4 / Impact of Ganges Water Dispute on Bangladesh

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INTRODUCTION

Bangladesh and India have about fifty-four rivers in common. Among them are the Ganges, the Brahmaputra and the Meghna—three major river basins of the world. Other rivers like the Dharla, Dudhkumar, Teesta, Monu, Muhuri, Khowai, Gumati, Mohananda, Ichamati and Someshwai may be termed medium-sized rivers, while the rest are minor or small channels. All these water courses may be considered as international rivers as they flow through two sovereign countries. Utilization of the water resources of these rivers and construction of river training works in the border regions have been subjects of contention between the two countries. The main focus has, however, been on the Ganges, which has become a thorny issue in the relationship between the two countries. The people of Bangladesh now see this problem as a potential threat to national security.

The Ganges has flowed through Bangladesh from time immemorial; the lives and livelihoods of its people, together with the flora and fauna, have been conditioned by the waters of this great river. The river provides drinking water, sustains agriculture, forestry, fisheries and inland navigation, helps to operate a quarter of the country's industrial activities, prevents salinity intrusion from the Bay of Bengal and plays a crucial role in maintaining the ecological balance of the country. The balance between man and nature in the Ganges basin of Bangladesh rests essentially on the Ganges water, without which the livelihood of one-third of the people would be threatened. This historical balance has been severely disrupted by the substantial diversion of the Ganges flow during the dry season by India through the construction of a barrage at Farakka in 1974, for the stated purpose of flushing the Calcutta port.

The Ganges dispute was recognized in 1951 when Pakistan protested to India about the proposed Farakka Barrage. Negotiations have been continuing between India and Bangladesh, and prior to 1971 with Pakistan, on this issue for the last 40 years. Instead of convergence towards an acceptable sharing arrangement, the issue has now become a divergent one with many other issues hooked up with it. There have been several short-term sharing agreements: the first one was worked out in 1977 and the last one expired in 1988. Now there is a total vacuum in the arrangement.

In the absence of any sharing arrangement, the Indian unilateral withdrawal of the Ganges waters during the dry season at Farakka continues at an alarming rate which is evident from the recent dry season flows of the Ganges at Hardinge Bridge. The Gorai, which is the main tributary carrying water to the south-west region, becomes totally dry at the beginning of the lean period.

The progressive utilization of the waters upstream in India, coupled with the massive unilateral withdrawal at Farakka Barrage, culminated in the lowest recorded flow at Hardinge Bridge of 13,521 cusec in 1992, compared with historical average flows of 75,000 cusec during the last ten-day period of March. It is apprehended that in future the flow could be even lower.

This study evaluates the damage caused to different sectors of water-use in the Ganges-dependent area in Bangladesh, due to progressive upstream withdrawal/diversion of the Ganges waters resulting in the drastic reduction of dry season flows in Bangladesh.

BRIEF HISTORY OF NEGOTIATIONS ON SHARING OF GANGES WATER

The proposal for diversion of Ganges water was first disputed in 1951 by Pakistan. Since then discussions and negotiations have continued. The whole matter may be divided into the following six phases:

Phase (Period)	*Focus*
Phase I (1951–74)	How to finalize respective shares before commissioning of the barrage. Discussions on respective claims and their justifications.
Phase II (1974–76)	Issue of augmentation of flow brought in. Failure in bilateral negotiation. Barrage operation begins in 1975 with concurrence of Bangladesh. Unilateral withdrawal of waters by India in 1976. Issue taken to UN by Bangladesh.
Phase III (1977–82)	Ganges Water Treaty (1977–82) signed and operationalized. Discussion on augmentation fails. Treaty not renewed despite provisions to do so.

Phase IV (1928–88)	Memoranda of 1982 and 1985 operationalized. Provisions similar to 1977 Agreement except guaranty clause. All regional rivers brought to the discussion table. Both sharing and augmentation options discussed. Both sides revise their proposals on augmentation.
Phase V (1982–88)	Negotiations continue but without success. Divergence in approach. Relationship between sharing arrangements and augmentation proposals becomes a very critical issue.
Phase VI (1993–present)	No dialogue, and India has unilateral control over the Ganges.

Before the commissioning of the Farakka Barrage, an interim arrangement was made for a test run to pass a flow of 11,000 to 16,000 cusecs through the Feeder Canal from 21 April to 31 May 1975, releasing the remainder for Bangladesh. After 1975, there was no renewal of the arrangement and unilateral withdrawal by India continued causing disastrous effects on the Ganges-dependent areas of the country, mainly the southwest region.

Repeated protests against the continued unilateral withdrawals were of no avail, Bangladesh took the matter to the United Nations. Through intensive efforts of the Non-aligned countries at the United Nations, the General Assembly adopted a consensus statement on 24 November 1976, according to which the parties decided, *inter alia*, to have an urgent ministerial-level meeting at Dhaka to negotiate a fair and expeditious settlement.

Pursuant to the General Assembly's consensus statement, negotiations continued between the two countries, and the Ganges Waters Agreement was signed on 5 November 1977 for sharing the Ganges water for a period of five years, from 1978 to 1982, during the dry months of January through May each year. The Agreement provided for 345,000 cusecs for Bangladesh, 20,500 cusecs for Calcutta port and a guaranteed minimum flow of 27,600 cusecs for Bangladesh during the leanest 10-day period between 21–30 April.

The Agreement specified, *inter alia*, a schedule for sharing of the flow on a ten-day basis, a guarantee of a minimum of 80 per cent of the quantum mentioned in the schedule for Bangladesh to protect against withdrawal in upstream reaches, formation of a Joint Committee comprising representatives of both the Governments who would implement sharing arrangements, carrying out investigations leading to augmentation of the Ganges flow at Farakka within three years by the Joint Rivers Commission (JRC) created in 1972, and review of the Agreement by the two Governments at the end of the third year.

During the Agreement period, Bangladesh and India exchanged their proposals for the augmentation of the Ganges flow, which were reviewed jointly by both parties. The Bangladesh proposal envisaged optimum utilization of the water sources of the Ganges basin by construction of storage dams in the upper reaches of the Ganges in India and its tributaries in Nepal, to conserve the monsoon flows for augmenting dry season flows. India's proposal was to transfer Brahmaputra water through a link canal across Bangladesh to the Ganges above Farakka. The proposal of each country was not acceptable to the other, and on the plea that the obligation under the Agreement was not fulfilled, the Agreement was not renewed in November 1982.

However, the Governments of Bangladesh and India did sign a Memorandum of Understanding (MOU) on 7 October 1982 for sharing the flows of the Ganges for another two dry seasons of 1983 and 1984. The MOU of 1982 included provisions for burden sharing instead of the guaranteed minimum flow. Besides sharing, the MOU asked for submission of pre-feasibility studies of the schemes for augmentation proposed by both parties.

Accordingly in 1983, the countries exchanged their updated proposals for augmentation, based on which the 'Report on Pre-feasibility Study of the Indian and Bangladesh Proposals for Augmenting the Dry Season Flows of the Ganga/Ganges at Farakka' was finalized in 1984.

In view of the differences of opinion, it was not possible to make any recommendation acceptable to both countries with regard to the optimum solution for augmentation of the dry season flows of the Ganges at Farakka which could be urgently implemented. In fact, the proposals were rejected by the two sides in March 1984. The MOU expired in 1984 and no formal arrangements for sharing the flows in future years were made. Bangladesh made serious efforts to reach a formal agreement but without success.

In the absence of any agreement, there was no sharing during the dry season of 1985. After painstaking efforts, the two countries signed another MOU on 22 November 1985 for sharing the waters of the Ganges at Farakka for three dry seasons commencing in 1986. Like its predecessor, the MOU of 1985 included provision for burden sharing instead of guaranteed flows. It also provided for negotiation on the flows of all common/border rivers between the two countries including the Ganges. The sharing of the Ganges flows under the MOU of 1985 ended in May 1988.

During the New Delhi summit held on 29 September 1988 between the heads of governments of Bangladesh and India, the Bangladesh Secretary of Irrigation and the Indian Secretary of Water Resources were assigned to work out an integrated formula for permanent/long-term sharing of the flows of common rivers between Bangladesh and India. In order to break the stalemate in the sharing arrangement, the Secretaries' Committee held six meetings alternately at Dhaka and New Delhi over three years, from April 1990 to February 1992. They emphasized the need for immediate allocation of the Ganges and Teesta waters on a priority basis, including the sharing of other common river waters as mandated. However, they could not decide on a general principle for the sharing of the waters at any of the common rivers, including the Ganges.

Due to the absence of any sharing arrangement or agreement on the Ganges waters, a deadlock has prevailed on the issue since the dry season of 1989. Bangladesh has, since then, passed through six consecutive difficult dry seasons. The seventh dry season has commenced and the deadlock on sharing shows no signs of resolution.

