges unilaterally. Bangladesh's renewed attempts to internationalise the water management issue by bringing it to the UN, the Commonwealth, and South Asian Association for Regional Co-operation (SAARC) only ended in worsening bilateral the relationship further[15]. The resulting vacuum in water sharing arrangements continued for more than eight years.[16]

The progressive utilisation of the Ganges water in the upstream, coupled with the massive unilateral withdrawal at Farakka point in India, culminated in the lower recorded flow of only 13,521 cusecs in April, 1992 (measured at Hardinge Bridge in Bangladesh) fell below the level

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14 B.M., Abbas, *op.cit.*

15 *Far Eastern Economic Review*, October 13, 1988, p. 24.

16 There are several studies which analysed the background and history of the dispute and reviewed the whole process. Notable among them are the works of Abbas (1982), Huq (1987), Begum (1987), Verghese (1992), Iyer (1993), Crow (1995) and Swain (1996). Cited in A. Nishat. "Water Sharing: Issues and Options", *Weekend Independent*, August 30, Dhaka, 1996, pp. 4-7.

of another non-agreement period (1976 and 1977)[17]. Another critical situation occurred in 1993, when the lowest flow recorded at Hardinge Bridge was about 9249.10 cusecs whereas the lowest water flow was 50,000 cusecs before 1975[18]. Due to reduced flow in the Ganges, the Gorai, a major right bank distributary of the Ganges in Bangladesh virtually dries up during dry season. Mentionably, the Gorai is the main source of freshwater supply to the southwest region of Bangladesh.

Indeed, the dry season flow of the Gorai river is most critical in controlling salinity in a large part of the southwest region of Bangladesh.

Methodology

In order to investigate the changes due to water diversion, as stated earlier, both primary and secondary data were collected for the present study. Primary data were collected through interviewing people of the Ganges dependent areas of Bangladesh with a questionnaire in order to determine the impact. Random sampling method was applied for data collection. Secondary data were used to analyse the change that have occurred in the Ganges hydrology regime before and after the construction of the Farakka Barrage. In this context, the mean monthly discharge data for the Ganges at Hardinge Bridge (1964-96) have been analysed. These data have been obtained from Bangladesh Water Development Board. Before describing the respondents' perceptions, some observations on the changes of the Ganges hydrology regime have been made. Other secondary sources included existing literature, daily newspapers, reports etc. have been extensively used. The results are then presented in tabular and graphical forms. The study was conducted in 1997 when two countries already reached with the treaty on sharing of the Ganges water.

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17 A. Nishat, "Impact of Ganges Water Dispute on Bangladesh", A paper presented at a seminar on *Asian Water Forum*, January 30-1 February, Bangkok, 1995.

18 N. P. Poppy, "Scarcity of Ganges Water: A Threat to G.K. Project and Environment", *Grassroots*, July- December, Dhaka., 1994. p.230.

Keeping this in view, we discuss the present situation (the 1997 to 1999 lean season flow at Hardinge Bridge) after addressing the perception of local community about the impact.

The questionnaire survey was conducted in 1997 covering six thanas in six districts(zilla): Bheramara (Kustia zilla), Lohagara (Narail zilla), Khasiani (Gopalgonj zilla), Dacope (Khulna zilla), Kalaroa (Satkhira zilla) and Mongla thana (Bagerhat zilla). The study area encompasses the southwestern parts of Bangladesh which are entirely dependent on the Ganges system for their fresh water requirements.

Socio-economic background of the respondents suggests that 33.34% were farmers, 13.33% fishermen, 20% landless day labourers, 10% professionals, 10% boatmen and 13.33% businessmen (Table 1).

Table 1. Occupational Characteristics of the Respondents

Characteristics	Frequency (F)	Percentage (%)
Farmer	50	33.34
Fisherman	20	13.33
Boatman	15	10.00
Businessman	20	13.33
Landless	30	20.00
Professionals	15	10.00
Total	n = 150	100

Mean Monthly Discharge of the Ganges at Hardinge Bridge

The flow of the Ganges is subject to great seasonal fluctuations. The monsoon flow of this river network is sufficient to meet the needs of the two major riparian countries, India and Bangladesh. The monsoon flow often causes devastating floods while the flow in the dry season is quite inadequate to fulfil the requirements in this highly populous belt. This section discusses the changes in the mean monthly discharge of the Ganges during pre- (1964-75) and post-Farakka (1976-96) period.

Spectacular effects of diversion are noticed in the mean monthly discharges (Table 2). Inspection shows that except June, rest of the monsoon months (July-October) experienced an increase while the dry months (November-May) had a substantial decrease. The discharge of the Ganges starts to decrease in October and continue up to the onset of monsoon. Changes in the dry seasonal flows were more pronounced than the monsoon flows.

Table 2 : Changes in mean Monthly Discharges

Apr	May	Jun	Jul	Aug	Sep	Oct	Nov	Dec	Jan	Feb	Mar
(in percentage)											
-52.56	-37.85	-15.81	12.16	6.56	14.50	1.63	-16.04	-32.49	-44.18	-51.76	-56.11

Among the seven months of the dry season, the decreases in the flows during February, March and April were the worst. February and March are the most important months when sufficient irrigation water is required for cultivation of *boro* (a rice crop planted in January-February and harvested in April-May) and the *rabi* (a cropping season spanning over November-May) crops.

Apart from the changes in the monthly mean discharge in the pre- and post-Farakka periods, it is also important to compare the discharges that occurred during the agreement and non-agreement periods. The magnitude of reduction in each month is comparable with the pre- and post-Farakka periods (Table 3). It demonstrates that April is the worst month of the non-agreement periods. Of course, it is possible to argue that this change might have been caused by natural factors. Since precipitation is the main factor that causes year-to-year variation in the river discharge, a decrease in precipitation in the upstream drainage basin in India and Nepal is one possible explanation. Mirza (1997)[19] analysed precipitation records of 10 meteorological sub-

19 M.M.Q., Mirza, *op.cit.*

divisions within the Ganges basin in India for the period 1971-94 and 66 stations in Nepal for 1971-90, and he could not identify any significant increasing or decreasing trend. Therefore, decrease in the mean discharge in the Ganges should not be attributed to precipitation changes.

