Chapter 10
Agreements & MOUs

India's parliamentary election in 1977 saw a dramatic change of power from Indira Gandhi to Morarji Desai of the Janata Party, ending a 30-year rule by the Indian National Congress, founded by a British civil servant, Alan Octavian Hume in 1885. The country's foreign policy remained, by and large, the same as formulated by the first Prime Minister after India's Independence from nearly 200 years of British colonial rule, Jawaharlal Nehru and followed by his two successors – Lal Bahadur Shastri and Indira Gandhi. Initially, the sharing of the Ganga water after the construction of Farakka Barrage in 1975 posed no problem with Bangladesh in the ambience of cordiality and friendship with the new republic, in whose emergence India played a crucial role by giving ample diplomatic and military help. Bangladesh also felt that the transfer of power from the Congress to the Janata Party in 1977 created a congenial atmosphere for coming to an understanding with India on co-sharing of the Ganga water and reconciliation of conflicting claims, leaving aside technical difficulties, as far as possible. Assuming power, the Janata government focussed on the water dispute and other bilateral issues with Bangladesh and sent Defence Minister, Jagjivan Ram who was in charge of irrigation in Indira Gandhi's cabinet, heading a delegation of officials to Dhaka on 15th April 1977 for discussions with Bangladesh government. After three days of discussions, the two governments issued a brief joint statement, as under:

> An understanding has been reached (on Farakka), details of which will be worked out at a meeting of the officials of the two governments, to be held in New Delhi, as soon as possible.

A minister-level meeting was followed by an officers' meet, next month, i.e., in May, in New Delhi and in Dhaka in July, that year. A short-term agreement was initiated at midnight of 30th September 1977 in New Delhi and finally signed on 5th November 1977 at Dhaka by S. S. Barnala, India's Minister of Agriculture and Irrigation and Rear Admiral M. H. Khan on behalf of Bangladesh. This has come to be known as the Farakka Agreement, the full text of which is given in Appendix B. Thus, a long outstanding and delicate dispute, fraught with technical, political and economic implications and hazards was solved for the time being.

The Agreement had 15 Articles, one Schedule and two side letters. It was subdivided into three major parts – A, B, and C. The period for water-sharing between

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two countries was sub-divided into 15 ten-daily periods with ratio, as shown in the Schedule. For assessing the actual quantum of release in the Ganga's downstream and in the Feeder Canal, a Joint Committee set up Observation Teams at Farakka and at Hardinge Bridge (over the Padma) in Bangladesh to record daily flows, as covered under Articles I–VII.

Articles VIII–XI related to long-term arrangements, under which Indo-Bangladesh Joint Rivers Commission was entrusted to carry out investigation and study of the schemes, relating to the augmentation of the dry-season flows, proposed, or to be proposed, by both sides to find a most economical and feasible solution. The two governments pledged to consider the scheme and take appropriate measures to implement it.

Articles XII–XV related to the review and duration of the Agreement. It could be reviewed after three years and would remain in force for five years from the date of effect. Though a short-term one, the Agreement added a new dimension to Indo-Bangladesh relations with the hope that political goodwill would overcome the difficulties which hitherto appeared insurmountable. India achieved the success of its policy of bilateralism which it had adopted in principle and focused on it to the outside world. The next United Nations General Assembly session was approaching and the signing of the Agreement before it enhanced the prestige of India in the world body which saw that a sensitive issue, like this should be resolved through bilateral dialogue.

Discussion on the Agreement

Before the Agreement was signed in November, 1977, several rounds of talks were held at officers' as well as Ministers' levels for finalizing the different articles. Discussions were also held between Morarji Desai, Prime Minister of India and General Zia-ur Rahman, President of Bangladesh in London in the middle of June, 1977 during the Commonwealth conference.' The Statesman' of 14 June 1977 reported that India renewed its offer of building a canal, linking the Brahmaputra and the Ganga to settle the dispute. It was made to the Bangladesh President by Morarji Desai in their talks in London. During the negotiation, canards spread and accusations made regarding the terms of agreement, which provoked angry protests by A. B. Vajpayee, the then External Affairs Minister of India (later a Prime Minister). Addressing a rally at Gandhi Maidan in Patna in early June 1977, he said a canard was being spread that India had been sold out in the agreement with Bangladesh and that it will completely ruin the Calcutta Port, as bulk of the Ganga water would be diverted from the Farakka barrage to Bangladesh. He said that the canard was baseless, as talks were still on with Bangladesh on the Farakka issue and no final agreement had been reached. Again, in a Rajya Sabha session in July 26, 1977, the opposition accused that the proposed meeting at Dhaka would endorse an agreement, under which India would have to be content with only half of 40,000 cusecs of water from Farakka which was needed to save Calcutta Port and that India would

have to restrict the use of the Ganga water to only 10% until the plan to augment the Ganga flow was accepted. Other Indian newspapers also questioned the accord. Experts also criticized it in the meetings of the Bengal National Chamber of Commerce, Indian National Chamber of Commerce and other organizations. Debesh Mukherjee ex-General Manager of the Farakka Barrage also held that the accord would not achieve aims.

The joint declaration of May, 1974 and the agreement of April 1975 were not followed in letter and spirit before the 1977 agreement was signed. Detailed observations in respect of gauge, discharge etc. to be made in the Bhagirathi-Hooghly in India and in the Garai-Madhumati-Dhaleswar, the Bhairab-Pussar and the Padma-Meghna in Bangladesh as well as hydrographic surveys and navigation track surveys, salinity, rainfall data, exchange of information through Joint River Commission to study the effects of increased lean-season flow in the Bhagirathi-Hooghly and corresponding decrease in the Padma-Meghna and its tributaries from 1975 to 1977 were not considered before signing the 1977 agreement.

In spite of all these odds, the long-standing dispute between India and Bangladesh was somehow resolved through the Ganges Water Agreement for sharing of water in the lean season from 1st January to 31st May, each year. Both sides made substantial concessions to safeguard respective interests. For India, the Agreement was quite detrimental to the interest of Calcutta Port as the minimum requirement of 40,000 cusecs was gradually reduced to 20,500 cusecs by end-April with provision for further reduction during abnormally low-flow season, as provided in Article II. From March to May, tides in the Hooghly are quite high and the water level reaches the maximum. Enormous quanties of sand and silt move upstream with the flow tide and much of the same get deposited on the bed. As upland discharge falls in these months, the ebb flow is not strong and siltation occur. The reduced discharge does not give enough force to the ebb current and therefore, does not help scour the deposited silt which gets continuously deposited and reduce the river's capacity. Thus, the interest of Calcutta Port was not protected in the Agreement. India had to remain satisfied with the low discharge of 20,500 cusecs, which is about 49% less than the minimum requirement of 40,000 cusecs. Moreover, India's original demand of sharing water from March to May was compromised in favour of sharing the same in fully dry season from January to May. However, India's demand for a short-term agreement was met, as it was valid for five years only and could be reviewed after three years, as provided in Article XIII. Moreover, New Delhi's demand for a long-term solution to the problem by augmenting the dry-season flow of the Ganga at Farakka was safeguarded in Articles – VIII to X. Bangladesh's demand of the entire 'historic flow' of the river was not fulfilled and it had to divert 20,500 cusecs to India in the driest period. Dhaka's subsequent demand for 44,000 cusecs during negotiation was also curtailed to 34,500 cusecs in driest period, a reduction by about 22%. Moreover, its original demand of water-sharing from November to June was scarified. Its demand for a long-term agreement of 25 to 30 years validity was not accepted. In terms of legal language, the Agreement was in the nature of a *'Pactum De Contrahendo*', i.e. 'an Agreement to conclude a final agreement at a later date.'

The agreement had three parts; Part A dealt with arrangement for sharing of the Ganga water at Farakka; Part B with long-term arrangements and Part C with review and duration. In a broad sense, the agreement was unsatisfactory, as the Part A dealt with the available water resource at Farakka, without going into reasons for its gradual decrease and suggesting action and to plug loopholes, where ever possible. The realities were not considered and the development activities of the two countries were either overlooked, or side-tracked. Technical considerations were over-shadowed by political motives for achieving success in foreign affairs within a short time by both the Governments. It is a fact that the lean-season discharge in the Ganga was falling for many reasons, one of which was the increase of withdrawal by The States in the upper reaches. The understanding was reached within a year of the Janata government coming to power in Delhi by giving substantial concession to Bangladesh at the cost of India's interests. Out of these divisions, the driest period of three 10-daily periods of last two in April and first one of May, need special mention, as the concessions were maximum during this period (more than 62% to Bangladesh). National interest including that of Calcutta Port was completely overlooked at the cost of improving bilateral relations. The rigidity, followed so long by both the Governments (the Congress in India and the military rule in Bangladesh) was diluted by the Janata government. In fact, India was willing to give more concessions, according to a statement by a secretary in Indian's Finance Ministry associated with the 1977 negotiations, as quoted by 'Ben Crow'.

> The new government was willing to make more concessions. They wanted to project an image of having achieved success in foreign policy in a short time. What they did with Pakistan and Nepal amounted to getting over some mental blocks. But with Bangladesh, there was a calculated sacrifice of the national interest with a view to achieving wider purposes. We thought that if the biggest irritant was removed, the climate would change.

On the country, concession by Bangladesh was quite small. Their demand for 44,000 cusecs in dry season: was cut down to 34,500 cusecs, with a 'distress clause', which was favourable to Bangladesh. Figure 10.1 and Table 10.1 show, how concessions were allowed by India to Bangladesh against very small concessions given by the latter.

Table 10.1 shows that the percent share of India from the total available flow at Farakka varied from 42.9 in January to 37.3 in the last 10-daily in April. The percent share of Bangladesh in the corresponding period varied from 57.1 to 62.7, i.e. in the driest period of last 10-daily of April. The percent share of Bangladesh was higher than India's and also of other periods of the season. Regarding concessions by India and Bangladesh against their demands of 40,000 cusecs and 44,000 cusecs respectively, that by India, from second 10-daily in January to last 10-daily in April varied from 1.7 % to 35.4%. In the same period, Bangladesh gained from 8.1 to 2.9 in second 10-daily in January to first 10-daily in February after a concession ranging from 2.1 to 17.3. Thus India's sacrifice was more than Bangladesh's, particularly in the leanest season in end of April. Bangladesh demanded restoration of the so-called 'historic' or 'natural' flow into the Ganga without human Interference, i.e. as it was pre-barrage, but in the context of global scientific and technical advances, a developing country like India should not have remained a silent spectator to the

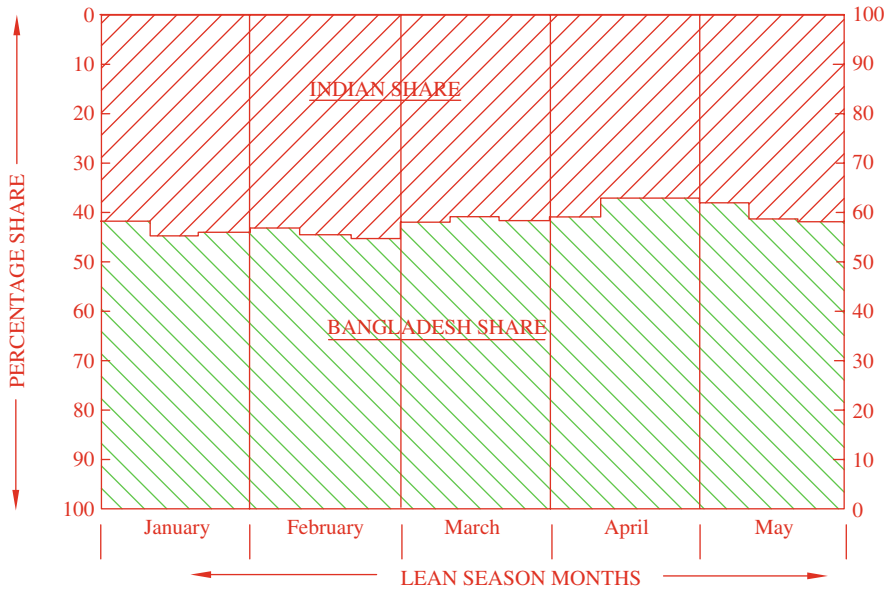

Fig. 10.1 Share of lean season flow of Ganga at Farakka between India and Bangladesh

Table 10.1 Percentage sharing of flow by India and Bangladesh at Farakka

Period	Flow reaching Farakka (Cusecs)	Percentage share and [Gain(+)/Concession(–)] given	
		India (40,000)	Bangladesh (44,000)
January: 1–10	98,500	40.6(Nil)	59.4(+14.7)
11–20	89,750	42.9(–1.7)	57.1(+8.1)
21–31	82,500	42.4(–6.1)	57.6(+4.3)
February: 1–10	79,250	41.6(–8.9)	58.4(+2.9)
11–20	74,000	42.6(–11.5)	57.4(–2.1)
21–28/29	70,000	43.9(–13.2)	56.1(–6.8)
March: 1–10	65,250	41.0(–20.3)	59.0(–8.4)
11–20	63,500	40.2(–22.8)	59.8(–9.5)
21–31	61,000	41.0(–24.6)	59.0(–13.1)
April: 1–10	59,000	40.7(–27.1)	59.3(–15.3)
11–20	55,500	37.4(–34.7)	62.6(–16.7)
21–30	55,000	37.3(–20.3)	62.7(–17.3)
May: 1–10	56,500	38.1(–32.7)	61.9(–16.0)
11–20	59,250	40.5(–27.0)	59.5(–14.8)
21–31	65,500	40.8(–20.3)	59.2(–8.0)

caprice of Nature and let its growing population to suffer. Therefore, the diversion of at least 40,000 cusecs of water into the Bhagirathi-Hooghly by blocking its natural flow by a barrage at Farakka was direly needed for the resuscitation of Calcutta Port, but the agreement did not fully provide for it. Figure 10.1 shows the disparity in the division of the water, considering the flow at Farakka.

Another point in Part A needs a special look. The agreement was drawn on the basis of past records of flow, reaching Farakka from 1948 to 1973 except for four years, from 1974 to 1977; the reasons were not mentioned anywhere. In fact, the flow reduced further in those four years, but was not reflected in the Agreement. It was based on the total volume of water to be shared. The share of India varied between 42.9% and 37.3% but not on a linear distribution. The distribution was erratic, because it was the flow likely to be available at Farakka. This left a scope for adjustments and complication in the operation of the gates of the barrage as well as of the head regulator. Had it been a linear distribution, based on actual flow at Farakka, in a ratio decided by the representatives of both countries and reflected in the Agreement, its implementation on the ground as well as the operation of the barrage and the head regulator gates could be much easier.

Both sides were convinced of the scarcity of dry-season flow to meet respective requirements which needed minimum of 84,000 (40,000+44,000) cusecs in the leanest season. They realized the need for augmentation of the flow through some other means. In fact, the Joint Rivers Commission (JRC), constituted in 1972 with representation of both the governments, aimed at augmentation of the Ganga flow through suitable schemes and actions, initiated much earlier. Thus, both sides realized the necessity of developing water resources in the Ganga basin for increasing the dry season flow.

Part B of the Agreement, dwelling on long-term arrangements provided a scope for augmenting the flow. The JRC was entrusted with taking appropriate action, proposed or to be proposed by both countries at a later date. Both had already formulated their proposals for augmentation which were under consideration of the JRC. We shall see later, how the proposals of the two countries were divergent and invited conflicts between them, leading to a deadlock.

As regards Part C, dealing with 'review and duration', the agreement was short-term with five years' validity, from the date of coming into force; it could be extended for a specified period by mutual consent, as provided in Article XV. The provision for review was made in Article XIII, after three years from the date of effect, to be made on the basis of past working, impact, implementation and progress of the arrangements, specified in Parts A and B, as mentioned in Article XIV. We shall see later how this review has become fruitless in spite of the provision for extension of the agreement for another five years.

There were two side-letters to the agreement–one from Bangladesh and the other from India, both dated 5th November 1977, confirming a point, raised by Bangladesh. It related to the proposal on augmentation and the scheme, or the schemes, for building storages in the upper reaches of the Ganga in Nepal.