ADVERSE EFFECTS OF REDUCTION OF THE GANGES FLOW

The Ganges is an international river with its basin spread over China, Nepal, India and Bangladesh. The river originates in the Himalaya and traverses south and south-eastward in India for about 1,400 miles, forms the common boundary between India and Bangladesh at about 11 miles below Farakka in India, and continues about 63 miles before finally entering Bangladesh near Rajshahi. Being the lowest riparian, Bangladesh has been deprived of any control over the river that carries huge cross-boundary flows during the monsoon to the tune of 2.5 million cusecs. However, the flow becomes scanty during the dry season and the average flow during the period reduces to about 60,000 cusecs at Hardinge Bridge in Bangladesh. The contribution of the trans-Himalayan tributaries in Nepal to the Ganges flow is quite substantial and is of the order of 71 per cent of the natural and historic dry season flows and 40 per cent of the total annual flow of the Ganges.

The impacts of reduction in the Ganges flow in various sectors are interdependent and interlinked. Figure 4.1 shows a network of this interdependency. In-depth analysis based on this diagram is a difficult task. In the following paragraphs sector-wise overall damages are summarized. Some of these were quantifiable while others could only be discussed qualitatively.

Tangible damages caused due to scarcity of water may be classified as

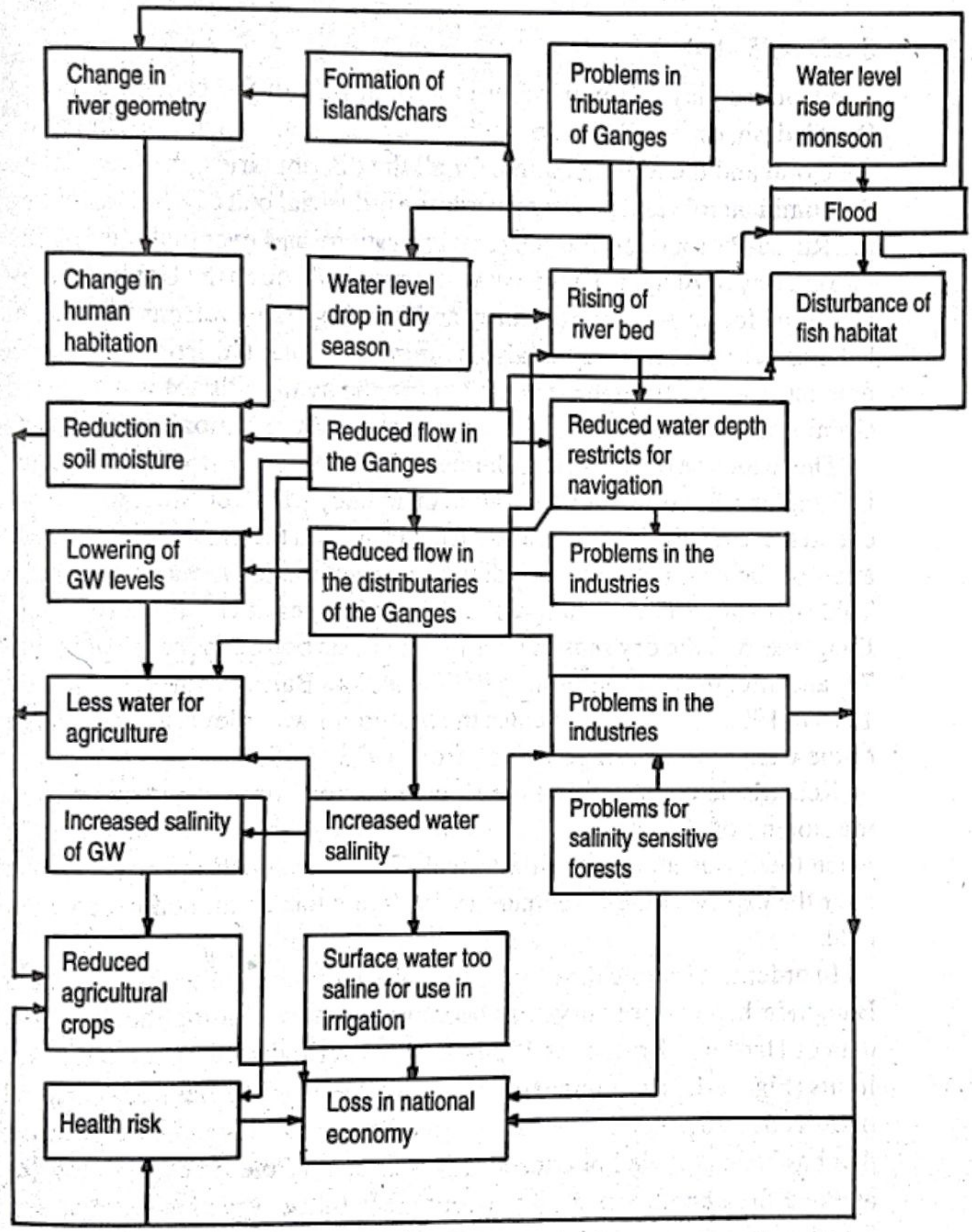

Figure 4.1. Network summarizing the impact of reduced Ganges flows.

direct or indirect damages. Direct damages are caused due to the shortage of water for meeting different demands. These are evaluated annually by the concerned agencies or the divisions of different Ministries. Such damages are incremental as well as cumulative. For the purpose of calculating the damages the 1991 price index has been used.

Surface Water

The Ganges plays an extremely important role in the economic life of Bangladesh, especially in the south-west region through its distributaries, the Gorai and the Mathabhanga. Of all the distributaries, the Gorai plays the dominant role as it passes towards the industrial belt of Khulna, linking the Rupsa-Passsur and the Sibsa river systems and eventually emptying into the Bay of Bengal. The sweet water supply through the Gorai is, therefore, vital for pushing back salinity and keeping an overall environmental balance. This distributary is also a source of potential irrigation development. Viewed from these perspectives, the availability of waters in the Gorai is a key factor for the very sustenance of the region's economy.

The reduction of dry season (January–May) natural flows in the Ganges in Bangladesh reduces the hydraulic efficiency of the channel to such an extent that even during high flows in the monsoon the progressive degradation of the channel and its hydraulic characteristics remains unabated. Table 4.1 shows the discharge of the river Ganges at Hardinge Bridge in Bangladesh in the dry season on a 10-day basis before (average of 1934–73) and after the commissioning of the Farakka Barrage during the period 1975 to 1992. Table 4.2 indicates the minimum water level and discharge of the Ganges at Hardinge Bridge from 1973 to 1992.

Records demonstrate that the flow reduction commenced since commissioning of the Farakka Barrage in 1975 and became critical in 1976 when there was unilateral withdrawal. The flow situation became grave after the expiry of the agreement in 1989 and has continued unabated to date.

In order to examine the effect of Farakka withdrawal on the Ganges in Bangladesh, a control curve has been prepared by plotting the discharge data of Hardinge Bridge for 1934–73 against time with upper and lower limits (Figure 4.2) The upper curve shows the flow that has been equalled or exceeded 10 per cent of the times and the lower curve indicates the flow that has been equalled or exceeded 90 per cent of the times. To show the average flow condition, a 50 per cent probability curve has been drawn. The deviation in the pattern of flow is clearly indicated by superimposing the ten-day flows of 1978 and 1992 in the control curve.

Table 4.1. Ganges at Hardinge Bridge: Average 10-day discharge (cusec)

Month		Average 1934–73	1975	1976	1977	1978	1979	1980	1981	1982	1983	1984	1985	1986	1987	1988	1989	1990	1991	1992
Jan.	I	108000	112689	77516	55232	89812	81508	54279	64081	57307	56248	81697	59101	113098	99422	54513	48037	53835	52823	61152
	II	101000	87227	65721	49617	81490	60345	49819	56817	50510	47634	74622	54377	99892	80112	47484	43529	50444	53221	53762
	III	95000	89170	57069	46333	67506	53803	41151	51852	45906	43300	67684	49605	79054	64130	44231	43616	35025	48642	42049
Feb.	I	91700	87227	55268	41954	63365	57235	39248	51063	46031	41156	63054	46200	65424	57079	40393	38467	24573	36300	30922
	II	89100	82319	52866	37681	57874	64997	35274	47734	51856	42186	50554	39949	61731	50550	38708	28409	22259	23675	28695
	III	85400	76951	47074	36374	63299	60252	33426	40903	49005	37642	50521	34587	66040	43175	36285	22677	24579	20892	25952
Mar.	I	81700	71865	35279	33443	63564	51787	32669	38343	46423	34413	50572	34198	74947	38482	34876	19397	27326	20815	21678
	II	78100	69605	28676	31218	52823	54368	32724	34529	45827	31127	44225	31452	59963	32110	36209	19059	28217	20298	16245
	III	75000	65120	24508	32030	48394	46372	32742	33990	44697	27149	37572	27233	47502	34563	34571	16153	27788	20176	15087
Apr.	I	72300	66074	25391	31889	56616	41318	33260	32687	46653	27621	33527	25547	42742	33010	34242	16513	28177	19839	14756
	II	70600	71830	25497	35103	60770	46070	33514	36712	56616	28829	34232	27829	44030	38537	33539	21070	30053	28246	14856
	III	69800	61236	26239	35491	64463	49373	35059	47781	63646	30678	36605	28822	49096	40687	41277	26570	33833	29263	16021
May	I	69700	53961	35173	40894	70825	51289	36046	50728	66696	43527	42437	31558	55473	46223	47401	25728	35615	30824	16120
	II	73000	57210	47816	39658	75444	49634	42672	53403	62739	54712	49599	29914	57217	46887	53317	31300	42994	46109	19362
	III	78900	69393	56292	43013	105433	63025	47027	61595	64635	64087	53666	31833	61952	46334	55601	47373	81683	44628	22885

Source: Joint Rivers Commission, Bangladesh.