Table 3. Mean monthly discharge of the Ganges at Hardinge Bridge for dry season in agreement (1977-1988) and non-agreement (1989-1996) periods.

Month	Observed discharge (m^3/Sec)		
	Agreement period	Non-agreement period	Decrease (%)
November	5718	4682	-18.11
December	2890	2326	-19.51
January	1723	1426	-17.23
February	1318	911	-30.88
March	1071	634	-40.80
April	1144	554	-51.57
May	1498	1041	-30.58

Calculated from BWDB data.

Defining Perception

"Perception" is the process and experience of gaining sensory information about the physical world as perceived by the people. The study of "perception" is an attempt to understand those aspects of observations of the world of things that depend on the nature of the observers[20]. Moreover, the perception of people differs according to the cultural background, educational attainments, economic status, personal values, and tastes of the individual.

Perception about the physical or cultural world may also widely vary from person to person. A problem is a problem in one place while it is viewed as a prospect in another. Such opposing perceptions were natural as the people ventilated their personal experiences of life disintegrated by

20 *The Encyclopaedia of the Social Sciences*, Vol. I and II, London, 1992.

spatial distances. In Bangladesh there is a generally shared perception that India's diversion of water of the Ganges not only led to the destruction of ecological balance and environmental system of Bangladesh, but also had the most devastating effects on the country's economic sectors, such as agriculture, industry, forestry and navigation[21]. Questionnaire survey trying to capture people perception adequately demonstrated that people at the grass roots level are quite aware of the problems and associated manifestation of the problems in this regard. Since water is one of the principal natural resources of Bangladesh, this perceptual study might help the policy makers, water resource managers as well as agricultural developers and environmentalists of the country in water management planning.

Impact on Agriculture

For Bangladesh, the reduced flow of the Ganges has had both immediate and long-term effects including lower agricultural and industrial production, depletion of groundwater reserves, depletion of soil moisture and changes in the soil structure. The long term effects involve changes in the ecology of the Delta, changes in the hydraulic characters its rivers and reduced navigation depth. The change in soil characters has the potentials of turning the affected regions into deserts.

Agriculture is the mainstay of the economy of Bangladesh. Currently, at 1984-85 constant prices, this sector contributes about 35% of the gross domestic product (GDP)[22]. In this pre-dominantly agricultural region, three quarters of the population in the Ganges dependent areas are engaged in agriculture, specially paddy cultivation and related activities (livestock, land preparation, post harvest processing etc.). Though Bangladesh is

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21 M.N. Islam, The Farakka Barrage: A Man-made Disaster for Bangladesh, in S.M.H. Kabir (ed.), *Environmental Crisis in Bangladesh*, Professors World Peace Academy of Bangladesh, Dhaka, 1993, pp. 29-33.

22 Bangladesh Bureau of Statistics, *Statistical Pocket Book*, Dhaka, 1995, p. 377.

otherwise well-watered regions on earth, the interference across the border has limited her capability to irrigate only 23% of the total arable land. The Ganges-Kobadak (G-K) project which is providing irrigation to 142,000 hectares of land in southwest region from the mid-1960s, has been severely affected due to withdrawal of water at Farakka[23]. Due to low water level in the Ganges at Hardinge Bridge, the G-K project was not able to facilitate the irrigation in all its command area in 1993-94 pre-*kharif* season. Because water level of at least 14 ft in the Ganges at Hardinge Bridge is necessary to operate the pumps of G-K project[24]. The Bangladesh Agricultural Research Council (BARC) spelled out that direct loss of agricultural products due to soil moisture depletion, delayed planting, and increase in salinity amounts estimated Taka 500 crore per year[25]. A production loss of about 7175 thousand tons has occurred during the entire post-diversion period (1976-95) which in financial term amounts to Tk. 5,149 crore at 1995 price index[26].

As far as impact of the diversion of waters at Farakka was concerned, 30.35% of them reported shortage of water during dry season in the rivers and in tubewells that hampered irrigation facilities in the area. About one-fourth reported yield decrease and 11.31% claimed an increase of river water salinity during dry season. Other adverse consequences as mentioned by them were losses of soil productivity. (5.36%), delayed plantation (14.28%) and increase of salinity in agricultural land (10.71%) (Table 4). "It is a bad time for us" said Kartik Kumar a farmer. He again said, "our life is linked to the Padma's (In Bangladesh the Ganges is called Padma) water...

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23 A. Swain, "Conflicts over Water: The Ganges Water Dispute", *Security Dialogue*, December 1993, 24(4): 29-33.

24 *The Daily Janakantha* (in Bengali), June 27, 1994.

25 *The Daily Star*, April 4, 1994.

26 Govt. of Bangladesh, *Adverse impacts on Bangladesh due to withdrawal of dry season Ganges flows at Farakka and upstream*, September, Dhaka, 1996.

Table 4. Respondents Perception about the Impact on Agriculture.

Types of Impact	Frequency (F)	Percentage (%)
Loss of agricultural production	41	24.40
Shortage of water for irrigation during dry season	51	30.35
Delayed plantation	24	14.28
Increased salinity affecting agriculture	37	22.02
Losses of soil productivity	9	5.36
Others	6	3.57
Total	**n = 150**	**100**

No water means no works, no food"[27]. Irfan Miah, a peasant of Lohagara thana, said that his 100 decimal rice plot needed more water and fertiliser than before.