In short, the dispute arose owing to the shortage of dry-season flow in the Ganga and on its sharing ratio, but the excessive initiative and hurry by the Janata Government in Delhi to improve India's relation with the new republic and compromised national interest in the agreement reflected the main motto of achieving political objective of scoring over the previous Congress regime, led by Prime Minister Indira Gandhi. It became clear, why the Congress Government was so rigid on the demands of the military rulers of Bangladesh and was dragging its

feet on making an agreement on sharing of the Ganga water. The minimum period of operation of Farakka feeder canal with 40,000 cusecs throughout the year for five years after commissioning of the barrage, as was decided in the cabinet meeting had not been followed in practice, leaving no scope to study its effects on Calcutta Port and on the Bhagirathi-Hooghly and to curtail the discharge from the present 40,000 cusecs, if found harmless and not injurious to the health of Calcutta Port. In a sense, the Farakka Barrage Project was never tested in field for a reasonable period of at least five years and the huge expenditure on the project became virtually infructuous.

The Agreement had other flaws too. Part A dealt with interim sharing of water, available at Farakka, based on 75% availability from observed records between 1948 and 1973. A pre-determined flow which might be available at Farakka in the next five years was considered for sharing at a certain ratio, not fixed in different 10-daily periods between January and May, every year. The minimum flow, likely to be available in the last 10-daily period of April (21st to 30th) was estimated at 55,000 cusecs, out of which India would get 20,500 cusecs (about 37.3%) and Bangladesh 34,500 cusecs (about 62.7%). Another provision in Article II was of great advantage to Bangladesh. In an exceptionally low-flow season, the flow toward Bangladesh would not go below 27,600 cusecs (80% of 34,500) in the last 10-day period of April. In fact, this provision was made for any 10-daily period, specifying that the flow toward Bangladesh would not be below 80% of the flow, shown in the schedule. It meant that if the flow at Farakka came down to 40,000 cusecs in the last 10-days period of April, Bangladesh would still get 27,600 cusecs and India would get the remaining 12,400 cusecs. We shall see later, whether this actually happened at Farakka.

Under Article IV, a Joint Committee of the representatives, nominated by two governments set up teams at Farakka and Hardinge Bridge (Bangladesh) to observe and record daily flows at those places. Accordingly, the observation teams were set up, every year, since 1978. Bangladesh kept a team at Farakka and India at Hardinge Bridge; they worked in association with respective team of the other country. Observations at the two places were done jointly, from 1978 to 1982 in a cordial atmosphere.

On Part B the future of the sharing of the Ganga water primarily depended. The Agreement provided that the JRC would carry out investigation and study schemes for augmentation and will submit recommendations to the two governments for consideration within three years. This part, however, remained unresolved for the full five-year term of the Agreement. A detailed discussion on this will follow, but this much can be said here that the basic question of increasing the dry-season flow could not be addressed in five years, in spite of prolonged negotiations in the Joint Rivers Commission (JRC). Thus, the negotiations reached a stalemate by the end of 1982. To continue the discussions on this issue and also on the sharing arrangement of water, a Memorandum of Understanding (MOU) was agreed between India and Bangladesh in October 1982 which the two governments signed on 7th October 1982 in New Delhi during the visit of General H. M. Ershad, President of Bangladesh. This will also be discussed afterward.

Although Part C provided review by the two governments after three years from the date of effect of the Agreement and further review within six months before its expiry, as agreed to by two governments, no worthwhile review was done; only a Memorandum Of Understanding (MOU) was signed at the end of the agreement tenure in 1982.

MOUs of 1982 and 1985

By the time the Agreement was going to expire (after the dry season of 1982), no unanimous decision on augmentation was arrived at by the Joint Rivers Commission, necessitating either to extend the validity of the 1977 Agreement, or to sign another. In October 1982, H. M. Ershad, then President of Bangladesh, visited New Delhi and discussed the matter with Indira Gandhi, then India's Prime Minister. They discussed, in the context of actual experience, gained by the two sides on the working of the 1977 agreement which was due to end on 4th November 1982. They agreed that satisfactory and durable solution on augmentation of dry season flow in the Ganga near Farakka had not emerged and that fresh efforts were necessary to clinch a solution. They also recognized that the basic problem was inadequate flow of Ganga water at Farakka in lean season for which both countries had to sacrifice much of their interests. Therefore, it was immediately necessary to arrive at an equitable formula for sharing Ganga water, available at Farakka through a Memorandum of Understanding (MOU). It was also a prime necessity that both the countries agreed unanimously for a long-term augmentation of the flow of the Ganga. Therefore, the two leaders asked their experts to expedite studies of the economic and technical feasibility of the schemes (to be discussed later), proposed by either side. It was decided that the Joint Rivers Commission would complete the pre-feasibility study and find an optimum solution within 18 months of signing of the MOU. The JRC would examine and accept the decision, after which the two governments would implement it. A sharing ratio of water available at Farakka was agreed to by the two governments in this period. Both sides further agreed that in the case of exceptionally low flows in either of the next two dry seasons, the two governments would immediately consult each other and find out ways and means to minimize the burden on either country. A copy of the MOU is enclosed at Appendix C.

The period of two dry seasons, up to which the MOU of 1982 was valid, was barren, because no unanimous decision by the JRC on the proposal for augmentation of the Ganga water at Farakka could be taken.

In 1982, India's political situation changed dramatically. Indira Gandhi returned to power, heading the Indian National Congress. Two years later, on 24th October 1984, she was assassinated and her elder son, Rajiv Gandhi took over as the Prime Minister. Mr. Gandhi and President H. M. Ershad met at Nassau, Bahamas in October, 1985 and arrived at an understanding, under which the Irrigation Ministers

of two countries met at New Delhi from 18th to 22nd November 1985 to evolve the terms of reference of a joint study by the Joint Committee of Experts (JCE) of water resources, available to both countries to identify options for the water-sharing for mutual benefit, including a long-term augmentation scheme. They also agreed to sign a MOU for sharing the Ganga water at Farakka for three years, commencing from the dry season of 1986 on the same terms as of the 1982 MOU. It was further agreed that the JCE would study two aspects – (a) sharing available water resources, common to both countries; and (b) augmentation of the dry-season flows of the Ganga at Farakka. The study was to be completed in 12 months, at the end of which a summit-level meeting between the two countries would take place to approve it. It was also agreed that an interim sharing ratio would be followed for next three dry seasons (1986–1988) with the same joint observation and monitoring that in case of exceptionally low flows in any of them, the two governments would hold immediate discussion and decide how to minimize the burden to either country.

Afterwards, a Secretary-level meeting of the two countries, held on 22nd November 1985, defined the sharing ratio in the event of exceptionally low flow at Farakka. It was decided that up to, and above, 75% of the standard flow for a corresponding 10-daily period, the release to Bangladesh would be pro-rata. However, if the flow at Farakka fell below 75%, the burden will be shared by India and Bangladesh on 50–50 basis. The copy of the MOU is enclosed at Appendix D.

Discussion on MOUs

All these years, joint observations at Farakka and Hardinge Bridge continued in a cordial atmosphere, but the JRC could not arrive at a decision on augmentation of the Ganga flow at Farakka. The 1982 and 1985 MOUs were nothing but extensions of the terms of the 1977 Agreement with slight modification of sharing ratios at certain 10-daily periods in January, February, March and May, which figure in Table 10.2.

The table shows that there were some changes in release of water to both India and Bangladesh in some periods of the lean season in the MOUs of 1982 and 1985, compared to those in 1977 Agreement. However, there was no change in the MOUs of 1982 and 1985.

Thus, the modifications were the minimum, with very little effect on either side. The two MOUs were extended to give an opportunity to the JRC and experts of both countries to come to an understanding on the proposal for augmentation of flow at Farakka. Other terms and conditions remained practically the same, except in case of exceptionally low flow seasons, where the burden on India was substantially reduced. The concession, given in the MOUs gave some relief to India. The two MOUs showed the desire of both countries to come to a solution of this long-standing dispute in a spirit of ‘bilateralism’ and without involving any third country, but this amicability disappeared after 1988 and no further agreement, or MOU, came up until 1996, as we shall see soon.

Table 10.2 Comparative study of discharge to be shared between India and Bangladesh as per agreement, 1977, MOU, 1982 and 1985

Period	Flow reaching Farakka (Cusec)	Withdrawal by India (Cusec)			Withdrawal by Bangladesh (Cusec)		
		1977	1982	1985	1977	1982	1985
1	2	3	4	5	6	7	8
January 1–10	98,500	40,000	40,000	40,000	58,500	58,500	58,500
11–20	89,750	38,500	38,000	38,000	51,250	51,750	51,750
21–31	82,500	35,000	35,500	35,500	47,500	47,000	47,000
February1–10	79,250	33,000	33,000	33,000	46,250	46,250	46,250
11–20	74,000	31,500	31,250	31,250	42,500	42,750	42,750
21–28/29	70,000	30,750	31,000	31,000	39,250	39,000	39,000
March 1–10	65,250	26,750	26,500	26,500	38,500	38,750	38,750
11–20	63,500	25,500	25,500	25,500	38,000	38,000	38,000
21–31	61,000	25,000	25,250	25,250	36,000	35,750	35,750
April 1–10	59,000	24,000	24,000	24,000	35,000	35,000	35,000
11–20	55,500	20,750	20,750	20,750	34,750	34,750	34,750
21–30	55,000	20,500	20,500	20,500	34,500	34,500	34,500
May 1–10	56,500	21,500	21,500	21,500	35,000	35,000	35,000
11–20	59,250	24,000	24,250	24,250	35,250	35,000	35,000
21–31	65,500	26,750	26,500	26,500	38,750	39,000	39,000

Political Instability

The political situation in the two countries impinged on water-sharing agreement. On 15th August, 1975, President Mujibur Rehman was assassinated and a military junta took over in Dhaka. A new government with Khondokar Moshtaq Ahmed as the new President of Bangladesh took office. The cordiality between the people of two countries, which developed since the freedom struggle in 1971 evaporated and the governments as well as the people on both sides began to eye each other with suspicion. Moshtaq Ahmed was an anti-Indian politician and did not like friendly co-operation between the two countries in Mujib's regime. However, his tenure was short and on 7th November, 1975, following a military coup, a new ruling elite came to power in Dhaka, led by Ziaur Rehman, a senior Army officer and a former freedom fighter. The government of Bangladesh became stable thereafter for about $5\frac{1}{2}$ years but instability returned after the assassination of Ziaur Rehman in May 1981, catapulting another senior Army officer, H. M. Ershad to power.

In India's March, 1977 general election, Indira Gandhi and her Congress Party were badly beaten by the Janata party, led by Morarji Desai. The new government was eager to develop and strengthen co-operation with Bangladesh on the Ganga water-sharing at Farakka and signed an agreement with Dhaka in November, 1977. The accord, reached in April 1975, was for testing the newly-constructed dry section of the feeder canal, wherein the release of water was gradually increased from 11,000 to 16,000 cusecs. More precisely, it related to the depth of the canal, which was allowed to adjust from about 3 m(10′ feet) to 3.5 m(12 feet) depth from 21 April

to 31 May 1976, as against the excavated depth of 6 m. This test-running was essential for avoiding possible damage to the dry canal and therefore, the accord for maximizing release cannot be considered for future lean seasons. After 31st May 1975, the discharge in feeder canal gradually increased up to its design-capacity of 40,000 cusecs in presence of the representatives of Bangladesh. Thus, an agreement by the two countries was absolutely necessary on the sharing of the lean season discharge at Farakka.

The Indian Parliament witnessed noisy scenes in 1978, when the Congress Party, then in opposition, described the agreement of 1977 in the *Rajya Sabha* (upper house) as a sell-out of India's interest. Indira Gandhi, who was the opposition leader in the *Lok Sabha* (House of Representatives), said: 'If the Government does not ensure adequate water supply to Calcutta Port, it will affect our national interest'.

The people and the Government of West Bengal, at that time formed by a coalition of Left parties, led by Jyoti Basu of the Communist Party of India (Marxist), opposed the accord vehemently, as they felt that the interests of the State and the people were compromised. They wanted the increased flow of the Ganga water into the Bhagirathi-Hooghly and save Calcutta Port. An all-party delegation of the State MPs, led by Prabhash Chandra Roy, State Minister for Irrigation and Waterways, called on S. S. Barnala, India's Minister of Agriculture and Irrigation on 15th September 1977 and submitted a memorandum on the Farakka Barrage issue. Mr. Barnala assured them that the interest of the Calcutta Port would be kept in view. The State Congress Party also sent a delegation led by Mrs. P. Mukherjee to the Prime Minister who iterated his awareness of the problems of the port. Mr. Desai also assured Jyoti Basu that the city's interest would not be sacrificed by the Farakka Agreement.

When the Agreement was finalized, neither West Bengal Government, nor the Farakka Barrage Project Authority, nor Calcutta Port Trust was associated with it. They were kept in the dark, which gave rise to resentment in all concerned quarters and the State government. After finalization, Jyoti Basu told reporters that West Bengal would protest to the Centre against the Agreement, because Calcutta Port could not be saved, unless 40,000 cusecs of water were available from Farakka Barrage. A. B. Vajpayee, then Foreign Minister of the Janata Government (later Prime Minister from 1999 to 2004) criticized the previous Congress regime for signing two specific agreements with Bangladesh – the first in 1974 under which India was debarred from commissioning the barrage without the consent of Bangladesh and the second was the 1975 short-term agreement, under which India was committed to draw between 11,000 and 16,000 cusecs. Mr. Vajpayee added that 40,000 cusecs were India's maximum need but in lean season, when the flow went down to 55,000 cusecs, withdrawal of 40,000 cusecs would leave only 15,000 cusecs for Bangladesh and none in the world could possibly appreciate this.

The public reaction in Bangladesh was not known but expectedly, the leadership in Bangladesh was demoralized for failing to get a satisfactory solution of the water-sharing issue in an international body, like the United Nations. A much-publicized Quixotic march of thousands of Bangladeshis, led by a firebrand trade union leader, Maulana Bhasani to demolish the barrage with tongs and hammers in 1977 was

cancelled at the last moment and ended in fiasco. The leaders did not know, how the interests of Bangladesh could be protected. As Khursida Begum wrote in her book, the experts of Bangladesh, failing to get the expected mediation of the international body, were in a restless state of mind, as to how to deal with India and to protect their country's interest. They felt, at least an agreement was necessary.

When the agreement was on the anvil, B. M. Abbas, a leading expert of Bangladesh expressed his view on the Farakka Agreement in a conversation with the President Ziaur Rahman:

> I was, by the time, quite anxious to get the Agreement finalized. The President at one stage, enquired, what would happen, if India did not renew the Agreement after five years. I said, who could say what would happen in future. The President did not commit himself immediately. Perhaps sensing my anxiety and to indicate his mind, he added that I need not worry; everything would be all right by the grace of Allah.

From the above, it was obvious that both sides were keen to find a workable formula for sharing the Ganga water at Farakka, even for a short period. India wanted not only to protect and further her interests but also to maintain good relation with a new country in the neighbourhood, even by sacrificing her own interests, to some extent. For this reason only, the Government of India agreed to release more than 60% of the Ganga flow in the leanest months of March and April. Bangladesh was satisfied that her interests received priority and the government was successful in signing such an agreement.

Ben Crow in his book, 'Sharing the Ganges' stated that it was the decisions of the Janata government in India that made the understanding possible.

He added that the agreement reflected the concerns of the time and defined the development of water resources of the Ganga basin solely in terms of increasing the dry-season flow. As shortage of water had caused the dispute to arise, the agreement, in its long-term arrangements of augmentation, maintained this focus. There was no provision for general regulation and development of the river's resources and little concern for floods. He further stated that even with this concentration on increasing the dry-season flow, subsequent discussions between the two governments did not materialize. Bangladesh refused to embark on feasibility studies of alternative schemes, unless Nepal was allowed to participate in the negotiations. India was unwilling to allow Nepal's participation, because the Indian government insisted that augmentation was a bilateral matter.