Table 4.2. Minimum water level and discharge of the River Ganges at Hardinge Bridge for the period 1973–92

a. Water level

Year	Date	Water level in ft. (m)
1973	1 April	21.11 (6.43)
1974	23–30 March	20.00 (6.10)
1975	5 May	20.03 (6.11)
1976	29–30 March	16.50 (5.03)
1977	20 March	20.25 (6.17)
1978	25 March	20.00 (6.10)
1979	12 April	20.32 (6.19)
1980	5 April	18.00 (5.49)
1981	8 April	20.09 (6.12)
1982	29 March	19.23 (5.86)
1983	7 April	17.63 (5.37)
1984	4 April	19.75 (6.02)
1985	5 April	18.60 (5.67)
1986	5 April	19.59 (5.97)
1987	4 April	19.06 (5.81)
1988	13 April	20.28 (6.18)
1989	3 April	17.85 (5.44)
1990	15 February	16.37 (4.99)
1991	1 April	16.60 (5.06)
1992	28 March	15.63 (4.76)

b. Discharge

Year	Date	Discharge in cusecs (cumecs)
1973	1 April	68,157 (1930)
1974	3–5 April	73,500 (2081)
1975	5 May	50,500 (1430)
1976	29 March	23,200 (657)
1977	20 March	30,300 (857)
1978	26 March	46,406 (1314)
1979	9 June	36,730 (1040)
1980	19 March	31,435 (890)
1981	8 April	31,141 (882)
1982	29 March	41,197 (1167)
1983	26 March	24,490 (693)
1984	4 April	31,354 (888)
1985	6 April	24,300 (689)
1986	6 April	40,184 (1138)
1987	4 April	29,138 (825)
1988	2 April	31,435 (890)
1989	27 March	15,479 (438)
1990	14 February	19,739 (559)
1991	1 April	18,633 (528)
1992	28 March	13,521 (383)

Source: Hydrology, Bangladesh Water Development Board.

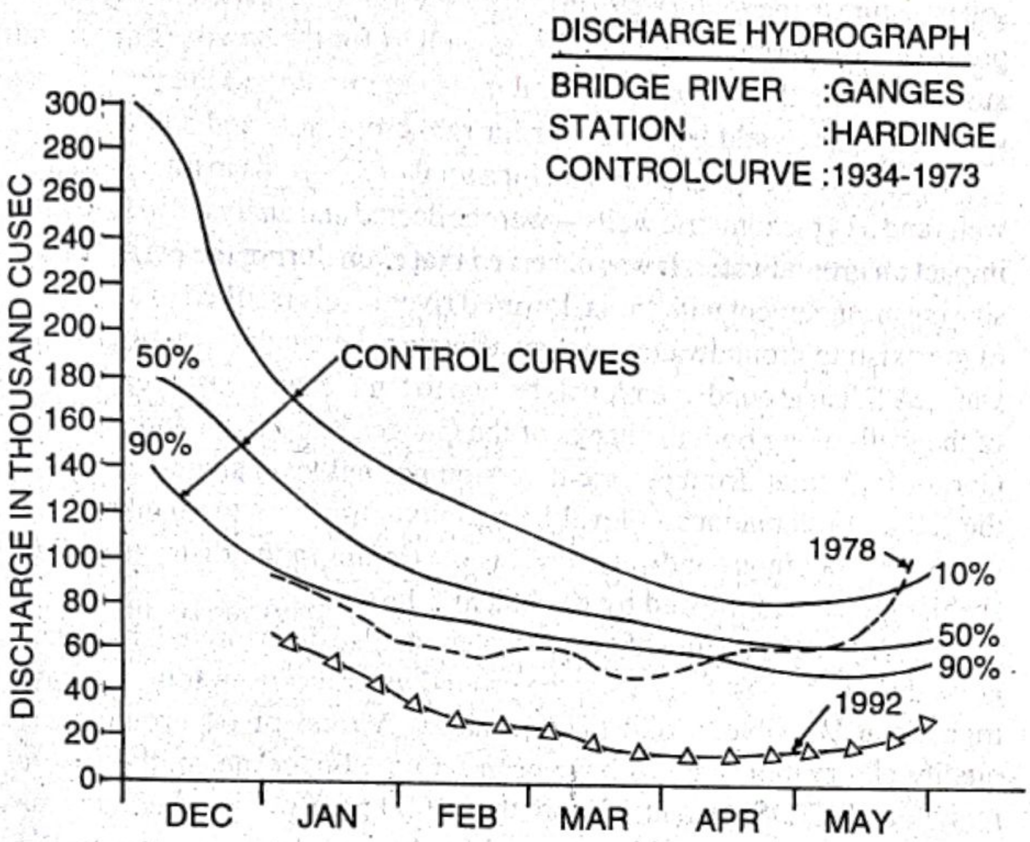

Figure 4.2. Discharge at Hardinge Bridge, December–May (1934–73, 1978, 1992).

A close examination of the curves clearly demonstrates the following facts. The flows throughout the entire post-diversion period from 1975 to 1992 fall within the envelope, where 1978 forms the upper boundary and 1992 the lower boundary, thus forming a new envelope. Even though the 1978 dry season flow forms the upper boundary in the newly developed envelope, the flow line remains below the lower boundary of the original control curve from January to the first ten-day period of April. This clearly demonstrates that the flow condition remained critical even during the period of the sharing arrangement. The 1992 flow line forms the bottom line, which entirely passes far below the lowest limit of the control curve. The trend indicates that if withdrawal of the Ganges water at Farakka is continued at the same rate, there will be hardly any water available in the Ganges in Bangladesh in the coming years.

Groundwater

An inevitable consequence of water reduction in the river channels is decrement in the amounts of sail moisture and ground water resources. The soil moisture in the south-west (in the dry season) was sufficient during the pre-diversion period for rabi crops, as well as for the sowing of jute and aus rice. Due to the reduction of soil moisture quantity in the post-diversion period, the yield is now lower for rabi crops, jute and aus.

Weekly groundwater table data for a total of 374 wells in total—60 dug wells and 314 piezometric wells—were collected and analysed to study the impact on groundwater. It was observed that even during the period of the sharing arrangement with India, lowered river levels resulted in a reversal of the existing groundwater gradient affecting the availability of groundwater. A fall in groundwater levels by two to ten feet was observed in most of the wells along both the banks of the Ganges, the Mohananda and the Gorai-Modhumati from the pre-diversion normal level since 1976, with the fall and fluctuations in level being maximum near the banks of the rivers. The fall in groundwater level is maximum in the districts of Rajshahi and Pabna, followed by Kushtia and Jessore.

In addition, the quality of groundwater has also deteriorated. In certain areas during the past few years, the groundwater has been found to have high Total Dissolved Solid (TDS) values. A total of 64 groundwater quality observation stations have been set up all over the south-western region, and a TDS content of more than 1000 ppm was marked in some stations in the districts of Jessore and Kushtia. In 1986–87, samples of groundwater taken from 50 stations of the south-west yielded TDS figures ranging from 147 to 3200 ppm. It may be mentioned that water with less than 500 ppm of TDS is satisfactory for domestic, industrial and agricultural uses, whereas water with more than 1000 ppm TDS content is termed brackish and unsuitable for domestic as well as industrial uses. This increase in the concentration of TDS has been observed since the Farakka diversion started, and the deterioration in groundwater quality has affected agriculture, industries, domestic and municipal water supplies, public health, as well as the quality of the soil itself over a large area. The deterioration in groundwater quality and quantity is a matter of great concern.

Morphology

The channel morphology of the Ganges and its distributaries has also been affected since the commissioning of the Farakka Barrage. Heavy sedimentation, increased shoaling, reduction in the navigable depth and instability of the channel resulted from the diversion of the silt-free water through the feeder canal of the Farakka Barrage and the subsequent release through the barrage of reduced flow containing a higher percentage of sediment load. A study of the longitudinal bed profile of the Ganges between the years 1974 and 1989 from its confluence with the Brahmaputra to the Indo-Bangladesh border, and a study of changes at several cross-sections between the years 1974 and 1991, revealed the fact that the bed of the Ganges has silted substantially more in the recent past when compared to the pre-diversion period. This could create severe flooding in monsoon months.