A study conducted by Soil Resource Development Institute (SRDI) reported that at least 76 microgram nitrogen is necessary for soil for production but most of the areas in the south-west region have only 5-15 microgram nitrogen[28]. This may contribute to agricultural production loss in that area. Another study found that a significant portion of land in Khulna and Satkhira districts was brought under shrimp cultivation in recent times. In the 1960s the area under shrimp cultivation on that districts was 2,500 ha. whereas it shot up to about 108,200 ha. in 1993-93[29]. This is due to increase more saline in recent times as reported by the local people.

Impact on Fisheries

The fisheries sector in south-western part of the country is of major importance to the economy of the region, in particular and the nation in

27 The Authori Interviewed these respondents in 1997.

28 *The Daily Inqilab* (in Bengali), December 1, 1993.

29 SRDI Staff, *Bangladesher Upakulio Krishi Paribesh O Labanaktata* (in Bengali),Dhaka,1997,p. 4.

general. The Gangetic water system in Bangladesh supports a population of over 200 species of fresh water fishes and 18 species of prawns[30]. The population of these fishes has been seriously affected by the hydrological, hydro-biological and ecological changes caused by the Farakka diversion. In the very first year of operation of the Farakka Barrage, the percentage of reduction in the availability of the fish at three leading points such as Khulna, Goalunda and Chandpur, during February to June, 1976 was 75%, 34% and 46% respectively compared to the corresponding period of previous years[31]. Production of captured fisheries in the Ganges dependent areas decreased from 2,77,000 metric tons in 1974 to 1,85,000 metric tons in 1991[32]. The loss is estimated at Taka four billion at 1991 price index. Human Rights Co-ordination Society showed in their Annual Report in 1994 that droughts in Khulna area had increased by 78 times compared to that of 1974 and fishing yields had fallen tremendously. This report mentioned that the loss in this sector is US$120 million per year[33].

The respondents reported a significant reduction in fish production in recent years. While asked to provide reasons for fall in fish production, the major cause given was shortage of water (36.42%). Over fishing as another contributing factor was opined by 21.19% respondents while 16.55% thought pollution of water was responsible for the fall in fish production (Table 5). Dhirendra, a fisherman of Kalaroa thana stated , "I do not get enough fish in the rivers and now I live from hand to mouth". Of course, he raised his hope that following the treaty between Bangladesh and India, "one day the rivers will be rejuvenated and he would be able to catch more fishes as he did before". Basher and his family opined that due to drastic reduction of fishes in the rivers and ponds, hundreds and

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30 A.A. Khan, *Economic Considerations and Alternatives in Water Policy Formulation for Bangladesh*, PATC, Dhaka, 1985.

31 Government of Bangladesh, *White Paper on the Ganges Water Dispute*, September, Dhaka, 1976.

32 *The Daily Star*, April 4, 1997.

33 *The Daily Janakantha*, (in Bengali), May 30, 1994.

Table 5. Reasons for Reduction in Fish Catches.

Reasons	Frequency (F)	Percentage (%)
1. Shortage of water	55	36.42
2. Over fishing	32	21.19
3. Polluted water	25	16.55
4. Use of current net	12	7.95
5. Increase salinity	12	7.95
6. River dry up, fill up of ponds, canals etc.	15	9.94
Total	**n = 150**	**100**

thousands of fishermen families have left their home from Ratiul village in Kashiani. During the field study, the authors also found that many fishermen in Lohagara thana had left their homes due to lack of sources of living. "Our life depends on Modhumati", said Arman, a landless villager in Bhatiapara. "I did not see in my childhood that this river dry up during dry season but now I see it. I don't know the cause but I heard they (India) blockaded our Padma". Hilsa is an anadromous fish that requires freshwater flow in its migration to upstream to spawn. The decreased flow and shallow depth of freshwater in the Ganges and its distributaries severely affected the spawning activities. It is necessary to cite here that, the Hilsa migration through river Kumar in Magura and Jhenidah district has been disrupted as a result of closure of this portion of the river by regulator near Magura town and dam disconnecting this river from river Kaliganga, a branch of the river Gorai, the tributory of the river Padma[34]. The losses incurred in the fisheries sector during the entire post-diversion period from 1976 to 1995 amounts to about Tk. 8,143 crore at 1993 price index[35].

34 Dept. of Environment, *Training Manual of Environmental Management in Bangladesh*, Dhaka, 1992, p. 77.

35 *Adverse impacts on Bangladesh due to withdrawal of dry season Ganges flows at Farakka and upstream, op. cit. p. 45*

Impact on Navigation

Water transport carries about 50% of the arterial freight traffic and around one fourth of the passenger traffic[36]. It is the only feasible means of transport in some areas of the country especially in the southwest and the northeast. The falling dry season flow has seriously affected the water ways dependent on the Ganges flows. The section of waterways which have been seriously affected by the upstream withdrawal are mainly, (1) the Ganges river from Godagari to Aricha, (2) the Padma river from Daulatdia to Tepurkandi, and (3) the distributaries from these rivers, like Gorai-Modhumati, Arial Khan, Madaripur beel routes etc[37]. A total of 685 km of waterways, which was navigable during pre-diversion time has been severely affected during the post-diversion period[38].

The respondents reported that due to dry seasonal low flows in the rivers, they have faced unemployment problem which virtually decreased their income. They strongly claimed this situation to be the result of the Farakka Barrage. About one-third of the respondents emphasised on drying up of the river during dry season. An old boatman in Bheramara Ferry Ghat recalled that, "I don't know why Padma dried up in the dry season but I heard they (India) have built some kind of wall on our Padma" Another boatman in Modhumati river reported with a sigh, "what a mighty river she(Padma) was". A ferryman by profession, Hossain had to dock his boat during the whole dry season from March through June. During this time he works as a menial labour in a sand quarry. Some businessmen told that their business was mostly disrupted during dry season

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36 A.A. Khan, *op. cit.*

37 A. Hannan, "Impact on Reduced Flow of the Ganges", A paper presented at a Seminar on *Impact of Reduced low Flow of Major Rivers in Bangladesh*, Organised by the WRE, BUET, Dhaka, 1980.