The political will of both the countries helped their leaders solve the long-standing problems of sharing the Ganga water at Farakka. Though it was originally technical, it turned out to be a political problem, affecting diplomatic relations between them. The goodwill gesture by India by agreeing to substantial reduction of the Ganga water to 20,500 cusecs, scaling down the original demand for 40,000 cusecs was more from political than from technical consideration. The concession by Bangladesh government by accepting 34,500 cusecs as against the original demand of 44,000 cusecs is a much lesser sacrifice, because many of their other demands were met. It has to be kept in mind that India's three joint rivers

– Bhagirathi-Hooghly, the Bhairab-Jalangi, and the Mathabhanga-Churni once carried substantial flow of the parent river, the Ganga-Padma but they were dying in the natural cycle with their mouths shut by silt. The same natural process was drying the Gorai-Madhumati of Bangladesh and could dry it more, even if the Farakka barrage was not constructed in 1975 and all its water could flow toward the sea. Therefore, the decay of these rivers was not beneficial to either country and Bangladesh cannot claim the entire water of the river for development of the Gorai-Madhumati and the region on either side. This is another justification for the construction of Farakka Barrage to develop water resources in this region.

Effects of the Agreement on India

Before the induction of upland discharge through the feeder canal into the Bhagirathi, the flow in the river was extremely irregular, quite high from mid-July to mid-September but in rest of the year, nominal, or nil. Soon afterward, the river's morphology began to change; its width, depth, cross-sectional area and cubic capacity improved up to 1977 but from next year, these began to reduce. In $2\frac{1}{2}$ years – from May 1975 to December 1977, the capacity for net tonnage handling of materials in Calcutta Port got a boost. Prolonged flow from upland deepened the channel and increased navigable depths up to the estuary below, required less dredging and the salinity in water in the port area went low. The entire river complex was in a state of flux and adjusted to the new morphological parameters. This took time, natural for a mighty river, because at least five years of ceaseless flow of 40,000 cusecs through the Bhagirathi-Hooghly, as recommended by experts, could improve it in all fronts, but this was not to be owing to chinks in the Agreement. The average decade-long discharge through the Farakka feeder canal and below from May 1975 to May 1985 figures in Table 10.3.

The Table 10.3 shows that though the percentage share of water in 1976 and 1977 i.e. before the Agreement, between India (River Bhagirathi) and Bangladesh (the Ganga) for the leanest period from March to May, from 46 to 48 for India and from 52 to 54 for Bangladesh, it fell to 36 to 40 for India between 1979 and 1985 (The agreement was partly implemented in 1978). Major flow was allowed for Bangladesh in the leanest months, the percentage varying from 60 to 64. The distribution of the total flow in these years has been shown in Table 8.2 ante. After the agreement period, 1980 was the driest year and the discharge in March and April was abnormally low. The minimum discharge was 1,058 cumecs, or 37,353 cusecs on 3rd April 1980 and India's share on that day was 304 cumecs, or 10,743 cusecs, which was about 29% of the total flow only. It was below 1,132 cumecs, or 40,000 cusecs, for 11 days from 24th to 27th March and from 31st March to 6th April 1980. The average percent share in the leanest months, March to May in 1980 between India and Bangladesh was 36 and 64 and in the full lean season, January to June, it was 32 and 68, respectively. The large difference in share that year shows the extent of compromise by India under the agreement, sacrificing national interest and

Table 10.3 Average discharge through River Bhagirathi and Ganga downstream (Cumecs)

Year	Period (River Bhagirathi)				Period (Ganga downstream)				Remarks
	Jan to June		March to May		Jan to June		March to May		
1	2	3	4	5	6	7	8	9	10
1975	406	–	406	–	–	–	–	–	Pre-
1976	(May	–	–	–	–	–	–	–	Agreement
	only)	45%	–	–	–	–	–	–	period
1977	1015	45%	1001	47%	1220	55%	1160	53%	
	973		901	46%	1174	55%	1050	54%	
1978	1039	47%	1004	48%	1180	53%	1070	52%	Post
1979	1027	38%	979	39%	1685	62%	1552	61%	agreement
1980	666	32%	516	36%	1421	68%	910	64%	period
1981	928	39%	804	39%	1478	61%	1252	61%	
1982	940	32%	904	40%	2018	68%	1374	60%	
1983	839	40%	689	39%	1275	60%	1068	61%	
1984	923	24%	727	40%	2885	76%	1089	60%	
1985	845	41%	605	39%	1220	59%	960	61%	

the interest of Calcutta Port. That year, the relevant clause of distress-sharing under Article II had to be applied, as per agreement, entailing a great sacrifice for India. Naturally, the improvement which could have occurred near Calcutta Port could not take place and port facilities declined in all fronts. The actual 10-daily distributions of water against the agreement quantity in 1980 are shown in Table 10.4.

The original demands of two countries were quite high – 1,132 cumecs for India and 1,246 cumecs for Bangladesh – but as the lean-season discharge at Farakka was low, the agreement provided for less discharge in the leanest month of April. However, the actual availability in 1980 was far below the quantity, given in the Agreement. Therefore, the available quantity was further reduced which reflected in Table 10.5.

In 1981, 1983–1984, 1986 and 1988, the available discharge at Farakka in the lean season was much less than that in the agreement. Thus, it proved to be theoretical than practical, though based on 75% availability of prototype data between 1973 and 1984. It also did not envisage that either side was bound by its clauses to ensure that this quantity would be available in lean season at Farakka. However, the fact remained that the actual availability of water at Farakka between 1980 and 1989 in most of the years was much less than that in the agreement and therefore, each country had got its share of this less quantity as per the ratio fixed. This was the *fait accompli* and both countries had to share the burden.

As a result, the movement of ships to and from Calcutta port as also the draft in the Bhagirathi-Hooghly decreased since 1978. At many places on the river – Katwa, Mayapur, Kalna and Samudragarh – the water went so down that even low-draft vessels (1.5 m. or so) could not ply in March and April. New *char* lands formed, following fall in discharge in the lean season. Dredging between Calcutta and Hooghly

Table 10.4 Actual 10-daily flow distribution against agreement quantity (cumec) of 1980

Period	Agreement quantity	Actual quantity available	Distribution			
			India		Bangladesh	
			Agreement	Actual	Agreement	Actual
1	2	3	4	5	6	7
January 1–10	2789	2681(–4)	1132	1011(–11)	1656	1670(+1)
11–20	2541	2278(–10)	1091	976(–10)	1451	1302(–10)
21–31	2336	1724(–26)	991	641(–35)	1345	1083(–19)
February1–10	2244	1445(–36)	934	393(–58)	1309	1052(–20)
11–20	2095	1379(–34)	892	412(–54)	1203	967(–20)
21–28/29	1982	1369(–31)	871	481(–45)	1111	888(–20)
March 1–10	1847	1356(–27)	757	482(–36)	1090	874(–21)
11–20	1798	1288(–28)	722	433(–40)	1076	855(–21)
21–31	1727	1134(–34)	708	318(–55)	1019	816(–20)
April 1–10	1670	1117(–33)	680	322(–53)	991	795(–20)
11–20	1571	1231(–22)	587	440(–25)	984	791(–20)
21–30	1557	1254(–19)	580	458(–21)	977	796(–19)
May 1–10	1600	1568(–2)	609	609(–0)	991	959(–3)
11–20	1678	1838(+10)	680	732(+8)	998	1106(+11)
21–31	1854	2085(+12)	757	849(+12)	1097	1236(+13)

Table 10.5 Minimum quantity of water available against original demand (cumecs)

Original demand		Minimum as per agreement		Minimum as available	
India	Bangladesh	India	Bangladesh	India	Bangladesh
1132	1246	580 (37%)	977 (63%)	458 (36.5%)	796 (63.5%)

point, – which reduced substantially in post-Farakka period had to be increased from 1980.

The Calcutta Port is about 230 km from the sea face of the Hooghly. In pre-Barrage days, maintenance of this long navigation channel with 15 major sand bars was a challenging task. Of the total length, the upper reach from Calcutta to Diamond Harbour is about 75 km and the lower reach from Diamond Harbour to the Sandheads is about 155 km. There are 17 sand bars on this course, which hinder navigation. This channel required constant dredging in pre-Barrage days, as it used to shift its courses in flow and ebb tides in various alignments. The bars also changed directions in two tides in a day, as also in different flow conditions owing to seasonal changes. The alluvial river-bed as well as bank materials, coupled with unpredictable morphological changes in the estuary aggravated the problems of Calcutta Port, requiring manifold increase in the volume and cost of dredging.

The diversion of assured 40,000 cusecs in the river continuously for at least five years, as advised by Dr. K. L. Rao, India's Minister of Irrigation and other

Table 10.6 Annual quantum of dredging in the Hooghly river below Calcutta

Year	Dredging between Calcutta and Hooghly point (Mm^3)	Dredging at Balari bar (Mm^3)	Remarks
1	2	3	4
1972–1973	1.92	0.30	Pre-barrage period
1973–1974	2.20	0.62	Do
1974–1975	1.12	1.53	Do
1975–1976	1.43	1.39	Post-barrage period
1976–1977	0.88	2.03	(Water released in feeder canal from April, 1975)
1977–1978	0.84	2.48	Post-agreement
1978–1979	0.48	0.79	Period
1979–1980	0.57	2.22	
1980–1981	0.42	1.68	
1981–1982	0.46	2.62	
1982–1983	0.21	2.82	
1983–1984	0.41	2.42	
1984–1985	0.38	1.61	
1985–1986	0.36	2.66	
1986–1987	0.28	3.33	
1987–1988	0.56	1.07	

experts could not be implemented owing to the signing of the Agreement in 1977. The assured quantity of water could flow in the lean season only for two years – 1976 and 1977 – which was not sufficient to bring about anticipated morphological changes. The quantum of dredging in the Hooghly below Calcutta Port is shown in the Table 10.6.

Table 10.6 shows, how in the pre-Barrage period, the dredging between Calcutta and Hooghly Point in 1972–1973 and 1974–1975 was much more than in the lower reach over the Balari Bar, this was reversed in the post-Barrage period. Dredging below Calcutta up to the Sandheads in pre-barrage days from 1946 to 1963 constantly increased. Below the Hooghly Point, sea-going vessels from Calcutta and Haldia harbour had to negotiate six major bars (their distances from Calcutta port in brackets), namely Balari (88 km), Jellingham (108 km), Rangafalla (115 km), Aucland (130 km), Middleton (158) and Gasper (172 km).

Experts believed, the release of 40,000 cusecs of water from Farakka Barrage could clear the entire river reach up to Haldia Port area, which is about 90 km from Calcutta port. Some experts recommended 46,000–55,000 cusecs to keep a safe margin. However, induction of 40,000 cusecs of water from June, 1975 upto December, 1977 could show some increase by way of silt removal in the river and improvement in the navigation channel had started. But after the signing of agreement in 1977 and implementation of the same from 1978 lean season, the gradual improvement in the navigation channel got a setback and the silts could move downwards from port area of Calcutta up to Hooghly point (upper estuary), started dropping over the Balari bar

area and also further down (lower estuary), which resulted in increase of quantum of dredging over Balari bar for maintaining the navigation channel. Thus, the full benefits of diversion of water from the Ganga could not be achieved as a result of the agreement. The ebb tide current did not become sufficiently strong enough during lean season in order to prevent the flood tide current, transporting sediment upwards.

The total length of the Bhagirathi-Hooghly is divided into five stretches through a line diagram in Fig. 10.2 to explain the position more clearly. The non-tidal reach of the Bhagirathi and the tidal reach below Nabadweep are sub-divided into two and three reaches, respectively. The flow direction and the sand movement are explained in the figure. Before the barrage came up, the mouth and the bed of the river gradually silted. The river bed which was once at the same level as that of the parent Ganga rose about 9 m, or 30 feet, in 1960. Plan and cross-section in Fig. 10.3(a, b) explain the position. Post-Barrage induction of upland discharge from 1978 reduced siltation in the lean season and pushed down the silt load from the upper reach and deposited it in the lower (non-tidal) and also in the upper (tidal) reaches. Because of tides, the silt that was pushed up with tide, moved down below Calcutta during ebb tides, but due to reduced upland flow-tide velocity, silt was deposited in the lower estuary below Diamond Harbour; the most affected reach was at Balari bar. As ships to Calcutta or Haldia ports came from the Bay of Bengal, they faced obstructions in the lower bars. Dredging over these bars had to be increased substantially in the post-Barrage days to keep the navigation channel clear. In spite of continuous efforts by Calcutta Port, the Balari bar silted up and the navigation channel from Haldia to Calcutta was completely blocked from 1988. An alternative navigation route had to be made thorough the Rangafalla channel on the eastern side of Nayachara island, as shown in Fig. 10.4. At present, ships to Calcutta port offload a bulk of the cargo either at Sagar island, or at Haldia, before entering Kolkata by taking a detour through Rangafalla channel.

Salinity reduced to a large extent in the Hooghly after the barrage came up, compared to that before 1975, when the water supplied to the city and the suburbs for drinking was quite brackish. Calcutta's drinking water is drawn from the Hooghly at Palta, about 24 km north of the city. The records of salinity in the dry season, kept from 1920 to 1967, indicated the condition of the river, as shown in Fig. 10.5. Salinity of the Hooghly water at Palta rose gradually. As salinity intrusion in the Hooghly depends on the quantity of sweet water in the river in the lean season, the volume of water fell fast in the course.

Besides the shortage and contamination of drinking water, boilers and other machineries of industrial units were heavily damaged for using saline water. The potable limit of about 0.2 ppt of salinity exceeded even at Serampore, about 50 km upstream of Calcutta, especially in lean seasons. However, landward migration of salinity could be arrested in post-Farakka period and the potable limit could be maintained even near Budge Budge, about 30 km downstream of Howrah Bridge in lean season, albeit for a short duration. Increase of salinity beyond potable limit was observed, even near Garden Reach just downstream of Calcutta, in lean seasons after 1977.