Navigation

Bangladesh is a riverine country and navigable waterways therefore developed as the principal means of transport in the country over the ages. Since the commissioning of the Farakka Barrage, in 1975, several waterways which are dependent on the Ganges flows have been severely affected. A total of 685 km of waterways which were navigable during the pre-diversion period have been adversely affected.

The confluence of the Ganges and the Brahmaputra was affected by shoals caused partly by the upstream diversion of water from the Ganges. As a consequence, the BIWTA ferry terminals at Aricha and Gualando were moved to Daskandi, 4 miles downstream, and to Daulatdia, 3.5 miles upstream, respectively, during the 1975–76 low flow season.

The upstream water diversion has led to decreased navigability of the south-western rivers. The immediate cause of this problem is massive siltation due to a lower water volume in the dry months. In little more than a decade, several important routes—one open to mechanized vessels—have had to be abandoned. During the pre-diversion period, the Ganges could be navigated by large steamers even in the dry season. Today, due to low flow in the dry season, the river can be crossed on foot near Hardinge bridge for 5 to 7 months of the year. The drying up of the Ganges has been so severe that there is often inadequate navigational draft even in the wet seasons. The same is true for the Gorai which, due to shoaling at its offtake from the Ganges, is unfit for navigation between Kushtia and Kamarkhali in the dry season. Similarly, the Bhairab river between Khulna and Jessore can now only be navigated by country boats in the lean season; while the stretch of the Alipur khal between Khulna and Manikdah—formerly used by steamers—is now totally unnavigable in the dry season. The mass deterioration of the navigational potential of the south-western rivers in recent decades is a direct consequence of the upstream water withdrawal.

Salinity

The most devastating effect of the diversion of Ganges water has been caused by the marked increase in salinity, in both surface water and groundwater, leading to higher soil salinity in the south-west region of

Bangladesh. The increased salinity is totally explicable in the light of the increased withdrawal of the Ganges water. A large part of the affected region is subject to the tides of the Bay of Bengal. Historically, this saline intrusion used to be counteracted by the upland flows. But with a decrease in the upland flows, the salinity has increased and advanced significantly inland. The major direct adverse effect of salinity is felt on agricultural production, fishery, forestry, power generation and industry. In addition, and most significantly, such marked increases in salinity pose short- and long-term impacts on health, mortality and the ecosystem as a whole.

The south-western region of Bangladesh is entirely dependent on the waters of the Ganges and its distributaries. The southern part of the region is characterized by a series of islands and estuaries. In the extreme south-west zone lie the Sundarban forests. The upland freshwater flows through the Gorai-Madhumati, the major distributary of the Ganges, governing the state of salinity in the region. The Gorai, which plays a major role in the area, branches out in its lower reach near Bardia into the lower Nabaganga-Atai and Modhumati-Baleshwar channels. Any reduction in the availability of Ganges water decreases the flow in the Gorai, concomitant with ingress of salinity. Ever since the upstream withdrawal of the Ganges waters started, an imbalance has been initiated in the Ganges-Gorai system, resulting in the intrusion of highly saline water penetrating deep inland through the estuaries. The increased salinity due to reduced dry season Ganges flows has had a severe impact on the agricultural and industrial activities of Khulna and adjoining areas and has inflicted material injuries to the Sundarban forests. Since the Farakka withdrawals commenced, the salinity ingress pattern in the area has tended to increase cumulatively due to residual deposits, a situation which would be further aggravated if the present pattern of Ganges flow continues.

The crop tolerance limits in the salt-affected areas have been surpassed, causing a significant decrease in crop yield in the region. Moreover, the soil characteristics of the area have deteriorated substantially due to the gradual accumulation of salt over the years. Once the soil became saline, not even subsequent floods and monsoon rainfalls could leach out the salt completely. There always remained some residual soil salinity which increased with time. This progressive accumulation of salt in the soil is now threatening permanent damage to soil fertility in the area.

The reduction in dry season Ganges flow raised the salinity of Khulna area from 380 micro-mhos/cm during the pre-diversion period (1974) to about 29,500 micro-mhos/cm by April 1992. The salinity front of 500 micro-mhos/cm moved through the Passur Estuary from 90 miles to about 136 miles inland after the diversion. These have resulted in increased soil salinity leading to crop damage and severe yield reduction.

The increased engulfment of new areas and the increased degree of salinity during the post-diversion period due to reduced Ganges flow have caused manifold adversities in the Ganges-dependent area: the river water has become non-potable and thus unfit for domestic use in many places; increased salinity has badly affected the industrial operations in and around Khulna, the nerve centre of industrial activities in the south-west region. Since the plants and machinery of the industrial units have suffered progressive damage due to increased corrosion as a result of increased salinity of the water used. In order to keep the industrial units operative, alternative arrangements for fresh water supply became essential, entailing substantial investment.

Fishery

In Bangladesh, fishery ranks next to agriculture in economic importance, and fish furnishes over 80 per cent of the animal protein in the diet of the people. Freshwater fisheries contribute about 88 per cent of the total fish production in the south-west region. Inland freshwater fishery includes capture as well as culture fishery, and covers a total area of 10.515 million acres (MAC) in Bangladesh, of which 4.394 MAC lies in the Ganges-dependent area (GDA).

The low flow of water in south-west Bangladesh during the dry season has caused (i) shrinkage of wetland and the consequent reduction of open water capture fisheries area; (ii) conversion of perennial wetlands into seasonal ones; (iii) drying up of reasonable wetlands; and (iv) creation of stagnant water bodies and the prevention of fish migrations. With altered flow pattern in the rivers, the ecological characteristics favourable for fish breeding grounds have also changed. Since the diversion of water in the Ganges, a significant reduction in the stocks of Carp and Hilsa has been observed in the south-west region. The Hilsa is an anadromous fish that migrates into freshwater upstream to spawn. The decreased flow and shallow depth of freshwater in the Ganges and its distributaries has severely affected this fish population.

Municipal Water Supply and Public Health

The Ganges river is the main source of domestic water supplies in the Ganges-dependent area of Bangladesh. More than 36 million people who live in the area have been using its water for domestic and other purposes. The damages cannot be fully evaluated in financial terms. However, these are qualitatively described below.

The people use both surface water and groundwater for domestic purposes. Due to the drastic reduction in surface water, the people have become totally dependent on groundwater. But the availability and quality of the groundwater have also become constrained, too, due to the lowering of the groundwater table and salinity intrusion. During the pre-diversion period, the water quality was well above the acceptable limit, but since the diversion it has been deteriorating continuously. It may be safely predicted that with the current trend of decreasing availability of the Ganges water, the groundwater in the Ganges-dependent area in the not too distant future will neither be suitable for domestic use nor for irrigation because of high salinity intrusion. Besides the quality, the availability of groundwater has been threatened due to the gradual lowering of the groundwater table, particularly in the Gangetic belt. Thousands of tubewells sunk by the Public Health Engineering Directorate for domestic purposes have become inoperative. New tubewells of greater depth have had to be installed, which have caused huge financial loss.

Increased salinity has had adverse effects on the general health of the people in the area, giving rise to an increased incidence of various ailments. Cases of water-borne diseases like typhoid, infectious hepatitis, diarrhoea, cholera, etc. among the inhabitants of the south-western region have been reported in increasing numbers. A special type of cholera bacteria has been discovered in the contaminated water in the area, which has been attributed to the pollution of the river water which is being exacerbated due to reduced flows.

Forestry

In Bangladesh the Sundarbans, littoral mangrove forests adjacent to the Bay of Bengal, south-west of Khulna district comprise an area of 1,006,060 acres (about 5708 sq. km). The forests extend about 50 miles (80 km) north of the Bay of Bengal and are bounded on the east by the Baleshwar river. To the west they extend into India. The predominant species of trees in the forest are Sundri (*Heritiera fomes*) and Gewa (*Excoecaria agallocha*), followed by smaller percentages of Keora (*Sonneratia apetala*), Baen (*Avicennia officialis*), Dhundal (*Carapa obovata*), Amur (*Amoore cucullata*), Kankra (*Bruguiera gymnorrhiza*), Golpatta palm (*Nypa fruticans*) and a few other minor species. With the increase in salinity, Sundri trees started dying and the regeneration of the species also decreased. This main species of trees in the Sundarbans may ultimately disappear if the salinity increases above the tolerable limit.