38 A. Nishat, *op. cit.*

and they had to spend more money to continue the business. The disruption in navigation had led to the loss of jobs of thousands who were earning their livelihood from this profession.

Impact on Environment

The ecology of estuarine and deltaic systems depends on the balance between water resources and human interventions into the environment. The withdrawal of water at Farakka initiated a process of environmental degradation. This process includes the weakening of resilience of the agroecological system and reduction of the biological potential of that system.

One of the immediate environmental effects of water shortage in the rivers is felt in the agricultural ecosystem of the study area where cropping is largely dependent on the Ganges waters. This is particularly acute when

Table 6. Impact on Environment.

Types of Impact	Frequency (F)	Parentage (%)
1. Loss of Agricultural Production (especially Aman and Rabi crops)	56	19.18
2. Decrease of river depth caused flood in the monsoon	45	15.41
3. Decrease of natural vegetation (especially mango, coconut, palmyara, betelnut)	43	14.73
4. Decrease of freshwater fishes	19	6.50
5. Disrupted navigation	16	5.47
6. Lowering groundwater table	21	7.19
7. Increase of salinity in the soil and river water	29	9.93
8. Others (fodder for livestocks, commercial, drought, desertification, river bank erosion etc.)	63	21.57
Total	**n = 150**	**100**

there is a drought like situation. For example, the rainfall in Rajshahi district was 28.75 inches in 1987 from June to September. This figure dropped to about 14.20 inches in 1993 during the same period. As a result 15 lakhs acres of land have been brought under *boro* cultivation in northern districts[39]. Majority of the respondents opined that due to low flow of the Ganges during dry season, agricultural output has been limited by loss of agricultural production (19.18%). (Table 6). Crop production has been adversely affected through greater evaporation or transpiration, soil moisture depletion, and non-availability of water for irrigation. A sizable proportion of the respondents(15.41%) thought that decrease of river depth causes flood in the monsoon. It may be noted here that, the main sources of flooding in Bangladesh are spill over from rivers, drainage congestion of local run-off due to extremely flat nature of topography, storm surges, and tidal blockage[40]. The major rivers carry about 2.4 billion tons of sediments annually resulting in gradual deterioration of morphological characteristics of the rivers[41]. Since the Ganges waters enter into Bangladesh after flushing the Calcutta port, large volume of silt enters through the river and the river beds of the south western region are rising gradually making the area prone to flash floods. In the Ganges dependent area about 240,929 ha. of land has been affected due to 1988 flood[42]. It is worth noting that before 1975, the Ganges had only one entry point into Bangladesh, but now it enters at two different points having a curved course of about 12 km in the Indian territory[43]. Experts viewed that it is mainly due to diversion of silt free waters in the

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39 *The Daily Star*, May 3, 1994.

40 M. N. Huda and J.U. Chowdhury, "Flood and Erosion", paper presented at a Regional Conference on *Floods and Erosion*, 7-10 September 1989, also N. Islam, *op. cit.*

41 M.Q. Mirza, *Holiday*, July 7, 1986 : also N. Islam, *ibid.*.

42 *The Bangladesh Observer*, October 15, 1988, also N. Islam, *ibid.*

43 *The Bangladesh Times*, April 30, 1985, also N. Islam, *ibid.*

upstream and pushing a large quantity of silt into the Ganges in Bangladesh.

The respondents also reported (14.73%) decrease of natural vegetation especially freshwater-based trees. The Ganges dependent area is rich in trees like coconut, betelnut and mango but local people said that these trees were decreasing in stock in the study area. While asked for causes, they opined that this was the result of increasing salinity in the soil and water. Natural vegetation is sensitive to temperature, precipitation (soil moisture) and soil quality. The flora and fauna of southwest Bangladesh have evolved in response to natural conditions to form a complex ecosystem, which is now threatened with degradation from inadequate supply of fresh water. Moreover, the increase of salinity and the encroachment of saline water have affected soil and plant nutrients resulting in large scale dying of *Sundari* trees[44]. The Forest Department estimates that Sundarbans is losing the timbers worth of about US$ 20 million every year and there is a possibility that if the trend continues this mangrove forest will be transformed into a barren land[45]. There is already a downward trend of country's timber production form 17,336,000 cubic feet in 1981-82 to 6,600,000 feet in 1991-92[46]. Not only the trees are affected, but according to a report, the increasing salinity has also created health hazard for world's famous Royal Bengal Tigers[47].

Deficiency in water resources in the study area from upstream withdrawal is also felt in the groundwater reserves throughout the whole area. It may be noted here that the surface and groundwater system in that

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44 Bangladesh Agricultural Research Council (BARC), *Proceeding of the Seminar on Top Dying of Sundari Trees*, Dhaka, 1990.

45 Department of Forest, "Special Salinity Survey in Sundarbans", DOF, Dhaka, 1982.

46 Swain, *op, cit.*

47 *The Daily Star*, January 9, 1994.

area are linked with each other. Any change in one system affects the other. Near the bank of the rivers, groundwater levels continuously declined since 1976 due to inadequate recharge from seepage in the dry season. During the year, 1995-96, groundwater level data were collected from 152 selected piezometric wells. It is observed from the analysis of water level data of 1995-96 that compared with 1978 position, most of the wells have registered considerable fall in the groundwater level. The fall of groundwater level is highest in the districts of Rajshahi, Kustia, Khulna and Jessore while the fall is lowest in Faridpur and Barisal districts[48]. The number of STWs in Khulna may still be lesser in numbers than of the Rajshahi areas, but the usable groundwater availability in southwest is only 1958 million cubic meters while the country possesses 45,738 Mm^3 [49]. Moreover, due to lack of water in the river, the groundwater is again depleting in the region, which is affecting capacity of these tubewells. The falling groundwater level has been already responsible in making 30 percent of these tubewells inoperative[50]. More importantly, the Ganges dependent area has been seriously affected with the arsenic contamination in the drinking water supply. This was reported first in 1993 and by now 34 out of 64 districts with a population of 10 millions are at risk. Experts believe that excessive use of groundwater for irrigation purpose is responsible for arsenic contamination in Bangladesh[51]. Among the respondents, 9.93% reported increase of salinity in the agricultural land as wall as in the surface and groundwater. In the past, sweet water of the Ganges and its principal distributory the Gorai used to flush down saline

48 Ganges Studies, Personal Communication.

49 N. Alam, "Use of Groundwater in Agriculture", paper presented to National Seminar on *Environmental Aspects of Groundwater Development in Bangladesh*, June 6, Dhaka, 1989.