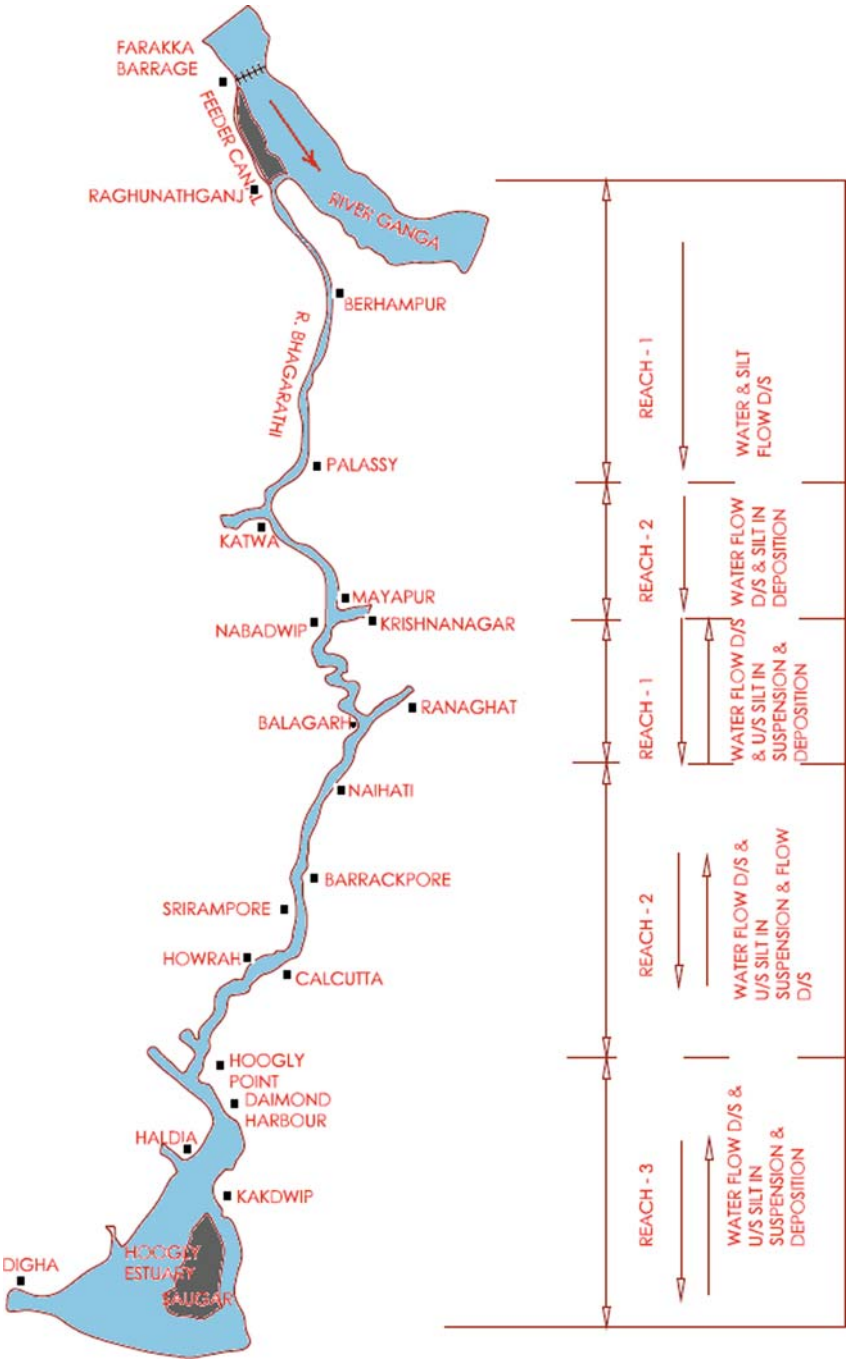

Fig. 10.2 Bhagirathi-Hooghly river system with water and silt flow in different reaches

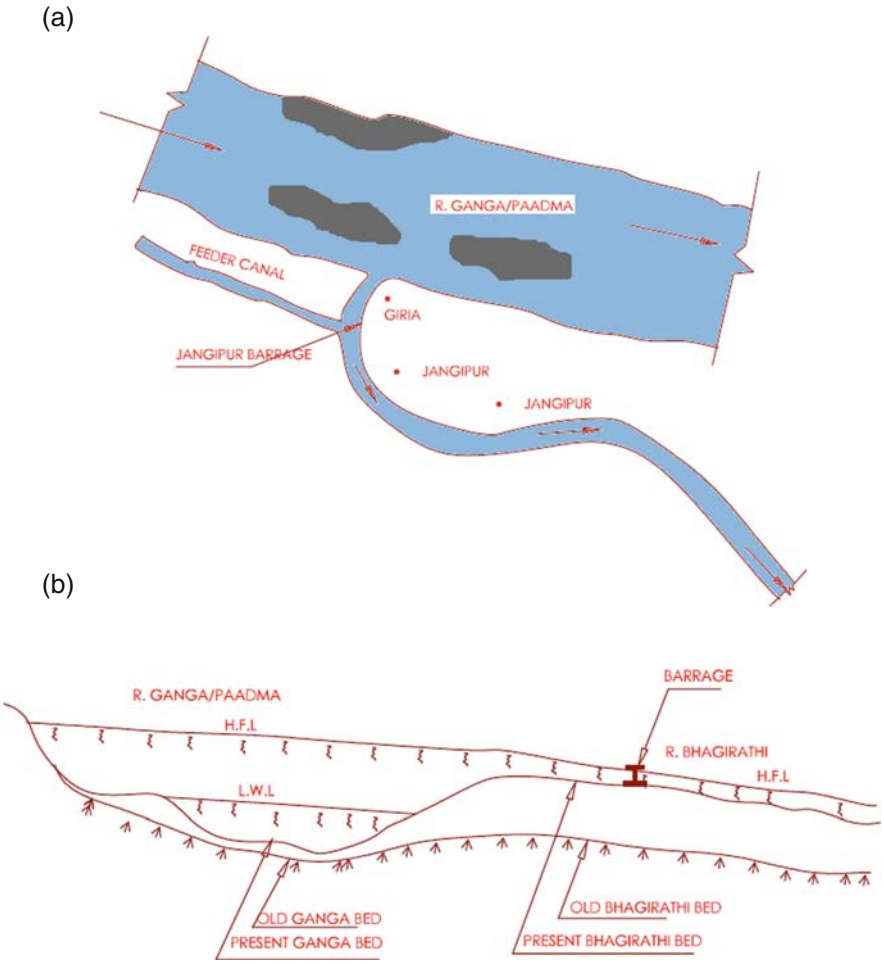

Fig. 10.3 (a) Typical plan of Bhagirathi offtake; (b) Typical cross-section near Bhagirathi offtake

Agricultural fields and orchards on both sides of the river faced severe water shortage, as the ground-water level had gone down in pre-Barrage days. Farm production came down substantially because intrusion of salinity in the soil. After the commissioning of the barrage, and owing to induction of sweet water into the river, round the year, from 1975, the ground water became saline-free and the level increased substantially which boosted farm production. However, the benefit did not last long and from 1978, after the Farakka Agreement came into effect, the discharge in the feeder canal went low in lean seasons. About 3000 km^2 on both banks in Murshidabad, Nadia, Burdwan, North and South 24-Parganas, Hooghly and Howrah districts were affected by the 1977 Agreement. The water-levels in tube and open wells went down abnormally. Low-lying areas on both sides which

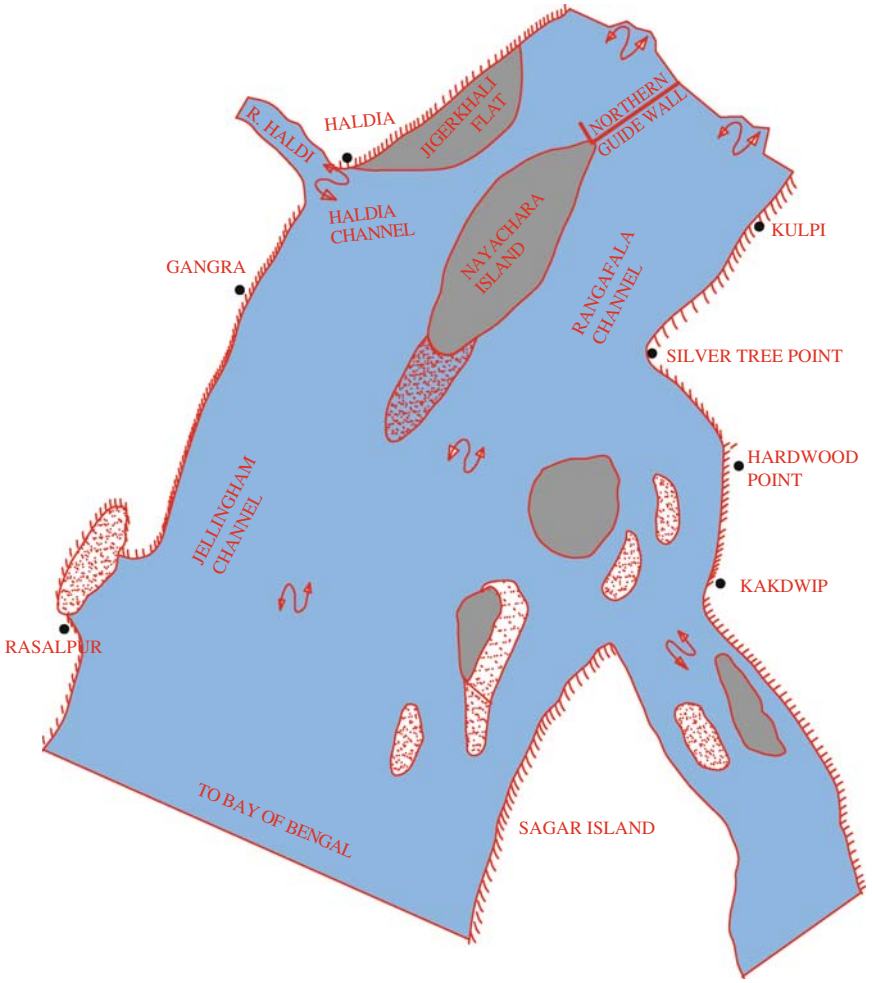

Fig. 10.4 Plan showing Haldia and channels in Hooghly estuary

remained dry before 1975 were filled by river water but afterward partly dried up in lean seasons, affecting fish and other aquatic life.

As water-level went low, the ground water table which used to be quite high in monsoon months, fell abruptly, causing erosion and bank-slips of the feeder canal as well as of the river banks. The feeder canal cross-section being unlined and artificially built with spoils of excavation gave way at many places owing to fluctuations of water-level, inside and outside the soil mass. Inspection roads on both banks were damaged at many places. The banks of the Bhagirathi-Hooghly were similarly affected at places like Jangipur, Katwa, Mayapur, Nabadweep etc. Power generation in thermal plants, located on the canal and river banks, also went down,

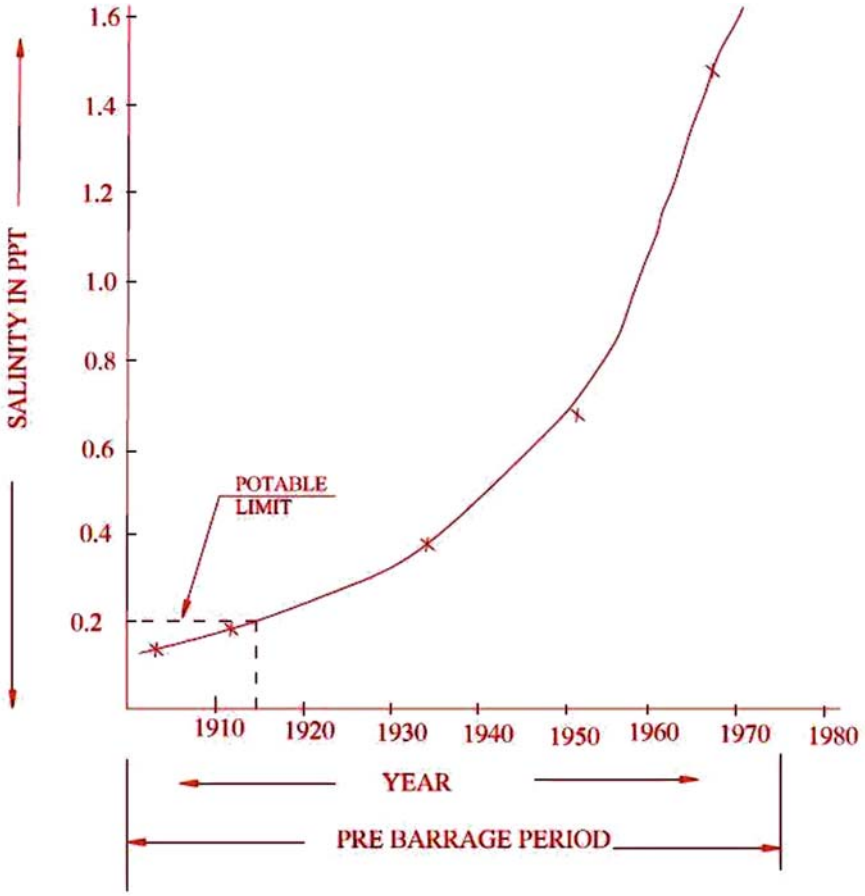

Fig. 10.5 Salinity level of Hooghly water at Palta

following decrease in water-level. The Super Thermal Plant near Farakka had to be partly shut down, every year, in March and April.

The 1977 Agreement also adversely affected the environment and ecology of the entire region. Aquatic life, commerce and transport, day and night temperature, humidity and water supply to industries etc. were all affected. Thus, the adverse effects are summarized as under:-

i) Agriculture activities hampered owing to reduced discharge and intrusion of saline water.
ii) Drinking and industrial water supply affected owing to increased salinity.
iii) Navigation hampered and trade and commerce affected owing to reduction in water level.
iv) Quantum of dredging increased substantially in the lower reach owing to siltation in the riverbed.

v) Port activities affected with reduction in cargo movement, restriction in movement of ships, delay in negotiating bars and crossings, resulting increase in port charges.
vi) Low-lying areas, e.g. ponds, nullahs, jheels (canals and lakes) etc. dried up during lean seasons affecting fish production and aquatic life.
vii) Erosion of canal and river banks increased owing to fluctuations in river and ground water.
viii) Generation of thermal power severely hampered and power plants partially shut down during lean season every year.
ix) Tube wells and open wells affected owing to decrease in water level.
x) Adverse effect on environment and ecology in the region.

Effect on Bangladesh

Like the Bhagirathi-Hooghly, other spill channels within Indian territory like Bhairab-Jalangi and Mathabhanga-Churni were heavily silted in the off-take. After closure of the Bhagirathi-Hooghly mouth in dry season, the British government in India before 1947 tried to maintain the navigation route, first through Bhairab-Jalangi and then through the Mathabhanga-Churni rivers, but both were ultimately blocked by silt at the mouths. It was obvious that the Gorai-Madhumati spill channel, passing through southern Bangladesh would have same fate as befell other channels owing to silt deposit. This was a natural phenomenon because of gradual south-eastward swing of the Ganga-Padma. The Ganga-Kapotaksha irrigation project, using high-power irrigation pumps was taken up by the then East Pakistan government at the mouth of the Gorai but faced severe siltation, even before the barrage came up at Farakka. The scheme would have irrigated the fertile alluvial soil in Kustia, Faridpur, Khulna and Jessore districts.

In spite of the above, diversion of the Ganga water into the Bhagirathi-Hooghly had adverse effects on Bangladesh. It is a riverine country; big rivers like the Padma, the Brahmaputra, and the Meghna criss-cross it and medium and small rivers as well as creeks flow through, carrying ample water for greater part of the year. It gets excessive rains, but as they occur in three to four monsoon months only, there is shortage of water in certain parts of the country in other months. The diversion of the Ganga water added to the shortage in south-western districts of Bangladesh and caused resentment and agitation in the people. The Bangladesh government protested to Delhi that reduction of the Ganga flow from 1976 caused widespread and grave damage to agriculture, industry and ecology of south-west Bangladesh. Some experts also expressed grave concern, as reflected in the views of a few of them, as reproduced below.

Amzad Hossain Khan, a water-management expert, said, Bangladesh has been losing around 5000 million taka (Bangladesh currency: 1 US$=BDT 60.00 in February 2009) annually, because of this diversion. Reduction in availability of water for irrigation affected about 60 million people. The Ganga-Kapotaksha project and many industries, like the newsprint industry in Khulna were also seriously

affected after the closure of the mouth of the Garai by silt. Increase in salinity of the river water spoilt the fertility of land. Navigation on rivers and creeks also suffered for lack of required depth of water. Some 21% of shallow tube-wells-and 42% of deep tube-wells in south-western Bangladesh went defunct because of ground-water scarcity.

M. Adel Mia, an environmental scientist in a paper titled 'Farakka Barrage: An Unprecedented Environmental Catastrophe in the Ganga Basin', highlighted adverse effects on environment and ecology of the Ganga-Padma sub-basin. He said, before 1975, the Garai, a branch of the Ganga, which used to carry about 170 cumecs of water during four monsoon months, now carried mere 40 cumecs since 1978 and that too for three months only. Fish production has come down and certain species like veda and small prawn are going to be extinct. The fertility of soil has reduced, following loss of organic matter which could be otherwise replenished from decay of aquatic life.

Mr. Mia added that salinity intruded into 2590 km^2 area after 1975, affecting 31,078 km^2 as against its intrusion into 18,129 km^2 before. Also affected was the world's largest mangrove area in the Sundarbans on about 5697 km^2 and about 45 million trees. Various species of animals, birds etc. in the Sundarbans were also endangered. Erosion of river banks and incidence of flood also increased and farm production substantially reduced. The Ganga-Kapotaksha irrigation project with the rated capacity of 152.82 cumecs had to be shut down in 1993 owing to non-availability of water. The paper mill at Paksey which needed 25,000 metric tonnes of sweet water for normal production stood on the brink of closure and had to be run by bringing water in barges from a distance of about 50 km. Employment opportunity of people also reduced and environmental pollution gave rise to various diseases. Mr. Mia further said, a field survey was conducted on a hundred villages on availability of water for drinking and other household purposes after diversion of the Ganga water at Farakka. The ground water table has receded below 25 feet, resulting in closure of hundreds of tube-wells. The villagers, hitherto using river water for drinking and other household activities faced hardships, as rivers and channels dried and ground-water table receded in lean season. Earth temperature also shot up, following rivers etc. going dry and sacred rituals of Hindus and other minority communities, which need holy river water, also suffered.