Agriculture

Shortage of water in the Ganges since the commissioning of Farakka Barrage in India has adversely affected crop production in a substantial area where soil moisture depletion through evapo-transpiration leads to water stress. Expansion of irrigation facilities in the area served by the Ganges suffered heavy setbacks that retarded growth in agriculture. The damages in the agriculture sector due to reduced dry season flows during the entire post-diversion period are manifold and have been quantified for individual causes like shortage of water in the crop fields, soil moisture depletion, soil and water salinity exceeding tolerable limits, lowered groundwater table and delayed planting. Inadequate soil moisture due to reduced surface water and groundwater has severely affected the area, mainly along the rivers' charlands and high ridges. While delayed planting of crops by about two months due to non-availability of surface water has resulted in considerably reduced yield, increased salinity, on the other hand, has caused severe damage to crops lying in the saline zone.

The damage caused to agriculture through moisture depletion, delayed planting and increased salinity has been evaluated for the entire post-diversion period. It is seen that a production loss of about 5,500,000 tons has occurred during the period which in financial terms amounts to approximately 35,000 million takas at 1991 prices (see Table 4.3).

Besides the stated damages, the economy of Bangladesh has suffered a serious setback resulting from the loss of the additional benefits that could accrue if the south-west region had retained its historic natural resources endowment.

In order to make a realistic assessment of the sacrifice made by Bangladesh in the context of reduced dry season flows of the Ganges during the post-diversion period, an attempt has been made to quantify the benefit that would accrue if 30,000 cusecs (out of the lowest monthly pre-diversion flow of 65,000 cusecs in the driest month at Hardinge Bridge) could be allocated for irrigation. In the present exercise the duty of water is considered as 69 acres/cusec (*c.* 28 ha/cusec); the situation prevailing in the year 1974–5 has been considered as the base; the cropping pattern practised and the yield level achieved during this base year are used for computing crop production in the concerned area. This is then compared with the expected changes in the cropping pattern and achieved yield levels under an assured water supply, taking into account the technological advancement and the increased demand for intensive land use.

The results of this exercise showed that the foodgrain production alone could be increased by 3.60 million tons.

Ecology and Environment

The ecology of estuarine and deltaic systems depends on the balance between water resources and human requirements and interventions. The withdrawal of Ganges waters at Farakka and other upstream points in India has adversely affected the lives of nearly 33 per cent of the population of Bangladesh in the south-western region, as it has initiated a process of land degradation. This process includes weakening the resilience of the agro-ecological system and a reduction in the biological potential of that system. The flora and fauna of south-western Bangladesh have evolved in response to natural conditions to form a climax ecosystem, which is now threatened with degradation by an inadequate supply of freshwater. The factors which have triggered the process of ecosystem degradation in this region can be grouped into two broad categories: (a) salinity increase in soil and water (surface and ground) from tidal ingress, and (b) accelerated siltation in channels. In specific terms, the manifestations of reduced water flow are in the form of: northward penetration of tidal water causing salinity increase in soil and water; diminished potential of the Sundarbans mangrove ecosystem; massive siltation and shoaling resulting in drainage congestion; decreased navigational draft in inland waterways; degradation of wetlands and reduction of open-water capture fisheries area; and deterioration of groundwater quantity and quality.

The environmental price tag for Bangladesh from water withdrawal in the Ganges is alarming in terms of salinity increases. Tidal action in the south-western estuaries is normally felt inland. During the pre-diversion period, normal flow of water in the Ganges and the Gorai-Madhumati helped to neutralize the salinity. However, due to reduction of flow in the post-diversion period, the salinity and the tidal limit are penetrating further into the country. In 1989, the salinity front of 500 micro-mhos/cm penetrated over 217 km inland from the mouth of the Passur—against 144 km in the pre-diversion period of 1968. In April 1992, salinity recorded in Khulna (144 km upstream from the Bay) reached to the extent of 29.500 micro-mhos/cm. Not only has this saline intrusion adversely affected the availability of potable water and soil conditions for normal plant growth, the Goalpara Power Station and the industries along the Rupsa-Passur-Bhairab complex have faced problems of operation and financial losses.

The salinity limits to irrigation are 2000 micro-mhos/cm, and owing to the decreasing trend of dry season flow in the Ganges, nearly 40 per cent of the south-west region now shows higher than 2000 micro-mhos/cm in the month of April.

The floral-faunal ecosystem of the south-west region is dominated by the mangrove forests of the Sundarbans. The Sundarbans extend over 5708 sq. km (about 1700 sq. km of which are rivers, streams and other water courses) in the Khulna region, and are subject to tidal inundation with a maximum amplitude of about 3 m at spring tides. On the basis of salinity, three zones are recognized from south to north: (i) a saline zone, (ii) a moderately saline zone and (iii) a freshwater zone. The predominant species of the forest—Sundri, which accounts for 60 per cent of the marketable timber from the Sunderbans—thrives in zone (iii), and to some extent in zone (ii). Sundri requires optimum concentrations of brackish water and does not have adaptive tolerance to high salinity. Hence, the northward intrusion of saline water has spelt hazard for the generation and regeneration of this tree. A significant ecological change has taken place in the Sunderbans during the past decade, which is evident from the creation of natural blanks accounting for about 10 per cent of the forest area.

There are reasons to believe that one of the contributory factors in the recent downward trend in timber harvests of Sundri is the rise of salinity due to reduced freshwater flow in the dry season. The Sundarbans are also a rich habitat of fish fauna (of which 120 species are of commercial importance); 270 species of birds including 95 species of waterfowl; over 50 species of reptiles and amphibians; and 42 species of mammals including the Bengal Tiger. This rich biodiversity has evolved over time in harmony with the other delicate ingredients of the ecosystem. The recent increase of soil and water salinity has upset the natural equilibrium of this ecological niche for the Sundarbans' flora and fauna, and the forest is faced with progressive biodiversity loss.

The topographic, edaphic, and human occupance characteristics of the Ganges catchment area encourage a huge generation of sediment load in the river; and the reduction of flow in the Ganges and its distributaries has retarded the scouring effect of the river water. Instead of being 'flushed' into the sea, much of the sediment in the Ganges and its distributaries inside Bangladesh are deposited within the channels. The result is extensive shoaling or development of charland (almost one-third of the total area in many cases), thereby causing drainage congestion in the high flow season.

Apart from the effects of environmental decay on the sectors of navigation, agriculture, fishery and forestry mentioned under the relevant sections earlier, legitimate concern is also expressed about the potential for an increase in the breeding of numerous disease vectors resulting from a change in ecological conditions. The consequence would be a progressive deterioration of health and sanitary conditions.

Finally, together with the general process of land degradation in the south-west, a creeping process of desertification is apprehended in the region. The lack of water might ultimately change the region into a sub-humid ecosystem with concomitant collapse of the present agro-ecosystem and the creation of an economically irreversible scenario.

Summary of Damages

The damages in different sectors during the entire post-diversion period (1976–92) which could be evaluated in financial terms have been summarized in Table 4.3. Though the damages in some sectors could not be computed for some years due to lack of basic data and information from the concerned governmental organizations departments, the cumulative total damage equals about 108,500 million takas.

The intangible damages have been discussed in the sectors of public health and ecology. Although these damages could not be computed in monetary terms they can not be ignored. The negative impacts in these sectors not only counteract national development but also directly degrade the quality of life; their far-reaching consequences are difficult to predict and may disturb the whole environmental equilibrium in an irreversible manner.

Even in terms of measurable damages in different sectors due to reduction of dry season Ganges flows, the table does not reflect the full picture. Since the commissioning of the Farakka Barrage, Bangladesh has been deprived of 65,000 cusecs of water which used to flow through her territory during the driest month. If the pre-Farakka dry season Ganges

Table 4.3. Summary of damages (1991 price index)

Items	Financial loss in million takas
1. Agriculture	35,000
2. Fishery	63,000
3. Forestry	8500
4. Industry	1100
5. Navigation	500
6. Dredging	400
Total	108,500

flow had remained for Bangladesh, an amount of 30,000 cusecs could have comfortably been used for irrigation in the vast Ganges-dependent areas of Bangladesh, with gradual development of the necessary structural facilities. Through the utilization of this amount of water, the country today could have been in a position to produce an additional 3.6 million tons of foodgrains annually which in financial terms would amount to 2300 crore takas. Thus, denying Bangladesh her historical share of Ganges waters has in fact deprived her of a benefit of 200 crore takas every year in the agricultural sector alone. Bangladesh has to work out a way to counteract the impact of the damages caused by this reduced flow, at least partially, if not fully.

LOOKING TOWARDS THE FUTURE

At present there appears to be an impasse in the Ganges water dispute which has become a complex issue, the solution of which has to come from the political masters. For India it may be of a peripheral nature, but for Bangladesh it is an urgent issue. India would, in her own interests, try and bring in as many issues as possible and thus gain the maximum possible benefits. In Bangladesh, the whole issue has become politically charged and the government, whichever political party is in power, will probably adopt a cautious approach. Thus, the dispute continues while the overall environmental situation of the southwestern region deteriorates. It is feared by researchers and concerned environmentalists that damages could reach irreversible limits.