50 *The Daily Star*, December 11, 1993.

51 M.F. Rabbi and E. Ahmed "Environmental Degradation of the Southwest Region of Bangladesh and Need for a Barrage on the Ganges" A paper presented at a seminar on *International Conference on Large Scale Water Resources Development in Developing Countries*, Oct. 20-23, Kathmandu, Nepal, 1997.

intrusion from inland into the Bay of Bengal. Due to reduced flow of the Ganges during dry season, the Gorai virtually dries up which allows inland saline intrusion in the southwest region of Bangladesh. Investigations since 1976 have established that the intrusion, concentration and duration of saline water in the southwest region depend mostly upon the quantity and duration of the upland flow received from the Ganges through the Gorai-Modhumati system[52]. According to the concerned Department of BWDB, in April and May in 1992 and 1995 the salinity at Khulna station was recorded at as high as 29,500 Micromhos/cm which was 1800% higher than pre-diversion average[53]. In the dry season of 1995, the salinity front of 500 Micromhos intruded about 213 km. inland through Pussur estuary in comparison with that of 147 in the pre-diversion year of 1968. The highest intrusion, recorded in 1983, was about 283 km.[54] along the same estuary. The most affected sector of increasing river water salinity is the industrial zone in and around Khulna. The country's only newsprint mill is situated in Khulna and due to high salinity concentration in the Rupsa and Bhairab river water during dry season, the industry has to procure fresh water from upstream[55]. Both surface and ground waters have become unfit for human consumption[56] since the salinity has exceeded the recommended level of 960 Micromhos for potable

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52 A. Nishat and S.K. Chowdhury. "Water Resource Policy for Asia", presented at a Regional Symposium on *Water Resources Policy in Agro-Socio-Economic Development*, 4-8 August, Dhaka, 1985.

53 Ganges Studies, *op. cit.*

54 Ganges Studies, *op.cit.*

55 M.Y. Ali, *Fish, Water and People : Reflection on Inland Open Water Fisheries Resources*, BCAS, Dhaka, 1997.

56 A. H. Khan, *Farakka Barrage: Its Impact on Bangladesh-An Overview*, Dhaka, 1993, p. 13.

water[57]. As the vast majority of the population is not served by municipal water supplies, they are exposed to and affected by various diarrhoeal diseases[58]. According to ICDDRB, diarrhoea has become in the southwest part of Bangladesh due to lack of freshwater. Every year at least 10000 people are affected in 25 districts[59]. In this context, Collwell[60] reported the growth of *V.Cholerae* in water of low salinity and high temperature in presence of high concentrations of organic nutrients in the coastal areas of Bangladesh.

It is significant that 21.57% of the respondents reported for others problems e.g. shortage of fodder for livestock, drought, riverbank erosion, commercial, desertification in the study area due to upstream withdrawal(Table 6). In the dry season people uproot grasses to use fodder, leaving behind barren soil which is then quickly eroded with the first monsoon shower. Drought is a critical problem in the south-western part of Bangladesh because after the cessation of monsoon rain usually by October, occasional rainfall are not sufficient to eradicate soil moisture deficit. Although this could be mitigated by supply of water from surface flow, this does not happen because of upstream withdrawal river flow dwindles down in the dry months. As a result aridity increases and the land becomes parched. River bank erosion is a common natural disaster in Bangladesh. The river bank erosion has a tremendous adverse

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57 Master Plan Organisation (MPO), *Surface Water Availability*, Technical Report No. 10, MPO, Dhaka, 1987.

58 Flood Action Plan (FAP 4), *Southwest Area Water Resources Management Project*, Vol. 9, Impact Studies, Sir William Halcrow and Partners Limited, Dhaka, 1993, pp.1-41.

59 *The Daily Janakantha* (in Bengali), April 28, 1994.

60 R.R. Collwell, "Global Climate and Infectious Disease: The Cholera Paradigm", *Science* 274:2025-2031.

effect on agriculture and it forces a large number of rural people to be homeless and to migrate[61].

When water is diverted at an upstream point, downstream channels go through severe morphological imbalances. It leads to the siltation of river bed and then shifting of the channel. Each river has its own capacity to carry silt and when the rivers have to carry additional load of silt or water in the monsoon seasons, they start erosion of the banks. Normally, shifting is a natural process in an alluvial river. However, man made changes such as an upstream withdrawal can have aggravating effects on bank line movement in the downstream areas. These problems have been observed in the Ganges. The number of islands in the Ganges has increased from 14 in 1973 to 24 in 1990, clearly portraying the unreliable movement of the river bed[62].

Decrease of freshwater fishes and the low flow of the rivers disrupted navigation transports are also adverse consequences of Ganges water withdrawal. As fish is the staple food of the Bangladeshies, depletion of fish stock over the years has posed a serious nutritional problem in the country. For example, per capita fish consumption rate in Bangladesh appears to have decreased from 11.7 kilogram in the year 1972 to 1.5 kilogram in 1988[63]. The study area has a vast river network but it becomes dry during whole dry season and disrupt navigation. The immediate cause of this problem is massive siltation of channels due to lower water volume in the dry months. It was observed

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61 K.M. Elahi and Jhon R. Rogge. "River bank erosion, Flood and Population Displacement in Bangladesh: A Report on the River bank Erosion Impact Study", Jahangirnagar University, October, Dhaka, 1990.