Other experts, like *Amjad Hossain Khan*, Ex-chairman of Bangladesh Water Development Board and an expert on Water Resources Development; *Md. Manirujjaman Mia*, Ex-Vice chancellor of Dhaka University, *Tarek Samsur Rahman*, Professor of Political Science, Jahangirnagar University, Dhaka and others also highlighted many other adverse effects.

Khurshida Begum in her Ph.D. thesis 'Tension over the Farakka Barrage – a Techno-political Tangle in South-Asia' said, 'The withdrawal of a large quantity of water through the Farakka Barrage in violation of the ad-hoc Agreement 1975 for "test running the feeder canal" produced harmful effects on Bangladesh.' This, she added, was bound to bear an impact, as it was an attempt to introduce a new ecological and environmental system against the usual course of Nature.

> A grave crisis has arisen for Bangladesh on account of India's unilateral action in diverting the waters of the Ganges at Farakka. . . ..These withdrawals amount to as much as three-fourths of the dry-season flow of the Ganga. It is difficult to find a precedent in the world, where such heavy amount of waters of an international river is appropriated unilaterally by a country at the cost of the vital interests of a neighboring country.

To counter these views, India issued a publication 'The Farakka Barrage' which said:

> The available technical and economic data, studies and observations show that the operation of the Farakka Barrage will not affect Bangladesh adversely. Some minor problems may arise, but these can be remedied without impeding the diversion of (the) Ganga water into the Hooghly.

According to Mrs. K. Begum, the Ganga along with its two main distributaries – the Gorai-Madhumati and the Arial Khan, serves about 37% of the total area of Bangladesh Of the eight districts that depend on its water, four – Rajshahi, Pabna, Kustia and Faridpur – are on the bank of the Padma and the other four – Jessore, Khulna, Barisal and Patuakhali – are in the Ganga delta. They get fresh water through its six distributaries – the Ichhamati, the Naba Ganga, the Bhairab, the Kumar, the Gorai and the Madhumati. Because of the Ganga's diversion in 1975, the minimum discharge at Hardinge Bridge came down to about 23,000 cusecs as against traditional average of 64,340 cusecs. The water and the ground-water levels came down by about five feet. The offtake of the Garai rose without any discharge through it. The affected area was about 52,000 km^2 (20,000 sq. miles), as claimed by Bangladesh.

India refuted this and held that the affected area did not exceed 2600 km^2 (1000 sq. miles) and therefore, reduction in flow of the Padma would not have any significant adverse effect. The effects on the Gorai-Madhumati reach would also be marginal and could be remedied by dredging its offtake. India also denied the fall in ground-water level, as about one-third of the Ganga's bank is within India and study of the ground-water table and functioning of tube-wells and lift-pumps by her has not noted any such adverse effect.

Salinity Intrusion

Mrs. K. Begum supported Dhaka's view that

> The most devastating effect of the diversion of the Ganga water has been generated from the marked increase in salinity, both intrusion upstream and soil moisture depletion, occasioned by depletion of ground water table. . . .Quite logically, with the decrease in the upland flows, the salinity increased and advanced . . . inland.

According to the Bangladesh government, salinity intrusion in the Bhairab was 13,600 micromhos per cm in April 1976, as against the traditional average of 500 to a very short-time extreme of 1000 micromhos per cm. The penetration was 160 km (100 miles) more, which was 270, compared to the normal 272 km (170 miles) from the coast. India refuted this, quoting the World Bank Report and stated that the withdrawal of 40,000 cusecs at Farakka would have practically no effect at all.

Irrigation Problems and Fall in Crop Yield

Mrs. Begum further quoted Dhaka's report on the dry season of 1976:

> Over 400,000 (0.4 million) acres of land were affected . . . owing to soil moisture efficiency and increase of salinity. More than 4000 low-lift pumps in the area suffered. All the shallow tube-wells . . . (and) a large number of deep tube-wells in the area were affected due to fall in the sub-soil water level. The subsidiary pumps of the G.K. Project ceased to operate, as the Ganges water-level fell below the lowest operation limit. The three main pumps faced operational difficulties. . .It is estimated that approximately 33% of the irrigation facilities could not operate, because of the decreased availability of water.

She also added that owing to delay in cultivation of one crop, the whole pattern of due-time cultivation was disturbed, which resulted in fall of production. Yield of rice alone fell short by 236,000 tons, or 20% of Bangladesh's food imports, excluding the loss of production of second crop, owing to delay in planting the first crop.

Impact on Aquatic Life

Mrs. Begum quoted the White Paper of Bangladesh as under:

> The reduced water availability significantly reduced the landing of fish, probably because of the disturbance of the historic food chain and inability of fish to tolerate shallow depths and the unprecedented levels of salinity. At three key landing points, at Khulna, Goalanda and Chandpur, the percentage of reduction in landing of fish during February to June, 1976 compared to the corresponding period of 1975 was 75%, 34% and 46%, respectively.

There was also sharp decline in the production and catch of *hilsa*, a migratory delicious fish, very dear to the people of two Bengals and a major Bangladesh export to countries where Bengalees live. To this, India replied that the Farakka Barrage could in no way be blamed, because it did not alter the flow pattern of the Ganga in monsoon months when the yield and haul of *hilsa* were the maximum.

Effect on Navigation

Surface transport infrastructure is under-developed in Bangladesh; as a result, trade, commerce, transport and communication are mostly dependent on ferry services in the Ganga and its tributaries, especially in south Bangladesh. Mrs. Begum quoted Bangladesh government's statement in support of her view that the Agreement had affected navigation too.

> Two major ferry terminals had to shift their operations, one four miles and (another) one five miles. . . . Ninety miles of navigation routes on the Ganga (from Godagari to Archa) went out of commission, 45 miles on the Gorai and 15 miles on the Padma. . . . In addition to these, in three specific reaches, navigation throughout the entire region was hampered.

To this, India replied that navigation on the Ganga and on the tributaries of Padma was possible only in monsoon months, from June to November and impossible in lean months. Mechanized navigation in the Ganga / Padma up to the confluence of The Brahmaputra is very few only, therefore the effect of withdrawal of 40,000 cusecs on Bangladesh navigation was negligible.

Impact on Forestry

Mrs. K. Begum said, Bangladesh claimed that the forests of Sundarbans, much of which is in Bangladesh, provides raw materials to newsprint and paper mills, match and furniture factories etc. Varieties of constructive activities have been affected by increased salinity after the diversion of the Ganga water and inflicted heavy and irreparable loss, which would ultimately affect 45,000 people, living on forest products.

Impact on Industry

The salinity level in the southwest region was so high after the diversion that the Goalpara Thermal Power station had to be closed for some time and thereafter operated intermittently by bringing fresh water in barges at increased cost from long distances. The Bheramara power station could not operate, as the water level of the intake channel went below R. L. 17 feet. Khulna newsprint mill was operated at half its capacity, as the chloride content of the water, used in the mill, increased by more than 20 times. The paper mills at Paksey also suffered miserably.

Effects on Health and Ecology

Bangladesh also alleged adverse effects on health, mainly because of increased salinity in the drinking water.

> Roughly 5% of the drinking water tube-wells were rendered inoperative. Substantial parts registered high salinity. The effect of salinity on health occurs when the body is incapable of absorbing any more sodium. The manifestations is hypertension. The short-term system of disease is dysentery; in addition the propensity to fall prey to cardio logical illness is increased.

About ecology, Bangladesh said:

> . . . It is necessary to consider total eco-cycle and ecology of the region. The wild lives of the Sundarbans are already endangered species. It is hard to reconcile to this abrupt change in the balance of Nature when the awareness of the necessity for taking full account of its own eco-system, that of its neighbour, that of its region and that of the world, is ever growing in countries, all over the world.

India refuted this, saying that the region being close to the sea, the problems of salinity and its adverse effects on environment have always been there.

> Ecological and environmental problems are complex and call for a comprehensive, integrated and multi-disciplinary approach. Such problems cannot be solved on the basis of an exaggerated emphasis on only [one] factor, such as, withdrawal at Farakka, or on the problems of only one area to the exclusion of others.

Mrs. Begum ended her litany of charges, adding that Nature's equilibrium was bound to be disturbed, following the diversion at Farakka. She proposed a joint study and co-ordinated efforts to find a solution and added that unilateral withdrawal and speculation of consequences by India have brought some kind of tension and uneasy

Fig. 10.6 Affected districts of Bangladesh due to water diversion as reported by Mrs. K. Begum

feelings between the two countries. It is clear from the above that both countries wanted to safeguard their interest by over-stating (by Bangladesh) and under-stating (by India) the post-diversion situation in Bangladesh.

The affected districts of Bangladesh, as reported by Mrs. Begum are shown in Fig. 10.6.

Ben Crow's Assessment

Another assessment was made by Ben Crow, a British research scientist in his book, 'Sharing the Ganges – the Politics and Technology of River Development'. He analysed three basic documents – 'The Farakka Barrage', published by

the Government of India, 'White Paper on the Ganges Water Dispute', published by Bangladesh government and 'Special Studies', published jointly by the Government of Bangladesh and a San Francisco–based firm of engineering consultants, International Engineering Company, funded by the World Bank.

Figure 10.7 shows the southwest part of Bangladesh, which was most affected by the diversion of the Ganga water at Farakka. Ben Crow said, the western part of the delta, stretching from the Bhagirathi in India across Bangladesh border, to the line of Gorai-Madhumati and Rupsa-Pussur rivers, was a moribund region before the diversion and many of the small rivers and channels were no longer tributaries of the Ganga. These channels were not having any flowing water except in the rainy season when they drained only the adjacent countryside. Though some land-building was occurring at the Meghna estuary, it was also affected by erosion, deforestation and bad farming practices. A comparison of early maps with more recent ones indicates that landforms are changing, but the total land area within the given boundaries has been roughly constant. Quoting a 1962 East Pakistan Report, Mr. Crow stated that in some periods, there had been almost no flow in the Gorai because of blocked offtake. Flows had been negligible from January to May in 1951 and at different times, an average monthly discharge of less than 1,000 cusecs was recorded for six months, from December to May. This makes it difficult to assess the effects of Farakka Barrage on Bangladesh.

Mr. Crow had no access to the records of diversion at Farakka from New Delhi. He made a tentative assessment, according to which the Ganga flow near Hardinge Bridge fell by 45% for three months, from February to April in 1976 and 1977 from those of earlier years.

On the effects of the Farakka diversion on ground-water levels in Bangladesh, the White Paper from Dhaka comments:

> The hydraulic cycle of surface and ground-water are interdependent. In 1976, the ground-water level in the highly affected area went down by five feet on an average with a range of three to eight feel below normal.

The 'Special Studies' report did not chime with the view of the Bangladesh government; it said:

> Ground-water conditions during recent dry season differ from conditions that existed during the dry seasons prior to 1975. Reported changes include lower water-levels in wells, increased pumping lifts, dry wells, reduced ground-water yields and increased salinity. The water levels during the dry season of 1976 were at the lowest level, ever reduced in many of the wells in the study area.

Analysing the field survey data of Bangladesh government, the Special Studies team concluded that out of 15 wells in the study area, in only five did the level in the adjacent river appear to be the determining factor. In the other 10 wells, water-levels appeared to be affected more by direct precipitation than by stream flow. The effect of fluctuations in the river-water level on the ground water reduced to 83% in a mile, 41% in 16 km (10 miles) and 16% in 32 km (20 miles) from

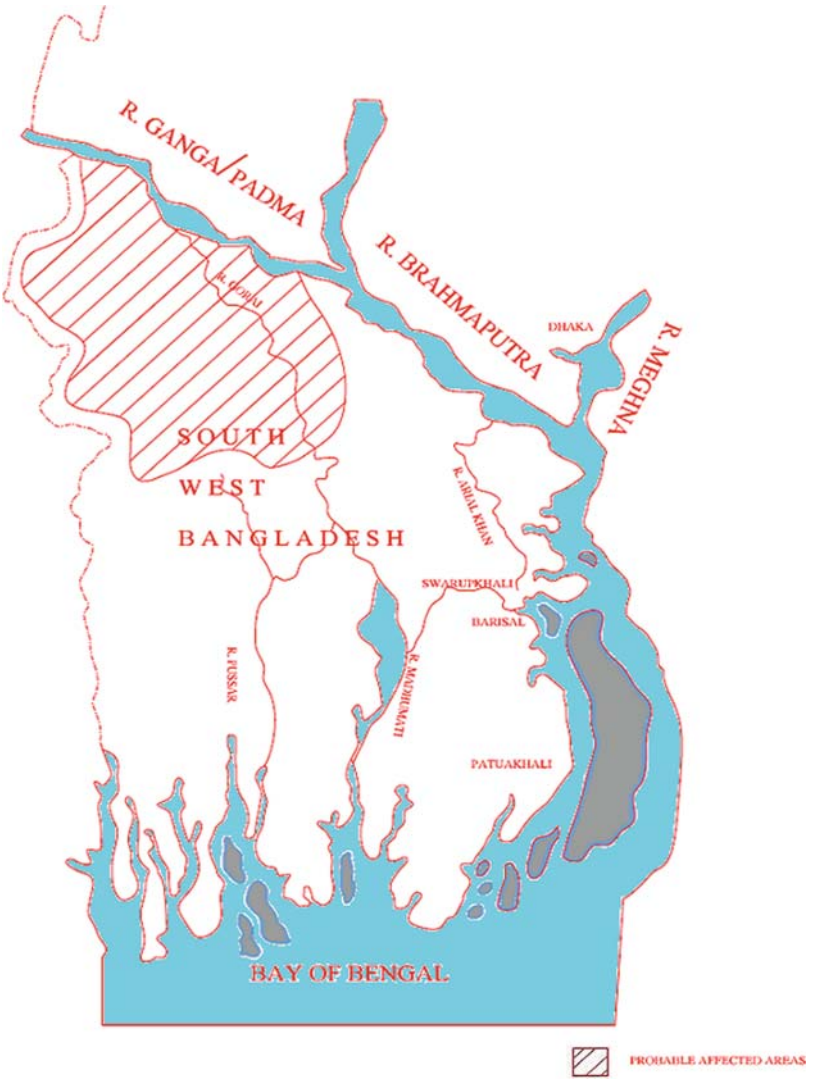

Fig. 10.7 South west part of Bangladesh showing the probable affected area due to water diversion

the river; it would be less in a confined, or a partly confined, aquifer. The geology of southwest Bangladesh indicates that much ground-water is stored in sandy aquifers, partly confined by lenses of silt. Moreover, the contours indicate that ground-water flows toward the Ganga, the Baral, the Gorai and the Naba Ganga etc. The team, therefore, concluded that though ground-water levels changed significantly in 1976 and 1977, its causes were difficult to establish accurately and the blame could not be laid wholly, or primarily, on diversion at Farakka. The

Bangladesh Government claimed that the increased intrusion of sea-water owing to withdrawals by India at Farakka into the rivers and canals disrupted functioning of industries.

> The increased salinity is totally explicable in the light of the increased withdrawal of the Ganga water. A large part of the affected region is subject to the tides of the Bay of Bengal. Historically, this saline intrusion was counteracted by the upland flows. Quite logically, with a decrease in the upland flows, the salinity increased and advanced . . . inland.