Before the Farakka Barrage was commissioned, there was general understanding that the Ganges waters would be shared. The issue of augmentation came later on. If the issue of deciding the respective shares of Bangladesh and India could be first settled, and then the approach for augmentation could be worked out, Bangladesh would have more confidence in the sincerity of Indias' intentions. The shares of water could be adjusted with benefits of augmentation flowing in for both the countries.

In terms of augmentation, the two sides have two independent proposals. Both would require huge sums of money and a long timeframe for implementation. Further, both the proposals would require the construction of large dams which might raise many questions from the environmental viewpoint. Therefore, the possibility of achieving the level of augmentation must be evaluated carefully within practicable timeframe considerations. On the other hand one-fourth of Bangladesh should not be left to suffer while the matter is debated. The issue of the Ganges has reached wide prominence. The potential for disputes over other common rivers must not be ignored. Some exchange of data on the Brahmaputra, Teesta, Dharla, Dudhkumar, Monu, Muhuri, Khowai and the Gumati has taken place. These rivers could be considered individually or together with the nearby rivers. Efforts should be made to maximize benefits through a basin-wide approach. A stage has been reached where the traditional approach to sharing may never bear fruits. Confidence building is necessary among neighbouring countries so that imaginative and innovative approaches may be adopted. Can SAARC open up this opportunity? Who will take the initiative in solving this dispute? Could it come from a neutral source? Can the two countries take lessons from past situations where similar problems have been resolved successfully? These are important questions for which no definitive answers are available at present.

5 / The Ganges-Brahmaputra System: A Nepalese Perspective in the Context of Regional Cooperation

HARI MAN SHRESTHA and
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Researchers have noticed that global warming caused by the enhanced greenhouse effect affects the earth's climate. This may have some influences on the regional hydrological cycle. The climate, topography and geological conditions of a given location, being nature's gift, cannot easily be changed in the short term merely by human actions. As the monsoon in the Ganges-Brahmaputra basin cannot be controlled, the extremely uneven flow conditions within a given hydrological cycle will continue to prevail. However, the available water resources within a given hydrological cycle could be regulated and managed to suit the requirements at different times of all the co-basin countries, for which we need to strive.

THE GANGES-BRAHMAPUTRA IN NEPAL

The north-eastern part of the Ganges basin lies in Nepal, with all the rivers flowing from Nepal being the left tributaries of the Ganga. The Brahmaputra basin does not extend into the Nepalese territory, but the river flows through Tibet, close and almost parallel to the northern boundary of Nepal (Figure 3.1). There is thus a possibility that the Brahmaputra could be diverted to the Ganges basin through Arun Valley or some other river of Nepal. In the event of such a diversion, Nepal's participation in the Brahmaputra basin would be relevant.

The distribution of the basin areas in each country is shown in Table 5.1. As may be seen from the table, Nepal cannot become a claimant to any riparian rights for the use of the Brahmaputra waters. The situation of Bhutan with respect to the Ganges basin is similar.

Table 5.1. Ganges-Brahmaputra basin area distribution

Country	Basin area distribution km²			
	Ganges		Brahmaputra	
	km²	%	km²	%
China	33,520	3.08	2,70,900	49.08
Nepal	147,480	13.56	—	0.00
Bhutan	—	0.00	47,000	8.51
India	860,000	79.10	195,000	35.33
Bangladesh	46,300	4.26	39,100	7.08
Total	10,87,300	100.00	552,000	100.00

Source: Nepal-Bangladesh Joint Study Report on Flood Mitigation Measures and Multi-purpose Use of Water Resources, 1989.

CONSTRAINTS AND COMPULSIONS

The geographical location of the Ganges-Brahmaputra and its riparian states are given facts. The climate, topography, geological conditions and political boundaries are not likely to change. The extremely uneven flow conditions in the Ganges-Brahmaputra basin will continue to prevail. As long as access across the main Himalaya remains difficult, Nepal and Bhutan will continue to be virtually land locked by India (being surrounded by India in the east, south and west, and by the great Himalaya in the north). Bangladesh, being the lowermost riparian lowland country located at the outfall of the three major rivers (the Ganges, Brahmaputra and Meghna), has to gain cooperation from the upper riparian countries, particularly for flood-moderation and low flow augmentation. All this indicates India's comparatively advantageous geographical position in relation to the Ganges-Brahmaputra, although in high dam flow regulation projects in the left tributaries of the main Ganges Nepal's cooperation would be essential. However, Nepal, because of its extremely small economic base, has to go to international/bilateral funding agencies for financial support even for irrigating its limited land with perennial and smaller water resources. These funding agencies often have refrained from providing support, due to objections raised by India.

BILATERAL COOPERATION AND INITIATIVES OF REGIONAL COOPERATION

Nepal-India cooperation in water resources development dates back to the early years of this century (1920), when through letters of exchange, some lands were exchanged to construct the Banbassa Barrage on the border river Mahakali (Sarada). Towards the end of the British rule in India, Nepal had granted permission for an investigation/survey on the Kosi to be undertaken. As a result of these investigations, the technical feasibility of a high dam/dams at the upper reaches and a diversion barrage near the Chatra gorge were indicated. The Government of India, however, decided to build the Kosi barrage at its present location on the alluvial plain, for which an agreement was signed between Nepal and India in 1954. The next project agreement between Nepal and India was signed in 1959. This was for the dam on the Gandaki, the second major river of Nepal after the Kosi.

At the time of these agreements, Nepal was not exposed to the outside world. It was ill-equipped in terms of administrative set-up, technical expertise, negotiating experience, and, above all, awareness of the country's resources and their utility. Thus, the agreements entered into were purely based on Indian initiatives aimed at fulfilling Indian needs. The biggest compulsion for Nepal, at that time, was to respond to the Indian initiatives. Therefore, neither the concept of international cooperation for maximizing the benefits to each partner, nor the securing of benefits for Nepal became a determining factor in deciding the location, type and technical parameters of the projects. Both agreements, signed after India's independence, received bitter criticism in Nepal. During the time of the Panchayat Government in Nepal in the 1960s, negotiations were held to revise the agreements, as a result of which a few clauses were amended. However, those revisions/amendments did not fully eliminate the Nepali feeling of discontentment with the projects.

With these experiences, Nepal realized the need for building its institutional capability to deal with investigations/surveys of river basins, including the expansion of its data base. Today, Nepal has indicative master plans for all its large and medium rivers, and has a good data base on river waters.

Nepal's initiative on regional cooperation on water resources dates back to 1977, when His Majesty King Birendra made an address to the 26th Session of the Colombo Plan Consultative Committee. On 5 December 1977, His Majesty the King in his address, said:

> Given genuine friendship and mutual cooperation, I declare in the name of my people and my Government that Nepal is willing to cooperate in such a joint venture, a venture that will lead not only to 'Planning Prosperity Together', but also emphasize our independence through interdependence.

Nepal cooperated with Bangladesh in 1978 through sharing of information on possible high dams in Nepal for the development of a proposal to augment the lean season flow at Farakka.

In October 1986, the Indo-Bangladesh Joint Committee of Experts (JCE) approached Nepal for information for their own study and analysis for the flow augmentation of the Ganges at Farakka. When the question of Nepal's involvement in the study was raised, the JCE did not respond affirmatively. At that time, although discussions were held among representatives of the three countries, officially, the meeting was of a bilateral nature as India and Bangladesh made their representation as a single body through the JCE.

Again, in the aftermath of the devastating floods of 1988, initiatives were taken by Bangladesh to seek regional cooperation leading to a long-lasting solution to the problem of floods. However, the studies were carried out only on a bilateral basis, with Nepal. The major recommendation (Recommendation related to the Fourth Activity, namely, Harnessing the Water Resources of the Region) of the Nepal-Bangladesh Joint Study Team was:

> This activity needs to be looked into from [the] wider perspective of finding durable solutions to the problems of floods and droughts through multiple use of water resources in hydroelectricity generation, navigation and irrigation by means of flow regulation including power systems interconnection, and therefore, calls for regional cooperation. For concrete programming of this activity all the beneficiaries (Nepal, India, Bangladesh) should get together and work in a common forum.

In the Second Indo-Nepal Sub-commission Meeting on Multiple Use of Water Resources held at New Delhi in April 1991 with regard to planning and survey/investigation of the Sapta Kosi multi-purpose project, Nepal stressed the need for the involvement of Bangladesh, but this was not acceptable to India.

The approach of the Indian government has always been to deal with Nepal and Bangladesh separately on a bilateral basis. However, in recent years, scholars and intellectuals of all three countries, and also international non-governmental organizations like the Global Infrastructure Foundation (GIF), have been pressing for regional cooperation. This is a positive sign towards the proper harnessing of the Himalayan water resources.

SHORTCOMINGS IN THE PAST

While starting afresh would be the best way, the shortcomings of the past agreements which have existed for so long cannot easily be wiped out. Not until each party's real concerns become transparent and each partner of the game becomes convinced of the facts, can the long-lasting cooperation in water resources needed for the survival and betterment of all, be achieved.