62 M. Shahjahan, "Dividing the Ganges", *The Bangladesh Observer*, May, 29-30, Dhaka, 1993.

63 M. Ur Rasheed," Bangladesh Fisheries", *Bangladesh Quarterly*, Vol. 14. No. 1, September, Dhaka, pp. .30-34, 1993.

that existing ferry terminals in the region required frequent shifting due to change in river courses[64].

During field study, the authors observed that a palmyara garden in Mongla thana was on the verge of extinction. When asked, the local people said that the trees were destroyed due to high salinity in the rivers and in soils. A gardener of Bheramara thana said that they (India) noosed the Padma and virtually it has dried. He stated that due to shortage of water, his jackfruit garden was damaged. Hotel boy Rahman said, "in the past, I pressed the tubewell one time to get the jug filled up with water but now it needs ten times more pressure to fill it up. *Financial Express*[65] reported that over 45 million trees have been destroyed in Natore district alone due to adverse effect of Farakka. "What can we do?" said some old villagers in Dacope thana(Khulna), "We can not believe this present situation. In our time the environment was very good but now the temperature is high, weather and environment is bad for living". "Would this study help to remove the present situation?", they enquired. A tubewell user in Bheramara thana stated that "before ten years we needed to bore 120 feet for a shallow tubewell, now the boring of 180 feet is minimum, which is putting a lot of extra cost to the farmers".

Impact on Social Life

Ganges issues always played an important role in socio-political life of Bangladesh. The uncertainty of water has had direct adverse impact on several aspects of human life. Loss of seasonal work of millions who cannot find sufficient surface and groundwater to sustain them during dry season compels them to migrate to other areas, especially urban areas. It may also kick off a major eco-migration in the region forcing people to move elsewhere. Moreover, it is needless to point out that the depletion of

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64 *The Bangladesh Observer*, December 26, 1993 and January 5, 1995, Dhaka.

65 *Financial Express*, May 8, 1994.

natural resources will deprive a substantial number of people who are directly dependent on those resources for their sustenance.

Among other social consequences, 43.75% of the respondents reported inter-family feuds due to lack of water in the dry season, 22.91% recalled inter-personal conflicts, while 20.83% and 15.51% reported inter-group and inter-community conflicts respectively. Most of the feuds and conflicts in the study area originated mainly from scramble for irrigation waters, as reported in Kalaroa, Mongla and Dacope thana.

With regard to mitigation of the problems, most of the respondents (41.89%) felt that construction of a barrage across the Padma in Bangladesh may remedy the problem on a permanent basis. About one-fifth of them thought that Bangladesh should maintain good relation with India and 11.05% emphasised on river/canal dredging. Other remedies as reported by them were: taking the issue to the UN (8.13%).

Perception about the Thirty-year Water Treaty

A question was put to the local community about the water treaty which was signed between Bangladesh and India on December 12, 1996. Out of 150 respondents, 142 (94.67%) heard and knew about the treaty. It was revealed that 73.29% people believed that this treaty is good for Bangladesh, because it will help get increased water flow. On the whole, most of the respondents were supportive of the treaty.

However, the people believed that the treaty had both negative and positive aspects(Table 7). About 36% people opined that due to this treaty, the water flow has increased and now they got more water than previous years; 34.48% respondents felt that if the treaty operates properly, it will be good for that area. But then a sombre realization was there about asymmetrical power relations. Two school teachers said "India is the power in South Asia, so Bangladesh can do nothing except maintaining a good relations with her".

Table 7. People's opinion about the recent water treaty between India and Bangladesh.

Positive opinion	F	%	Negative opinion	F	%
It will increase water flow	42	36.21	Both sides would not maintain the treaty	16	25.80
If it would operate properly then good	40	34.48	Water yet to get	17	27.42
It is better to have a treaty without any treaty	4	3.45	The treaty has no guarantee clause	7	11.29
Desertification will be controlled	4	3.45	Don't know the details about the treaty	2	3.23
The treaty makes good relation between two countries	2	1.72	If it is operative then the river will be rejuvenated	4	6.46
It will help the total development of the country	5	4.31	Don't know	16	25.8
Don't know	19	16.39	Other's	0	0.00
Others	0	0.00			
Total	**n=116***	**100%**		**n=62****	**100%**

*34 sample did not put any answer. **only 62 sample answered in negative.

On the negative point of view, 27.42% respondents felt that even after signing of the treaty they did not get enough water; 11.29% argued that there is no guarantee clause in the treaty as was with the 1977 agreement. About one-fourth of the respondents believed that the terms of the treaty will not be adhered to. A landless rickshaw puller said, "Bangladesh can not recover from the loss of Farakka Barrage whatever the terms. This is our river, so why should we need treaty?"

It will be pertinent at this point to make an overall review the thirty-year Ganges water treaty.

Sharing of the Ganges Water: The 1996 Treaty

Under `The 30-year Ganges Water Treaty` on sharing of the Ganges water arrangements have been made to share the water in the following way: Under the indicative schedule (Table 8), India's total share during the

Table 8. The Sharing of the Ganges Water under 1996 Treaty

Period	Average of total flow (1949-88) cusec	India's share (cusec)	Bangladesh's share (cusec)
Jan 1-10	107516	40000	67516
11-20	97673	40000	57673
21-31	90154	40000	50154
Feb 1-10	86323	40000	46323
11-20	82859	40000	42859
21-28	79106	40000	39106
Mar 1-10	74419	39419	35000
11-20	68931	33931	35000*
21-31	64688	35000*	29688
Apr 1-10	63180	28180	35000*
11-20	62633	35000*	27633
21-30	60992	25992	35000
May 1-10	67351	35000*	35351
11-20	73590	38590	35000
21-31	81854	40000	41854

(* Three ten-day periods during which 35000 cusec shall be provided).

lean season (1st January to 31 May) amounts to about 48% of the total available water, as against 52% for Bangladesh[66]. The schedule also specifies the three ten-day periods during which 35,000 cusecs shall be provided, alternately, to each of the two countries. For Bangladesh those dates are March 11-20, April 1 to 10 and 21 to 30, whereas for India the dates are March 21 to 30, April 11 to 20 and May 1 to 10. The period from March 11 to May 10 is considered the critical period of the lean season because the flow of the Ganges during this period is usually the lowest of the lean season.