The Special Studies team reviewed the traditional and current salinity data, collected by Bangladesh government and analyzed them to obtain the best assessment of the extent and causes of damage. It compared salinity intrusion in 1967–1968 with that in 1976 and 1977. Of the five regions of southwest Bangladesh, in which comparisons were made and which the Bangladesh government claimed to have been affected by salinity following Farakka withdrawal, the team could identify only one in the Pussar estuary, from Rupsa-Pussar to the upper Gorai-Madhumati region which was found to have been affected by increased saline intrusion. It mentioned that major industries of Khulna are located in the region and it was there that the increased salinity in the Ganga water was most pronounced on the industries. Higher velocity of water there maintained a steep salinity gradient which, in normal years, kept salinity relatively low, adjacent to Khulna. Industrial water offtake there could, therefore, be operated, without difficulty before diversion. A small change in the Gorai flow in 1976 dramatically reduced salinity in this sensitive stretch for Bangladesh's industrial production.

Because of rise in salinity, the power station, paper mills, jute processors etc. in Khulna could not use highly saline water, or incurred damage by using it. Bangladesh government said, high salinity caused industrial losses, from December 1975 to June 1976, to almost 120 million taka, (or then 8 million US dollar). Major losses (39 million taka) were reported from Goalpara Power Station which had to use more chemicals and spend more (18 million taka) on hauling sweet water for the jute mills in Khulna, owing to power failures. Chalna Port authority incurred a whopping loss of 50 million taka to change design because of salinity intrusion. The team, however, mentioned that there might be serious consequences on industries owing to unexpectedly high salt content in cooling, or processing, of water. The estimated loss of 120 million taka was perhaps inflated, but some damage indeed took place because of increases in salinity, due perhaps to diversion of water to the Bhagirathi-Hooghly at Farakka.

On the effects of diversion on 'agriculture and forestry', Mr. Crow analyzed three documents, mentioned before. Agriculture accounted for 56% of the gross domestic product (GDP) of Bangladesh, of which rice alone contributed 30%. Jute contributed 77% of the value of commodity exports and forest-based industries contributed 5% of the GDP. In southwest, most wood came from the Sundarbans, a large mangrove forest and swamp, where the main flora was *Sundari* trees which thrive in mildly saline water.

India refuted these claims, saying that

(a) it is rainwaters that moist soil, not ground water,
(b) salinity did not affect the Padma water,
(c) no adverse effect was noticed in Indian territory below Farakka because of diversion, and
(d) the experts who visited Bangladesh did not observe any decrease in water for irrigation.

India also disagreed with the estimated loss on the ground that Bangladesh had provided no target, or base level, of production, against which such losses can be calculated. India also remarked that the quality and productivity of *Sundari* woods depended on local rainfall and on the depth and spread of the tides. 'The lean season flows in the Padma cannot reach any part of the Sundarbans and the Farakka withdrawals cannot thus have harmful effects on forestry in Bangladesh.'

The team concluded that there has indeed been some fall in farm production of the order of 0.65 million tonnes and that the forests did decline because of increased salinity. Though the team disagreed with the 'White Paper' of Dhaka on other counts, it over-estimated the loss of farm production than that given in the White Paper. The analysis of data was weak and not based on practical considerations. It was not appropriate to attribute reduced flows in the Gorai-Madhumati to that in the Ganga-Padma. Siltation in the mouth of the Gorai was a natural phenomenon which might have reduced the flow in the Gorai-Madhumati, as happened to the Bhagirathi-Hooghly, the Bhairab-Jalangi and the Mathabhanga-Churni. Therefore, both the White Paper and the Special Studies reports might have been based on weak analyses.

Ben Crow stated that as there was rise in salinity in certain areas after diversions from Farakka, farm production was bound to fall, though it was difficult to quantify it, owing to unknown factors. Similarly, the flows in the Gorai-Madhumati might have enhanced salinity in water in the Sundarbans. Therefore, the decline of the Sundarbans forests could not be due to Farakka diversions.

Regarding navigation, the Bangladesh government claimed that ferry services on the Ganga, the Gorai-Madhumati etc. were disrupted badly owing to India's withdrawals at Farakka. As a result, navigation became difficult, or even impossible, in many rivers of southwest Bangladesh and led to shifting of several ferry terminals. The 'Special Studies' team found that the affected routes were not the most important but conceded that the Farakka Barrage did have an adverse effect and that India's diversions of the Ganga water at Farakka did seriously disrupt inland navigation. Commercial navigation also suffered to the extent of 10 million tonne-miles and Bangladesh did incur a loss of three million taka, or US$ 50,000 (in February, 2009 exchange rate), because of reduced water depths in the Ganga after Farakka diversions.

Bangladesh claimed that the withdrawals reduced fish yield and haul because of disturbance of the traditional food chain and inability of fishes to breed and live in shallow depths and owing to rise in salinity. The Fishery Directorate recorded

a static yearly catch until the dry season of 1975 but thereafter a sharp decline. India maintained that the main *hilsa* catch could not have been affected, because it took place in the monsoon season when all gates of the barrage are kept fully open. However, New Delhi conceded that *hilsa* catch was going down even before the withdrawals. The team observed that reduced flows could affect fish spawning and therefore, reduce breeding but statistical evidence was not sufficient and conclusive.

Bangladesh government in its White Paper argued that increased salinity affected the health of its people and the eco-system of the region, especially in the Sundarbans. Drinking water ran short in southwest Bangladesh in 1976 and 1977, as water-level receded in wells, ponds and *nulla*s (narrow canals) and bred many diseases. India argued that no adverse effect was noticed in people in the Indian part of the Sundarbans. The 'Special Studies' team had no word about ecology, except that in the region it was indeed affected in the recent years owing to the construction of Farakka Barrage.

One can see that the views of Bangladesh government and of the 'Special Studies' team were one-sided, biased and not always based on facts and circumstances and did not take into account the various causative factors. Most of these exponents over-estimated the effects of the withdrawals of the Ganga water at Farakka on Bangladesh. On the other hand, India's assessment of the effects of Farakka withdrawals on Bangladesh was based on certain assumptions, held in pre-Farakka days, and not on studies after the diversion and therefore, smacked of under-estimates.

The Special Studies team analysed the data in a neutral and realistic manner. According to it, the Gorai-Madhumati and the Rupsa-Pussar used to be moribund in the dry season, even before Farakka Barrage came up. Flows in the river were negligible in four to five months, even in 1951 and 1954. The mouth of the Garai had silted up, requiring dredging in dry season. Therefore, the diversion of water at Farakka might not have had any ill effect on reduction of discharge in the Gorai-Madhumati.

The diversion had some adverse effects on the ground-water table in Bangladesh. As the Special Studies team said, it was difficult to quantify the effect, as it depended on many other factors, like rainfall, ground slope, location of permeable strata and perched water bodies below the ground, soil stratification etc. The team added that the ground-water contour in southwest Bangladesh sloped toward the river, i.e., the flow of the ground-water of the region was toward the river only. India's claim that the Ganga below Farakka flowed through Indian territory on the right bank, for more than 100 km and that no adverse effect of Farakka withdrawals by India on ground-water has been noticed. Therefore, Dhaka's allegations of adverse effects on Bangladesh were not fully justified.

Another allegation of increased salinity intrusion in southwest Bangladesh was, however, partly true. Agriculture and industry in the Pussar estuary from Rupsa-Pussar region to that of the upper Gorai-Madhumati were indeed affected by increased salinity. Big industries at Khulna – paper mills, power station, jute-processing units etc. were affected partly by saline water but the estimated loss of 120 million taka in 1976 appeared exaggerated.

The claim of Bangladesh government that Farakka withdrawals by India had adverse effects on agriculture and forestry was exaggerated, as stated by Ben Crow. Farakka withdrawals might have enhanced salinity in the Gorai-Madhumati basin, but salinity intrusion in the Ganga-Padma because of them was negligible. Increased salinity in the Gorai-Madhumati basin might have affected farm production, but its adverse effect on the forests in the Sundarbans was doubtful. Similarly, the navigable depths in the Ganga-Padma and the Gorai-Madhumati might have reduced somewhat after diversions from Farakka which led to suspension of ferry services, reduction in trade and commerce etc. in southeast Bangladesh.

The claim of Dhaka that fish haul, especially of *hilsa*, was reduced substantially because of Farakka withdrawals, is not based on facts. Fish catch can go down owing to increase in the catch of matured fishes and of spawns and small fishes, extensive netting in rivers downstream, pollution of water by industrial and other wastes, excessive withdrawal of water etc.

Although the effect of Farakka withdrawals on the flow of the Gorai-Madhumati, increasing salinity, or harming agriculture, industry and other aspects are difficult to assess correctly, the overall impact of the diversions on the ecology and the environment of southwest Bangladesh cannot be denied. Shortage of drinking water in the dry season, spread of various diseases, decrease in fish production etc. might be the indirect results of withdrawals at Farakka.

There were other direct and indirect effects on the sedimentation pattern of the Ganga-Padma, which would eventually increase siltation and erosion of the river-bed and banks, ultimately affect the channel pattern and invite other morphological changes.

The factors responsible for these adverse effects and to what extent these were responsible for overall ecological degradation etc. of southwest Bangladesh owing to withdrawals at Farakka are summarized in Table 10.7.

Table 10.7 shows that there were many other factors for adverse effects on southwest Bangladesh. Farakka diversion did partly affect and might have accelerated the effects but other reasons were more prominent too. Had there been no diversion at Farakka, the adverse effects attributed to it would have occurred, some day, because of other factors.

Augmentation Schemes Ignored

The 1977 agreement and the two MOUs of 1982 and 1985 could only resolve the issue of sharing the Ganga flow at Farakka in the lean season between 1977 and 1988. Though these also provided for augmentation of the flow at Farakka, no solution could be found over this long period, either by the Joint Rivers Commission (JRC) or by the Joint |Committee of Experts (JCE).

The Article VIII of the 1977 Agreement, inter alia, stated:

> The two governments recognize the need to co-operate with each other in finding a solution to the long-term problem of augmenting the flows of the Ganges during the dry season.

Table 10.7 Effect of Farakka withdrawals on Bangladesh (South-Western Region)

Sl. no.	Prototype evidences	Probable factors responsible	Effect of Farakka withdrawal fully or partly
1	Reduction of *Discharge* in Gorai Madhumati	i) Siltation at the offtake-point and in river bed due to southward swing of Ganga Padma river like that of Bhagirathi-Hooghly river in Pre-diversion day ii) Farakka Diversion	Partial
2	Impact on *Ecology* and Environment	i) Increased population ii) Damage of forestry for habitation and indiscriminate felling of trees iii) More and more urbanization iv) Increase of industries v) Farakka diversion	Partial
3	Increase of *Salinity* ingression and through tributaries e.g. Gorai Madhumati etc.	i) More withdrawal of surface as well as ground waterii) Blockage of river mouths iii) Aggradation of river bed iv) Farakka diversion	Partial
4	Loss/Damage to *Industries*	i) Deterioration of labour management relationshipii) Old and obsolete machineries iii) Non-modernisation iv) Disturbance in Power Supply v) Water scarcity vi) Decrease of investment vii) More salinity in water viii) Farakka diversion	Partial
5	Lowering of *Ground Water* Table	i) More withdrawal for irrigation and domestic Purposesii) Less rainfall iii) Farakka diversion	Partial
6	Loss of *Navigation*	i) Siltation in river bed ii) Siltation in offtake point of tributaries iii) Less rainfall in catchment area iv) Farakka diversion	Partial
7	Loss of *Agricultural Production*	i) Less irrigation facility ii) Less use of fertilizer and pesticides iii) Less rainfall iv) More salinity v) No change of cropping pattern vi) Farakka diversion	Partial
8	Loss of *Forest Products*	i) Indiscriminate felling of trees by miscreants and for habitation purpose.ii) Less rainfall iii) Industrial and environmental pollution	No effects.

Under Article IX, the JRC was entrusted with studying the most economic and feasible schemes for augmentation of dry-season flow, proposed, or to be proposed, by either government and with submitting its recommendations to the two governments within three years. Accordingly, the proposals were submitted by two sides and considered by the JRC, but no consensus could be reached in spite of several exchange of data etc. and no final recommendation could be made to the governments.

The two proposals for augmentation of the discharge at Farakka made by the two governments were as under.

India's Proposal

India's proposal comprised the following:

(i) Construction of a barrage across the Brahmaputra at Jogigopa in Assam, to be about 2.40 km long, i.e., longer than Farakka Barrage;
(ii) Construction of a link canal, about 320 km long, joining the Brahmaputra, upstream of the proposed barrage at Jogigopa and the Ganga, upstream of the barrage at Farakka of a capacity of about 2,830 cumecs, or 100,000 cusecs, of the size of 2,750 metre width and 9.0 metre depth.
(iii) Construction of three dams – one across the Dihang, a tributary of the Brahmaputra in Arunachal Pradesh, and the other over the Subansiri in Assam and the third over the Barak in Mizoram.

The Indian proposal, outlined in Fig. 10.8, aimed at water transfer from the Brahmaputra basin to that of the Ganga, i.e., from a surplus to a deficit river to augment the flow of the latter in dry season. The main barrage was proposed to be constructed at Jogigopa in Assam, about 110 km downstream of Guwahati, the Assam capital, where the river is narrow and the banks are rocky and stable. The link canal was to stretch over 215 km in India, i.e., about two-thirds of its total length and over 105 km in Bangladesh, i.e., about one-third of its total length. The canal would run over about 45,000 acres of land in India and 20,000 acres in Bangladesh, to become the largest man-made canal in the world.

Indian proposal provided for augmentation of the Brahmaputra discharge in the dry season. Three storage reservoirs were proposed across three rivers in India's north-eastern provinces – Assam, Arunachal Pradesh and Mizoram. The Brahmaputra after flowing east through China for more than half of its length, takes a sharp southward turn and enters Arunachal Pradesh with a steep downward gradient of about 2.29 km out of 230 km (1:140) approximately. The proposal included construction of a rock-fill dam of about 260 mheight, across the Dihang on its right with a gross storage capacity of about 32,500 million M^3 (MCM), almost equal to that of the largest reservoir in the USA. It would augment the Brahmaputra flow in the dry season by 1,700–3,400 cumecs. A hydro-electric power station below the

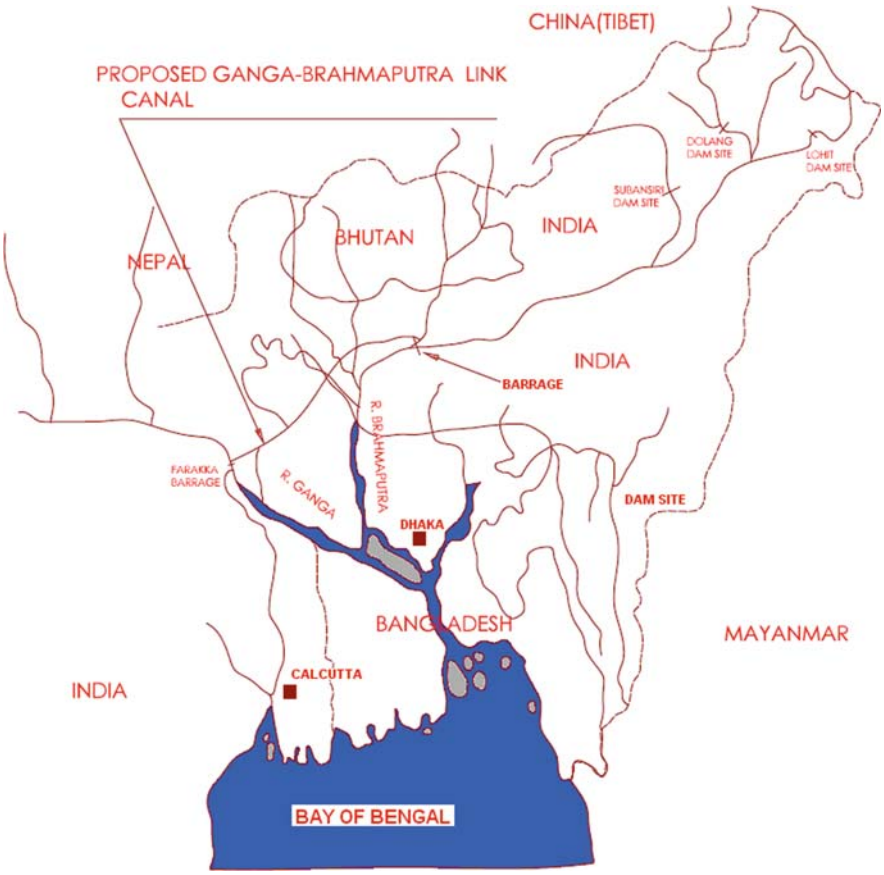

Fig. 10.8 Indian augmentation proposal

dam would generate about 7,500 MW but could submerge about 350 km^2 area, the major part of which would to be in India and the rest in China.