In this context, an understanding of the hangovers of the past is useful in identifying the corrective measures required to pave the ground for lasting cooperation. Therefore, the highlights of what happened in the past are briefly outlined here.

Before Indian Independence

On the river Mahakali (Sarada), which forms the border between Nepal and India, the Banbassa Barrage was constructed, with the entire barrage site located in Indian territory through an exchange of land. This arrangement gives Nepal rights for the supply of a mere 460 cusecs (13m^3/sec) of water from 15 May to 15 October (wet season) and 150 cusecs (4.25 m^3/sec) from 15 October to 15 May (dry season), with the provision for the supply of up to 1000 cusecs (28.3' m^3/s) provided a surplus is available, whereas the Sarada canal withdraws up to 14,000 cusecs (396 m^3/s) for India.

In addition, smaller barrages were constructed very close to the Nepal-India border, creating reservoirs like Mahali, Siswa and Bijwa. These have caused submergence of land in the Kapilvastu district of Nepal.

After Independence

(1) Around 1958, a barrage was constructed, again, close to the Nepal-India border for irrigation in India, thereby blocking the outlet of Danda river. This has created submergence of land in the Paklihawa area of Nepal.

(2) The Ring bund was constructed very close to the Nepal-India border in the Sitamadhi district of India, blocking the natural drainage and creating submergence of the Gaur area in the Rautahat district of Nepal during the monsoon season.

(3) Construction and heightening of the earthen embankments in an almost east–west direction close to the Nepal-India border were effected, thereby slowing down water flows during the monsoon period from the limited north–south sloping Nepalese agricultural land of the Terai region because of limited slopes.

(4) Ignoring the very appropriate site at Chatra gorge, the Kosi barrage was constructed on the alluvial plain on the Nepalese side of the border, which ensured that almost all the diverted water would be used in India. This created large-scale submergence of the limited plain land of Nepal, where, with the passage of time, the accumulation of silt caused by the barrage in the stretch between the barrage and Chatra resulted in the danger of the Kosi breaking its banks even under normal flood conditions.

(5) In the case of the Gandak, if the barrage had been constructed near Deoghat, upstream of the Chitwan Valley in Nepal, some more land in Nepal could have been supplied with irrigation water; but the barrage was constructed at the Nepal-India border, with India withdrawing water up to 29,000 cusecs and leaving Nepal with the provision of withdrawing only up to 850 cusecs.

(6) On the border river Mahakali (Sarada), near Tanakpur, a town in India located at the west bank of the river upstream of the old Banbassa Barrage; the Tanakpur Barrage was constructed by India for hydroelectric power generation. This was done without consulting Nepal, compelling it, at a later stage, to allow the construction of the left afflux bund in its territory. India is already deriving the benefits from the project, but it is still an unsettled matter so far as Nepal is concerned.

(7) Some kilometres downstream from the Nepal-India border a huge barrage was constructed on the Ghagra (Karnali) river for irrigation development in the Indian state of Uttar Pradesh, again without consultation with Nepal.

The above facts indicate that India has been able to do a lot in the past for its own benefit from the enormous quantum of water diverted from the major rivers flowing from Nepal, without regard for the adversities faced by its neighbour. The fraction of waters received by Nepal from these projects is negligible (in the ratio of about 3 : 97), and even this is not supplied regularly on a sustainable basis.

At this juncture, it would be worth mentioning two matters related to smaller water uses in Nepal.

(i) On India's request for assistance and cooperation for flood control to save life and property in Uttar Pradesh from the Rapti (west) floods, Nepal made a pre-feasibility study of a storage project (Bhalubang) in Deokhuri valley on the Rapti river, and an understanding was reached for a joint investigation to enhance the level of study of the project. In the initial stage of the workimg of the Joint Technical (investigation) Team, it was agreed that Rapti waters from the storage project would primarily serve the needs of Nepal, with the surplus being used in India. At a later date, the Indian side went to the extent of arguing that the Rapti (Bhalubang) project was a joint project, with the result that the financial assistance for the project, already sanctioned by the Canadian government, was cancelled, stalling the project.

(ii) Recently, the Government of India sent an objection notice to the Kuwait Fund for Arab Economic Development, when the Fund agreed to provide a loan to the Government of Nepal for the Babai Irrigation Project in western Nepal. This project is a substitute for three existing traditional farmers' irrigation systems and is aimed at providing a permanent irrigation system and expanding the irrigated area from 6500 ha to 13,500 ha through improved water supply. The weir-cum-bridge has already been constructed for the project.

It must, however, be mentioned that, while dissatisfaction with past Nepal-India cooperation on water persists, India's assistance in Nepal's infrastructure development projects (including the construction of hydropower plants at Trishuli and Devighat) has received wide and due recognition in Nepal.

PEOPLES' SENTIMENT AND GOVERNMENT AGREEMENTS

People living around the project areas notice with dissatisfaction what has been happening. For example, in the country where almost all the waters originate, and a project (with its inevitable submergence of land) is fully or partially located, there is, apparently, no possibility of water diversion for the much needed irrigation. As a result, even the limited land available on one side of the border is mostly barren in the non-monsoon period, while the other side of the border has been able to utilize these river waters to the maximum because of the disproportionately advantageous location of the project or other related structures. As indicated earlier, there has even been the arrangement of land swapping so as to locate the project (e.g. the Banbassa Barrage) entirely on the other side of the border. People in Nepal, surviving under a subsistence agricultural economy, face the predicament of not having water for the enhancement of agricultural productivity of their own land, while they helplessly witness the abundance of greenery on the other side of the border resulting from the diversion and use of the very waters which originate from their own country. These local farmers, landowners and people who are concerned about national interests, blame their own rulers of the past, rather than India, for entering into such one-sided agreements. They are very sensitive to any such future deal on water matters. The introduction of Article 126 in Nepal's new constitution (requiring ratification of such agreements in the National Assembly by a two-thirds' majority) is seen as a measure to safeguard the country from such mishaps in the future.

PROPOSALS NOT CONDUCIVE TO COOPERATION

Indian proposals, whether they relate to the Brahmaputra-Ganges Link Canal or to the Kosi High Dam Project, are conceived mainly for that country's own long-term benefits. There are a number of other projects on the Brahmaputra, Kosi, Gandaki and Karnali rivers which require priority attention for gradual development of benefit to all the co-basin countries, but the greater emphasis placed by India on these particular projects has not encouraged mutual cooperation, for the following reasons:

(1) *Brahmaputra-Ganges Link Canal:* This huge canal, 324 km in length (125 km within Bangladesh) is aimed at a massive water transfer of 2832 cumec and will separate the northernmost part of Bangladesh from the rest of north Bengal. Among the numerous adverse effects of this massive water transfer, significant points that should be noted are that an area of about 16,750 ha needs to be acquired in Bangladesh alone for the construction of the canal and there is a possibility of waterlogging in about 240,000 ha of highly fertile lands in north-western Bangladesh, all of which will involve massive resettlement. In addition, the dry season flow of the Brahmaputra would also be under India's control at two points, namely the Jogighopa barrage and Farakka Barrages, without any notable benefit to Bangladesh.

(2) *Kosi High Dam Project:* The 269 m high Sapta Kosi Dam Project, as proposed by India, would submerge the Sun-Kosi diversion-cum-storage site, which is a life-line project for Nepal as it irrigates the Terai land located west of the Sapta-Kosi and east of Birgunj. The Sun-Kosi project will also provide irrigation benefit to lands in north Bihar (India) located near the Nepal-India border and the existing West Kosi Canal. Nepal's proposal which put emphasis first on survey/investigation of the Sun-Kosi Project before proceeding with the Sapta-Kosi Project has not yet been accepted by India. India's approach, so far, has been to conduct surveys and field investigations of the Sapta-Kosi High Dam Project in isolation. Accepting an Indian proposal of this kind would be tantamount to allowing prior appropriation of the almost entire flow regulated by the Sapta-Kosi dam for Indian use.

It may be worthwhile here to give at least one other example where immediate cooperation is not likely. This is in respect of the Karnali (Chisapani) Multi-purpose Project. This project was studied under Nepal's initiative with the financial support of the World Bank. The Indian side wanted to see this project designed at as low as 20 to 25 per cent capacity factor and the study proceeded accordingly. However, after completion of the study, India would not recognize the capacity benefit. Similarly, due to India's non-recognition of flood-control and irrigation benefits from such a major flow regulating project (gross storage volume of about 28 billion m^3), the project will have to be indefinitely shelved.

NOT A PROBLEM OF WATER SCARCITY

In terms of average water availability, the Ganges and Brahmaputra basins are water-rich basins. As can be seen from Table 5.2, water availability per km^2 of land surface in the Brahmaputra basin and the Nepalese portion of the Ganges basin is more than four times the world average. Even with extensive abstractions for irrigation all along the upper and middle Ganga in India and its main tributaries from Nepal, the average water availability in the Ganges after entering into Bangladesh is still higher than the world average (about 1.25 times).