The agreement was arrived on the basis of the average availability of water between 1949 and 1988. India has assured in the treaty article II (ii) that every effort would be made by the upper riparian to protect flows availability[67]. The treaty further stipulates in article II (iii) that if the flow at Farakka falls below 50,000 cusec in any 10-day period, the two governments will enter into immediate consultation to make adjustments on an emergency basis, in accordance with the principles of equity, fair play and no harm to either party.

Water Availability: The 1997 Scenario

Under the bilateral treaty signed by the heads of government of Bangladesh and India, the Farakka Barrage was opened for allowing the flow of water into the river Ganges/Padma of Bangladesh on 1st January 1997. However, as it turned out a few months after the Treaty had been concluded, actual availability during the first lean season of the Treaty was far less than the average flow of the Ganges for the period 1949-88, as reiterated in the indicative schedule under the Treaty. The first reports of a decline in the flow of the Ganges at Farakka started circulating during the

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66 Salman, M.A. Salman, (ed.), *World Bank Technical Paper* No. 414, Washington D.C. 1998, p.139.

67 T.S. Rehman, (ed.), *Gangar Pani Chukti : Prekkhit O Sombhabana* (in Bengali), Mowla Brothers, Dhaka, 1997, p.52.

last ten days of February 1997, when the flow was supposed to favour Bangladesh. During that period, Bangladesh stated that it had received only 24,559 cusecs, instead of 39,106 cusecs stipulated in the treaty[68]. The situation became quite serious in late March and on March 27, the Ganges flow in Bangladesh recorded only 6,457 cusecs, the lowest ever[69]. By early April, the flow kept fluctuating between 10,000 and 25,000 cusecs[70] and by early May water availability at Farakka was only about 40,000 cusecs, instead of 67,351 cusecs specified in the Treaty[71]. It is ironic to note that this substantially low flow occurred during the period when India and Bangladesh were to receive 35,000 cusecs of water in alternate three ten day period. The indicative schedule under the treaty shows an average availability of more than 60,000 cusecs of water.

Table 9 : Availability of Water at Farakka 1997

Period	Agreed Quantities for Bangladesh at Farakka (cusecs)	Actual Release to Bangladesh at Farakka (cusecs)
Jan 1-10	62180	62019
11-20	49635	49556
21-31	48762	48884
Feb 1-10	45604	45604
11-20	41015	41029
21-28	37399	38387
Mar 1-10	33085	33489
11-20	35000	35028
21-31		17857
Apr 1-10	35000	30137
11-20	19526	25613
21-30	35000	35065

Source : *The Daily Star*, May 14, 1997

68 Kazi I. Shakoor, "Water Treaty Remains as Elusive as Ever?" *Dialogue*, Dhaka, April 14, 1997.

69 *The Independent*, April 1, 1997.

70 Salman, M.A. Salman, *op. cit.*

71 K.I., Shakoor. *op. cit.*

The flow data released at Farakka for Bangladesh from 1st January to April, 1997 as submitted by Ministry of Water Resources, Government of Bangladesh in the *Jatiya Sangsad* (Parliament) on 14.05.97 and reported in the press is presented in Table 9 [72]:

The statement of the Minister has clarified the issue of share and release to Bangladesh below the Farakka Barrage. If we compare the actual release to Bangladesh and actual data recorded at Hardinge Bridge, the two sets of figure differ widely from the 3rd 10-day of February till April 1st 10-day. The flow data of the Ganges as monitored at Hardinge Bridge from 1st January to 30 April, 1997[73] is presented in Table 10.

Table 10. Mean Monthly Water Level of the Ganges at Hardinge Bridge during 1997 lean season.

Period	Water level m/Pwd	Maximum	Minimum	Mean
Jan 1-10	7.073	7.250	6.405	6.742
10-20	6.733			
21-30	6.450			
Feb 1-10	6.386			
11-20	6.096	6.465	5.815	6.133
21-28	5.864			
Mar 1-10	5.734			
11-20	5.577	5.815	5.095	5.550
21-31	5.359			
Apr 1-10	4.952			
11-20	4.746	5.110	4.680	4.828
21-30	4.787			
May 1-10	5.373			
11-20	6.477	7.120	5.150	6.194
21-31	6.685			

72 *The Daily Star*, Dhaka, May 14, 1997.

73 *The Daily Star*, Dhaka, May 26, 1997.

If we analyse the situation the following issues emerge: (1) From January 21, the flow was much below the amount of water released at Farakka. The shortfall was to the tune of 12698 cusecs in the 3rd 10-day of February; (2) In March, share of Bangladesh between release and as recorded at Hardinge Bridge varies from 10000 to 15000 cusecs; (3) on 27 March the flow recorded at Hardinge Bridge was 6457 cusecs and on 28 March, 8064 cusecs. However Bangladesh issued no official statement regarding this. According to Article II(iii), the two sides should enter into immediate negotiation in such a situation. For low flow in the Ganges during 1997 lean season, Indian officials said that due to slow melting of ice in the Himalayas, withdrawal of water at the upper riches and less rainfall, water could not be released as per the Ganges water accord[74].