The proposal also included a second dam across the Subansiri, another tributary of the Brahmaputra on its right in Assam in hilly-cum-plain area. This would also be a rock-fill dam, about 240 m high, and store up to 18,000 million M^3 (MCM) to augment the dry season flow of the river by about 700 cumecs and also generate about 1,800 MW but submerge about 100 km^2 area in Assam alone. These two reservoirs would also help mitigate floods in the Brahmaputra basin and reduce the peak flood of 1.50–1 million cusecs.

A third rock-fill dam was also proposed by India, to be constructed over the Barak at a place, called Tipaimukh in Mizoram, which would directly augment the flow of the Ganga. It will have a storage capacity of 7,000 million M^3 (MCM) of water to augment the dry-season flow of the Ganga by about 300 cumecs and generate about 600 MW of hydro-electric power. It would effectively control floods in Cachar district in Assam as well as in Sylhet and Dhaka districts of Bangladesh.

The proposed 320 km long Ganga-Brahmaputra link canal would intercept a number of rivers and rivulets in India and Bangladesh, The largest one is the Teesta; the canal would cross it almost at right angle in Bangladesh. India proposed a level-crossing with four-way navigation facility in all directions. This would be a very big engineering project and the level-crossing would possibly be the largest such in the world. The estimated cost of the Indian proposal at 1983 price level was 160,000 billion rupees.

Bangladesh's Proposal

Bangladesh was totally opposed to transfer of any amount of water from the Brahmaputra basin to that of the Ganga. Dhaka believed that transfer of water from one basin to another was not the best way of augmenting the dry-season flow. Instead, it proposed that the available water of the basin should be gainfully utilized by making arrangements for storage of surplus water during monsoon months. The proposal of Bangladesh comprised the following:

a) Construction of storage dams in the upper reaches of the Ganga basin in India and Nepal for storing surplus water and its release in the dry season;
b) Construction of a canal through the Tarai region of Nepal to carry water from the Gandak and the Kosi to the Mahananda, the Karatoya and the Atreyi; and
c) Augmentation of dry-season flow by conserving a part of the river's monsoon discharge in storage dams in the upper reaches in India and Nepal to enable surplus water flow to the Ganga basin even after meeting the future needs.

New Delhi made an overall assessment of the requirement of water of Nepal, India and Bangladesh. Bangladesh proposed 83 storage dams in the upper reaches of the Ganga, of which 31 would be in Nepal and 52 in India, some of which ares shown in Fig. 10.9. It was estimated that the dry-season flow of the Ganga could be increased to about 5,100 cumecs (180,000 cusecs) by releasing water from these reservoirs in India.

The stored water in the reservoirs of Nepal could be released through natural rivers, joining the Ganga. A part of it could be diverted to the Mahananda and the Karatoya to augment their flows in West Bengal and Bangladesh respectively. The canal could also be used for navigation and be a river route of Nepal to the sea. Moreover, the storages would have high potential for generating hydro-electric power at a cheap rate to boost industries in Nepal, India and Bangladesh. Power generation as per Dhaka's estimate would be more than 10,000 MW.

The 1983 Bangladesh proposal envisaged optimum increase of surface water resources of the Ganga basin to 0.5 million cubic metre (446 million acre-feet) in a year. It also assessed the total demand in the Ganga basin for various purposes by the co-basin States as under:

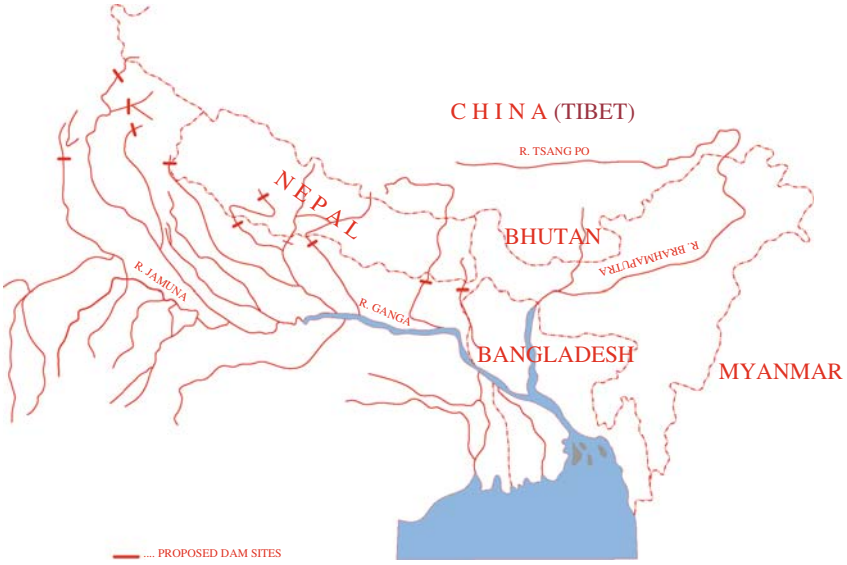

Fig. 10.9 Bangladesh augmentation proposal

i) Nepal: 0.029 million million cubic metre (23.5 million acre feet)
ii) India: 105 million million cubic metre (85 million acre feet)
iii) Bangladesh: 0.055 million million cubic metre (44.5 million acre feet)

Total: 0.189 million million cubic metre (153 million acre feet)

Views of Bangladesh on India's Proposal

Bangladesh argued that India's proposal for construction of a link canal between the Brahmaputra and the Ganga to augment water in the latter violated the principles of inter-basin transfer. B. M. Abbas stated that the universally accepted basic principles in respect of transfer of water from one river basin or sub-basin to another were

a) the present and future requirements of the exporting basin must be fully met, or safeguarded, i.e. the water from the exporting basin, or region, should be surplus;
b) the requirement of the importing basin, or region, should be reduced to the minimum possible by tapping alternative sources which, except on special consideration, should be cheaper than the proposed imported water and effect savings in existing water uses, efficiently.
c) the impact of bulk transfer from exporting region, hydrological changes, ecology, environmental pollution, aesthetics and human interests in water and properties in the rights of way through which such transfers are affected to the minimum, have to be studied.

Mr. Abbas added that the present dry-season flow in the Brahmaputra is not adequate to meet the full requirements of the basin, whereas the available flow in the Ganga basin, if properly conserved, can meet them. Moreover, the impact of any transfer of water from the Brahmaputra basin to that of the Ganga in the dry-season would be severe on the economy, environment, ecology and the life of the people of Bangladesh. He also maintained that India's policy of bilateralism did not stand, because the Ganga flowed between India and Bangladesh–making them co-riparian countries; therefore, no difficulty is envisaged by associating Nepal with the scheme.

Another Bangladesh officer apprehended that India was trying to develop the whole of India with the Ganga water, because India's suggestion included watering drought areas. He anticipated that inter-basin transfers of water on the scale, implied in India's proposal would pose a threat to Bangladesh. Another officer commented.

> No sensible authority would even entertain the concept of bringing the whole of the stated 60 million hectares of land in the Indian territory under intensive irrigation at the expense of other co-basin countries.

The Bangladesh Government apprehended that construction of a link canal would uproot about 50,000 people from the thickly populated region; this made India's proposal unacceptable to Dhaka.

India's Reply

India disagreed with Bangladesh's interpretation of 'bilateralism'. New Delhi argued that as the problem is between two countries – India and Bangladesh – the issue was indeed bilateral and as per the UN guidelines, a solution has to be found by the two countries themselves. India rightly criticized Bangladesh for insisting on the participation of Nepal, because Kathmandu would obviously support Dhaka's views to get on her own proposals. Nepal also might not be interested in Bangladesh's proposal of storage dams in the Ganga basin, because these would be mostly located within Nepal and could submerge land in her territory. India maintained that Nepal could be consulted, but it cannot participate in the discussions.

India's second argument against Bangladesh was that its proposal was neither precise nor definite, but was based on probabilities and assumptions. Its layouts of storage dams, navigation canal etc. was technically unacceptable to India, as those were not based on prototype data and physical investigations. India thought, the proposal for storage dams and reservoirs which would be among the highest in the world was impractical, because it was not based on site conditions.

India added that just as the existing storages in the upper reaches of the Ganga were serving local needs, the future ones would also have to do that. As such, the proposed reservoirs in India would not help augment the flows at Farakka. The future needs of the basin State cannot be sacrificed for flow augmentation in a lower riparian country. Also, the idea of a waterway, connecting the Gandak and the Kosi along Nepal-India *terai* region for diversion of their waters to the Karatoya, the Atreyi and the Baral rivers in Bangladesh was not supported by any data. The canal,

if constructed, would pass through seismically vulnerable areas and be a danger for India. Besides, construction of 83 reservoirs along the entire northern territory of India would make the whole of India and Bangladesh geo-technically and seismically unstable. India, therefore, maintained that Bangladesh proposal upheld only its own interests, ignoring the safety aspects for India and Nepal, not to speak of development of their water resources.

The Two Proposals in prism

The 1977 Agreement, signed between the two countries on sharing the Ganga water at Farakka, was in three parts.

1) Arrangements for sharing of the Ganga water at Farakka;
2) Long-term arrangement;
3) Review and duration.

The second MOU was signed on 22nd November 1985 between Rajiv Gandhi, the then Prime Minister of India and President H. M. Ershad of Bangladesh, during their meeting at Nassau, Bahamas. They recognized the gravity of the problem of inadequate flow in dry season and sharing it for mutual benefit as well as long-term solution for augmentation of the flow. They agreed to sign another MOU for three years, commencing from the dry season of 1986 on the same terms as of 1982. The Joint Committee of Experts (JCE), comprising Secretaries of the two governments and two engineering members of the commission from each side would study the schemes and identify alternatives of water sharing. This effort also came to naught and the tenure of the MOU expired after the dry season of 1988. The minutes of the two meetings are given in Appendix E.

It is clear that both sides were adamant and rigid about respective schemes and did not come to a compromise. The technocrats were hopeful about the success of their schemes and took a rigid and pessimistic view of the scheme of the other country. India contended that available water in the Ganga basin would be just sufficient for her future needs, while the quantum of available water, estimated by India for her future requirement, was unacceptable to Bangladesh; this quantum did not tally with that in Bangladesh's estimate. Dhaka did not agree with India's view that the Ganga basin would not have adequate water to meet local needs and for augmenting flows in the dry season. The assessment of water availability and its requirement, as assessed by the two countries, are given in Table 10.8.

Table 10.8 shows that there was wide variation in the estimates of demand and storage capacity, put forward by two countries. The units of water measurement, adopted by them, were also different.

Ben Crow in his book 'Sharing the Ganges' has mentioned that the Indian proposal was a carefully written, well-reasoned document, longer and more detailed than its Bangladesh counterpart and has been discussed in three parts. The proposal outlined the context in which India wished the augmenting of the Ganges flow to be

Table 10.8 Estimate of dry season water demand and storage capacity

Sl. no.	Assessment	Demand	Probable Storage
A)	**Indian's Assessment**		
a)	For Nepal	Not estimated	Not estimated
b)	For India		
	i) Irrigation (Rabi season)	320,000 (cusecs)	
	ii) Calcutta Port	40,000 (cusecs)	80,000 (cusecs)
	Total	360,000 (cusecs)	80,000 (cusecs)
c)	For Bangladesh		
	i) Irrigation	50,000 (cusecs)	
	ii) For Gorai River	5,000 (cusecs)	
	Total:	55,000 (cusecs)	
	Total (India's Assessment-excluding Nepal)	415,000 (cusecs)	80,000 (cusecs)
B)	**Bangladesh Assessment**		
	i) For Nepal	24 (MAF)	50 (MAF) 130,000 (cusecs)
	For India	150 (MAF)	54 (MAF) 180,000 (cusecs)
	iii) For Bangladesh	33 (MAF)	
	Total (Bangladesh Assessment)	207 (MAF) 614,000 (cusecs)	104 (MAF) 310,000 (cusecs)

considered, highlighting the needs of different parts of India and also the problem of flooding of both the countries. The proposal described a 'flood-drought-flood syndrome', a perennial problem for both Bangladesh and India and indicated the urgency and importance of control of floods and removal of drought, facing both the countries.

India realized that simultaneous development of the Ganga and the Brahmaputra basins would be absolutely necessary for the development of water resources in two countries, on which hinged the welfare of more than 400 million people in the two river-basins, which was nearly one-tenth of the world's population. Though the implementation of such schemes would be very expensive and need high technical expertise, large-scale development of both the countries would be possible only with such an effort. A joint venture for the development of the two basins by linking the Ganga and the Brahmaputra and facilitating inter-basin transfer of water could open up a new communication system, develop agriculture, generate hydro-electric power, increase fish breeding and catch and many other allied benefits. Scarcity of water in the Bhagirathi, the Jalangi, the Mathabhanga and the Gorai would be mitigated and Calcutta Port in India and Chalna port in Bangladesh would improve. B. G. Verghese, a renowned former editor of a major Indian newspaper and associated with a noted think-tank, the 'Centre for Policy Research' New Delhi, in a lecture delivered in New Delhi on 12th December 1977 remarked:

> The fantastic potential of the greater Ganga Basin cannot be allowed to remain grossly under-utilized for another long period of years, by which time costs will have risen greatly and population pressures will have multiplied.

Mr. Verghese added that the 1977 agreement unlocked the door, which had hitherto barred access, to the potential of the basin, but the 'fantastic potential' of the Ganga and the Brahmaputra would not be tapped easily and technical and political obstacles have to be surmounted. India's proposal of linking the Brahmaputra with the Ganga by a 320 km link canal would develop both the countries. The water from the Brahmaputra in lean season could be utilized in the drought-prone areas of northern Bangladesh and also of the upper reaches in India. A link canal could augment water to the Teesta, the Mahananda, and the Punarbhaba for the benefit of Bangladesh. Huge hydro-electric potential from the barrages and dams in the Brahmaputra and the Barak valley could also be utilized by both the countries for development of industries etc.

The Brahmaputra goes in spate about two months before the Ganga. The minimum discharge in the river is about 5,000 cumecs, i.e., 175,000 cusecs, which is normally seen in mid-February but that in the Ganga is about 1,415 cumecs, or 50,000 cusecs, normally occurring in end-April. Thus, there is a time-lag of two to three months in the minimum discharge in the two rivers. This fact can be gainfully exploited for augmenting the Ganga flow by the Brahmaputra flood water but in spite of all technical data given to Bangladesh representatives in the JRC, they did not see merit in Indian proposal. The comparative hydrographs of the Ganga at Hardinge Bridge and of the Brahmaputra at Bahadurabad for 1981 and average are shown in Fig. 10.10(a, b). The hydrograph of the Ganga at Farakka is assumed to be the same as at Hardinge Bridge.

Dhaka's charge that New Delhi was trying to develop the whole of India with the waters of the Ganga under its proposal was also ridiculous. More than 90% of the river basin as well as the course of the river lies in Indian territory. Under the relevant law, the future needs of a country should be first considered before those of its lower riparian States. The plea of Bangladesh for the transfer of the Brahmaputra water to the Ganga basin to meet the future needs of the two countries holds good about utilization of the Ganga water too for India's needs. The geographical footprint of the river should also be given due consideration.

Construction of a 320 km link canal through the two countries would displace more than 40,000 people in Bangladesh and over a 0.10 million in India. A vast land, occupied by agriculture, orchard, villages etc. would be needed for construction of the link canal, buildings, townships, colonies, diversion structures etc. and for disposal of excavated spoils. Another vast chunk of land would be needed for rehabilitation of the affected people. As population density of both the countries is among the highest in the world, loss of land would affect the economy of both. North-eastern India being seismically vulnerable, construction of barrage, dams etc. and the impounded water in the reservoirs would make the entire region prone to earthquakes.