The problem is due to an extremely uneven distribution of flow in terms of time and space. During the monsoon period alone (June–September), some 72 per cent of total annual run-off is lost to Nepal in the form of instantaneous flow. This monsoon flow needs to be captured behind dams and regulated and managed to fulfil the demands of both Nepal and the countries downstream. The effective water-holding capacity of potential dam sites, so far identified in Nepal alone, has been estimated to be some 77 billion m^3. This constitutes almost 68 per cent of the total flow of July, August and September. These dam projects taken together will be able to increase the dry season (December–May) flow by about 4950 m^3/s. This increment alone is more than 170 per cent of the average dry season natural flow.

Similarly, the storage projects identified in the upper reaches of the Brahmaputra (Dihang, Subansiri) have a total effective holding capacity

Table 5.2. Water availability in the Ganges and Brahmaputra basins

	Land surface (km^2)	Run-off (km^3/annum)	Water availability (m^3/km^2 per annum)
Earth	148,900,000	40,000	269,000
Ganges	1,087,300	363 (at Hardinge Bridge)	334,000
Brahmaputra	552,000	615 (at Bahadurabad)	1,114,000
Left tributaries of the Ganges:			
Nepal + Tibet	c. 180,700	200	1,107,000
Nepal	147,181	174	1,182,000

Sources: 1. Nepal-Bangladesh Joint Study Report, 1989.
2. M.I. Lvovich, World Water Resources, 1974.

of around 45 billion m^3. This could substantially regulate the flow at down-stream reaches, significantly contributing towards flood moderation and dry season flow augmentation.

Nepal requires water mainly for year-round irrigation of limited irrigable land mostly situated in the Terai plain. The irrigable area, as indicated in the Master Plan for Irrigation Development of Nepal (1990), does not exceed 2.2 million ha and is distributed as shown in Table 5.3. This area is little larger than that of the single Gandak Project as shown in Table 5.4.

Out of this available irrigable land, the water use inventory studies

Table 5.3. Irrigable land in Nepal (hectares)

Region	Cultivated	Cultivable	Total
Terai	1,338,000	406,000	1,744,000
Hill and Mountains	428,000	6000	434,000
Total	1,766,000	412,000	2,178,000

Table 5.4. One example of Nepal-India cooperation: the 'Gandak Project'

A. Command area in acres				
India				
UP	831,000			
Bihar				
Saran district	1,408,000			
Champaran, Muzaffarpur and Darbhanga	1,754,000			
	3,993,000	(96.5%)		
Nepal				
Bhairhawa	40,400			
Parsa, Bara and Rautahat	103,500			
	143,900	(3.5%)		
B. Water Diversion Capacity (cusecs)				
			India	Nepal
Main Western Canal	15,800			
Main Eastern Canal	14,110		29,065	845
			(97.2%)	(2.8%)
	29,910			
Out of which,				
Nepal Eastern Canal	613			
Nepal Western Canal	232			
	845			

completed for 65 districts show that about 983,000 ha receive some kind of irrigation (mostly seasonal). These studies also show that farmers' irrigation systems (traditional) occupy about 73 per cent of the total irrigated area, while agency-managed systems (modern) occupy only 27 per cent of the irrigated area.

Potential sources for hydropower development are located in the mountainous regions in the upstream reaches of the Terai land and do not consume water. However, they would have some implications for flood moderation, if development is undertaken with storage reservoirs. The daily release pattern from peaking hydropower plants could be smoothened with the help of appropriate re-regulating facilities to suit the irrigation water requirements at downstream reaches.

Another area where water is required in an appreciable quantum, is in maintaining the depth of at least one major river (possibly the Kosi) for navigation to the sea. This is, in any case, required for India, if Bihar is to be connected with the sea through an inland waterway. The use of water for navigation conflicts to some extent with its use for irrigation, particularly in India.

Under any circumstances, Nepal's water needs are limited by irrigable land availability, and thus enormous surpluses would be available if flow regulation dams were to be built. In the case of the Brahmaputra, an enormous surplus will remain, until large inter-basin transfer becomes technically, economically and politically viable.

WATER DEVELOPMENT FOR ENVIRONMENTAL PROTECTION AND POVERTY ALLEVIATION

Due primarily to an ever growing population, pressures on natural resources—including land and forests—have reached a point of serious concern. The man-environment nexus which is vital for the survival of the vast majority of the rural population (and no less so for the urban dwellers) is deteriorating and trapping more people into poverty. The self-defeating vicious cycle of environmental degradation and poverty, aggravated by rapid population growth and lack of capital continue unabated as constraints, which prohibit faster harnessing of water resources.

Water resources development in the Himalayan area can be environmental-friendly for the following reasons:

— Large quanta of energy concentrated in river networks, currently being released and contributing to erosion and sedimentation, could be converted into a cleaner and usable form of energy for productive and domestic purposes. This will also help to reduce deforestation (more than 75 per cent of the present energy requirements of Nepal are supplied from fuelwood alone).

— Flooding in the downstream reaches could be reduced by capturing monsoon flows behind dams, providing relief to a large segment of the rural poor, and preserving farm lands.

— The augmentation of dry season flows would increase agricultural productivity per unit area, thus offsetting the need to farm marginal land and forest areas. This would also decrease salinity intrusion in the coastal regions. For example, a single Karnali (Chisapani) Multi-purpose Project could increase the dry season flow of the Karnali river fourfold.

— By providing an adequate supply of good quality water for all domestic uses, health hazards would be avoided.

— Hydroelectric power would reduce the need for thermal power generation in the region, thus reducing emissions of carbon dioxide.

— The possibility of inland river navigation connecting river ports to seaports would be facilitated, leading to the promotion of trade and industry.

— Employment generating opportunities would be increased, thereby contributing to the alleviation of poverty.

However, it needs to be noted that the building of identified storage reservoirs in Nepal would entail the submergence of around 160,000 hectares of mountain gorges and valleys. Resettlement of human populations and disturbance to wildlife would be major problems which would need to be tackled carefully.

ENTERING THE ERA OF DEVELOPMENT THROUGH COOPERATION

Rectification of the anomalies of the past is the first essential step towards faster development through cooperation. Recognition of the following facts will not only help to bury the past, but will also lead to long-lasting cooperation for future development:

(1) The Ganges and Brahmaputra basins are not water-deficit basins. The available water resources within a given hydrological unit can be regulated and managed to meet the requirements at different times of all the co-basin countries.

(2) The total water requirements of the smaller co-basin countries of the Ganges (Nepal, Bangladesh and Bhutan) are not large compared to what has already been abstracted by India.

(3) India, due to its technological capability and economic strength, has been able in the past to make extensive abstractions for irrigation along the upper and middle Ganga in India and its major tributaries flowing from Nepal; while for several reasons, including its very small economic base, Nepal has not been able to provide irrigation water on a sustainable basis even for its limited irrigable land.

(4) The potential high dam storage project sites existing in the Ganges and Brahmaputra basins could produce multiple benefits accruable to different co-basin countries. They need to be transparently assessed and a mechanism for the sharing of the costs and benefits established.

(5) Considering that (a) the building of high dams to create larger storage regulation reservoirs requires a long lead time, and (b) Nepal has cooperated with India in the past for large water abstractions, India should support Nepal (even if small disadvantages may occur to India), when Nepal seeks financial and technical support from international or bilateral sources to implement irrigation projects in Nepal. This will greatly help in winning the trust of the Nepalese people.

(6) India's unilateral actions, as have been taken in the past have been often close to or in the no-man's lands of the Nepal-India border. Developments such as the construction of ring bunds or embankments, the Tanakpur hydroelectric project, etc., need to be stopped as they have adversely affected public opinion in Nepal and have caused ill-feeling.

(7) Storage projects, being the ultimate solution for flow regulation, need to be planned so as to fulfil the long-term need of all co-basin countries. This requires the establishment of common institutional fora by co-basin countries. Since the flow regulation projects, either in the Ganges or in the Brahmaputra basin, would not only be international projects, but also pose great technological challenges, the participation of appropriate international agencies in these fora (for funding as well as technical support) seems necessary.

(8) The large hydropower potential concentrated in the multi-purpose project sites of the tributaries and main courses of the Ganges and the Brahmaputra need to be harnessed with a view to integrate the power systems of the co-basin countries to achieve the most effective use of their different resource endowments (India is a coal-rich country, Bangladesh is gas-rich, and Nepal is hydropower-rich).

(8) Water issues, being complex, and related directly with the welfare of the people, should be delinked from other political issues.

To conclude, just 'a little larger heart' attitude on the part of India will help to accommodate the full long-term requirements of all its smaller neighbours. This approach will also open the door for regional cooperation in water matters through which India will still be the net gainer, and may even receive surpluses for use beyond the Ganges and the Brahmaputra basins.