According to the information published by *India Today*[75] the water flow of the Ganges was drastically reduced due to withdrawal by Uttar Pradesh and Bihar since 1988 to the tune of 25000 to 45000 cusecs through

Table 11 : Flow Recorded at Hardinge Bridge

Period		Flow Recorded at Hardinge Bridge in Bangladesh (cusecs)
Jan	1-10	70829
	11-20	55788
	21-31	50.045
Feb	1-10	48340
	11-20	38319
	21-28	25689
Mar	1-10	23291
	11-20	19930
	21-31	13823
Apr	1-10	17857
	11-20	24559
	21-30	27695

Source : Mean Daily Water Level of the Ganges at Hardinge Bridge, BWDB, Dhaka, 1998

74 *The Daily Star*, Dhaka, April 7, 1997.

75 *India Today*, New Delhi, April 30, 1997.

440 lift irrigation equipments. Mr. B.G. Verghese, a renowned Indian writer and columnist in an interview with press in Dhaka, said that this year, low flow of water in the Ganges as the natural accident due to prolonged winter and absence of winter rains[76]. A. Nishat, a renowned water expert of Bangladesh in an interview with *The Daily Sangbad*[77] has stated that due to withdrawal of Ganges water in the upper riches of Farakka viz. Punjab, Hariana, Delhi, the discharge of the Ganges at Hardinge Bridge was much lower than agreed quantities in the treaty in 1997. The water level of the Ganges at Hardinge Bridge during 1997 lean season is shown in Table 11 for dry seasonal flows[78].

Water Availability: 1998 and 1999 Scenario

It has become apparent during the implementation of the treaty in the first year (1997) that Bangladesh did not get its share of water of the Ganges at Farakka. But in the treaty, it is mentioned that every effort will be made by upper riparian to protect the flows of water at Farakka as in the 40-years average. In the second and third year of implementation of the treaty, data were compiled by the authors for 1998 and 1999 (January-April) lean season from the national newspapers. In 1998, "Bangladesh has got due share of the Ganges water", according to the member of Indo-Bangladesh Joint River Commission in Dhaka. According to *The Daily Star*[79] the availability of water in the Ganges at Hardinge Bridge was 29,041 cusecs on average during January1-10, 88,383 cusecs average flow occurred in February 1-10, February 11-20 flow recorded at Hardinge Bridge was 70584 cusecs and in the last 10 day (21-28) the recorded average discharge was 54,284 cusecs. From the beginning of March and at

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76 *The Independent*, Dhaka, April 21, 1997.

77 *The Daily Sangbad* (in Bengali), Dhaka, April 5, 1997.

78 Mean Daily Water Level of the Ganges at Hardinge Bridge, BWDB, Dhaka, 1998.

79 *The Daily Star*, Dhaka, June 15, 1998.

Table 12 : Availability of Waters during 1998

Period		Agreed quantities for Bangladesh at Farakka (cusecs)	Actual release to Bangladesh at Hardinge Bridge (cusecs)[80]
Jan	1-10	67516	182286
	11-20	57673	154292
	21-30	50154	118313
Feb	1-10	46323	88363
	11-20	42859	73584
	21-28	39103	54242
Mar	1-10	35000	46686
	11-20	35000	40960
	21-31	29688	38685
Apr	1-10	35000	43980
	11-20	27633	53241
	21-30	35000	53627
May	1-10	32351	74885
	11-20	35000	92039
	21-31	41854	84965

Source : Mean Daily Water Level of the Ganges at Hardinge Bridge, BWDB, Dhaka, 1998

the end of May no data was reported to the newspapers issued by Water Resources Department. The Water Resource Minister of Bangladesh reported to the Jatiya Sangsad (JS) on 14 June, 1998 on the availability of water in the Ganges at Hardinge Bridge in the second year of implementation of the treaty. He stated to the JS that Bangladesh received more water from Ganges than agreed in the Treaty for the period January-May"(Table 12).

In 1999[81] lean season, the flow recorded at Hardinge Bridge was (January 1 to April 10) has been presented at Table 13.

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81 *Weekly 2000* (in Bengali), Vol. 1, No. 48, April 23, Dhaka, 1999. p. 12

Table 13 : Flow Recorded at Hardinge Bridge during 1999

Period		Agreed quantities for Bangladesh at Farakka (cusecs)	Actual release to Bangladesh at Hardinge Bridge (cusecs)
Jan	1-10	67516	95934
	11-20	57673	85728
	21-30	50154	81480
Feb	1-10	46323	64873
	11-20	42859	61760
	21-28	39103	53185
Mar	1-10	35000	41600
	11-20	35000	35683
	21-31	29688	33892
Apr	1-10	35000	35376

Source : *Weekly 2000* (in Bengali), Vol. 1, No. 48, April 23, 1999, p. 12.

Conclusion

Water scarcity and water pollution are increasingly jeopardising the lives of millions of people in developing countries. It is the consensus of the world body that freshwater is a finite and vulnerable resource, essential to sustain life, development and the environment. According to our analysis, environmental destruction resulting from projects like the Farakka Barrage can be colossal unless corrective steps are taken. In this study most of the respondents viewed that water diversion made significant changes on their socio-economic environment.

Despite the considerably low flow of the Ganges during the critical period of the lean season of 1997, it is still a major breakthrough that India and Bangladesh have succeeded in signing a long-term treaty on the sharing of the Ganges water during the dry season. First of all, this has filled in the vacuum that prevailed since the expiry of the 1985 MOU on May 31, 1988. Secondly, the most important outcome of the Treaty is that it has created a conducive atmosphere for discussing and deliberation, on a number of water related issues between the two countries. It has been

observed that there is a strong feeling among the South Asian countries like Nepal, Bhutan, India and Bangladesh that there is no alternative but to co-operate each other for economic development in the region. The region is poor but rich in natural resources like water as a prime mover. There are enormous possibilities for generation of cheap hydropower and augmentation of the dry season flows of the river system. Other benefits like navigation, trade and commerce could follow. The goodwill created by signing the 30-year Ganges water treaty should not be lost sight of. The problem faced in the first year of its implementation should not be taken as a negative point. Based on our experiences, we should move forward to correct the mistakes and misunderstanding through mutual dialogue, meetings, seminars etc. and with transparency at all levels.