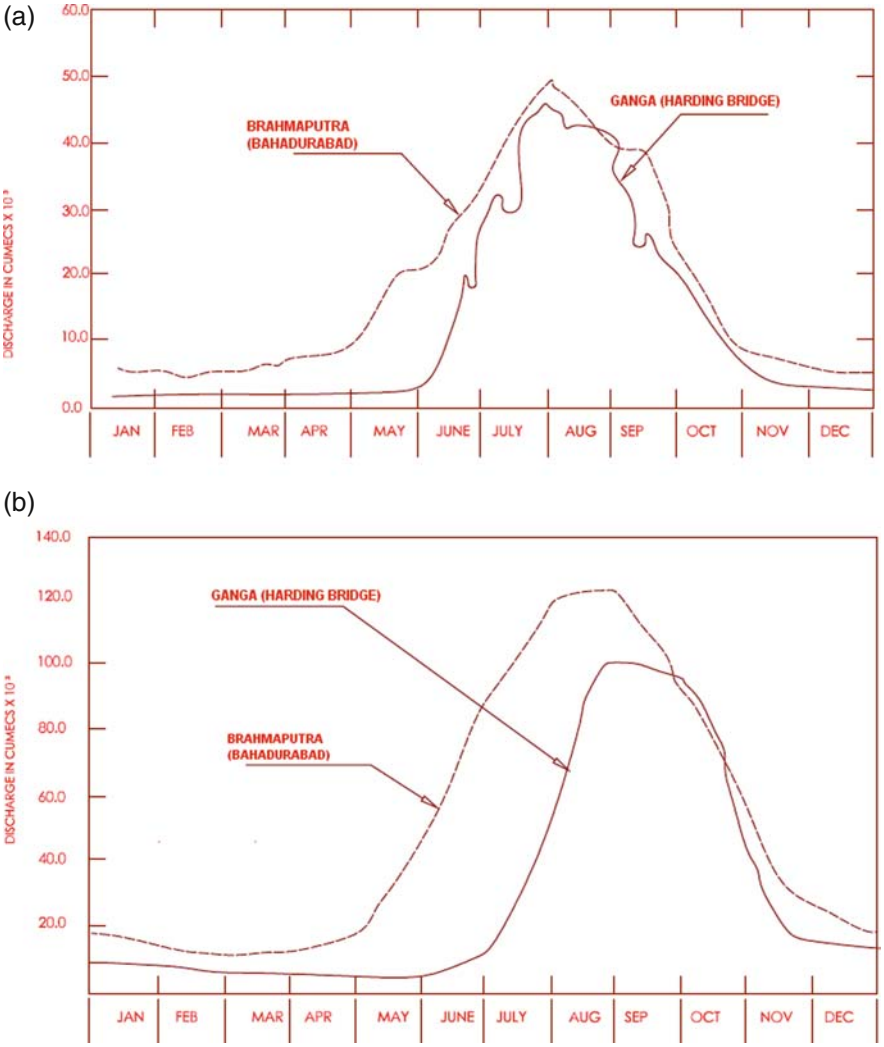

Fig. 10.10 (a) Discharge hydrograph of Ganga and Brahmaputra rivers in 1981; (b) Monthwise average discharge hydrograph of Ganga and Brahmaputra rivers

As the proposed link canal would cross a number of rivers and rivulets, a number of cross-drainage structures would be needed. One such structure would be a level-crossing for the Teesta. Bangladesh expressed doubts on the feasibility of such a structure, as the river carries huge volume of sediment. These structures including canal embankments normally cause serious drainage congestion on either side, depending on the natural ground slopes, as experienced while excavating the Farakka feeder canal. Their routine repair and maintenance of such a long canal and the drainage of its outlets would be very difficult tasks.

Bangladesh also charged that India's proposal was a threat to the sovereignty of Bangladesh, because India wanted to control the Brahmaputra water, as it was doing the Ganga water at Farakka. This was impossible, because the link canal and the cross-drainage structures on the Teesta and many other structures would be within Bangladesh. Moreover, Bangladesh being a lower riparian State and all its rivers originating from the upper reaches, should not have any suspicion on any joint water resources development programme for the benefit of two countries. Bangladesh did not give any details of their future requirement of the Brahmaputra water. Besides, the river inundates large areas, almost every year, in both countries. In view of these, India's proposal was reasonable and acceptable to both countries.

As Ben Crow had remarked:

> The Indian proposal did not refer to questions of equity of rights; it was concerned with practice and technical opinion. Enough water could not be stored within the Ganges basin for the needs of the three countries. The Indian scheme was justified, not as the most equitable way of sharing and developing the resources of the region but as the only feasible method by which all the needs (as estimated by India) could be met. The scheme was legitimized not by political value judgments, but by reference to technical expertise. Science or expertise was used in this way to authenticate one view of 'reality'. The Indian proposal was the only feasible, realistic option because the experts said so.

Bangladesh gave a very attractive picture of future storage facility by constructing reservoirs at 83 places (some are shown in Fig. 10.11) in the sub-Himalayan belt (all within India and Nepal), which would accommodate a total capacity of 104 MAF, as shown in Table 10.7 against the India's figure of only 80,000 cusecs. This looks absurd, as the Himalayan region is seismically sensitive and any major interference with Nature could cause disaster to Nepal and India. The Himalayan rocks are young, not more than 10,000 years old, friable and prone to landslides. Construction of a number of dams and reservoirs in this region could make the region unstable and trigger landslides, dam-bursts etc. following disturbance of the balance of Nature.

Bangladesh proposed a navigation canal, joining the Kosi in India with the Teesta in Bangladesh along the Himalayan foothills. The canal would be aligned east-west, against the natural north-south ground slope, which would affect the drainage system of the region. Any eventual breach of canal embankment would cause a catastrophe to the lower reaches, particularly in the Uttar Pradesh, Bihar and West Bengal. Thus, the proposal was quite absurd and India was right in not accepting it.

India's objection to Nepal's participation stemmed from her policy of bilateralism too. Since 1972, Dhaka never raised it, nor did Pakistan before. India's Treaty of Friendship with Bangladesh in 1971 was valid for 20 years, which provided for resolving all issues and disputes through bilateral discussions only. Nevertheless, India agreed to discuss the issues with Nepal before finalizing any scheme with Bangladesh but Dhaka insisted in Nepal's direct participation. New Delhi conceded that Nepal could be consulted after the scheme was approved by Bangladesh and if needed, a separate treaty could be signed with Kathmandu, later. India felt that Dhaka's insistence on involving Nepal was an attempt to influence the outcome of a study by a third country and to politicize the issue. Besides, multi-lateralism

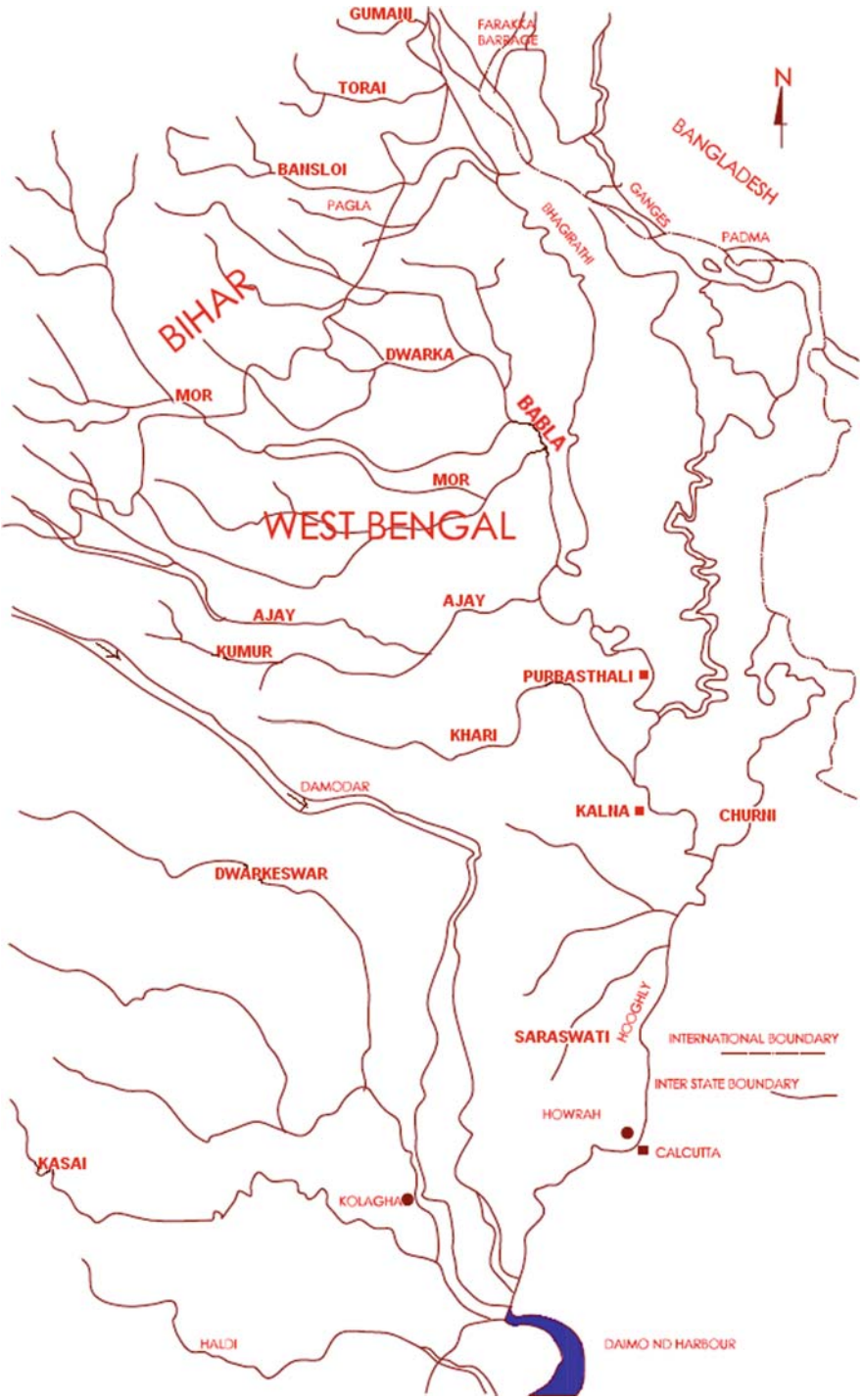

Fig. 10.11 Index map of Bhagirathi-Hooghly

could slow the progress of talks on these crucial issues, already delayed for years. New Delhi also feared that Nepal would not agree to construction of some 31 reservoirs in its territory, because they could submerge a large part of the hilly country. Curiously, Dhaka's proposal made no mention of this eventuality of submergence and displacement of people in India or Nepal but it admitted this mistake later. Besides, the scheme of Bangladesh would have least affected its own territory but done so much to India and Nepal. As all the dams and reservoirs would be in India and Nepal, they would submerge, and seismically affect, parts of these two countries only. Thus, Dhaka's scheme was biased in its favour and lacked equity and uniformity.

In short, India's proposal was based on following major considerations:

i. It was not possible to store sufficient water in the Ganges basin, which would be available for augmentation of dry season flow at Farakka after meeting future requirements of India and Nepal.
ii. Inter-basin transfer of water from the Brahmaputra to the Ganges basin would not only make available sufficient water for augmentation of the Ganges flow at Farakka during lean season, but also reduce the flood hazards of both Bangladesh and India.
iii. Sufficient water is available in the Brahmaputra river even during dry season.
iv. There is a time lag of about two-and-a-half months in the flood flow of the two rivers, the Ganges and the Brahmaputra, the floods occurring in the Brahmaputra earlier than in the Ganges.
v. The issue was purely bilateral and therefore, Nepal's inclusion in the formulation of the scheme was not necessary.
vi. The scheme was technically sound, feasible, realistic and uniform.

Bangladesh proposal was based on the following major considerations:

i. It was possible to store sufficient water in the Ganges basin itself, even after meeting the future demands of Nepal and India, which could be made available for augmentation of the Ganga flow at Farakka in the dry season to meet the requirements of both the countries.
ii. The Brahmaputra water would not be sufficient for transfer to the Ganges basin after meeting future needs of Bangladesh.
iii. As most of the tributaries of the Ganges originate from Nepal, that country should be directly involved in the augmentation scheme.

However, arguments and counter-arguments continued for and against each other's proposal for years together and ultimately, none of the proposals could be consider and therefore ultimately dropped.

Developments after 1982

The agreement of 1977, which was valid for five years, expired in 1982 but no solution was found to the issue of augmentation of dry-season flow of the Ganga at

Farakka; both sides stuck to their own stands. Two Memoranda of Understanding (MOU) were signed by India and Bangladesh – the first in October 1982 and the other in October 1985 on sharing of the available dry season flow at Farakka. The first MOU was for two years only, commencing from the dry season of 1984 and the second for three years from the dry season of 1986. In these five years, there was notable shift in the aims and objectives of the Bangladesh government. A section of Bangladesh politicians and officials realized the impracticability of their earlier stand of constructing a number of storage dams in the upper reaches of the Ganga tributaries, most of which would be in Nepal and India. However, a new thinking emerged slowly and rather secretly, to which support was meagre in all concerned quarters.

According to the new thinking, sharing of available dry-season flow of the Ganga at Farakka would be a separate issue, not to be confused with the long-term scheme of augmentation of dry season flow in the river. The thinkers favoured signing a long-term agreement with India to foreclose giving a chance to India to draw more water from the Ganga's upper reaches in dry season but they did not get much support in Bangladesh until 1996.

The new thinking was initiated by Anisul Islam Mehmud, the then Water Resources Minister; he was in favour of a long-term sharing of water of not only the Ganga but of all the 54 rivers that flow from India into Bangladesh – three big, namely, the Ganga, the Brahmaputra and the Meghna and 51 small ones. Only some technocrats of Bangladesh supported his idea. Humayun Rashid Chaudhury, the then Foreign Minister, was a staunch supporter of the 'old line' and had more influence in the cabinet.

In India too, there was a radical change in the approach to the issue. The then Prime Minister, Rajiv Gandhi wanted an early settlement of the issues but his government did not want to shift its stand, to remain consistent in its policy toward a new neighbouring country.

Anyway, the new thinking in Bangladesh along with India's eagerness for a quick and durable solution of the twin problems of sharing and augmenting the dry-season flow of the Ganga at Farakka gradually received diplomatic and technical support in Bangladesh. Dhaka realized that a short-term agreement with New Delhi of two to three years' validity would not boost overall development of its water resources, nor would it provide any security for Bangladesh to seek technical and financial support from the outside world. Other countries will not make any large investment on developing water resources in Bangladesh, unless they are assured of future availability of water in any river.

Moreover, planning and execution of a long-term scheme take much more time than a short-term arrangement. It also realized that sharing could be a bilateral issue but augmentation would not be possible without involving Nepal, or other countries, which makes the issues trilateral, or multilateral. If water from the Ganga was available to Bangladesh following a long-term treaty with India, it could plan major irrigation schemes. At the same time, an agreement on all rivers flowing from India to Bangladesh would assure huge volume of water, which India alone could utilize by constructing small dams and barrages within its own territory. This was an

apprehension, because India had already started constructing barrages across some rivers, like the Gomati and the Teesta. Therefore, instead of raising only one claim of sharing and augmenting the Ganga water, Bangladesh thought it prudent to claim share of water from all rivers, flowing from India into Bangladesh. It contemplated constructing two barrages, one over the Ganga-Padma below the Hardinge Bridge and the Gorai outfall and the other over the Brahmaputra near Bahadurabad, both within Bangladesh.

Time passed but a durable solution eluded. The two-year MOU of 1982 expired after the dry season of 1984. Another MOU that was signed in November 1985 was to be in force until 1988. The so called 'old line' of Bangladesh on augmentation gave way to the new approach. Politicians as well as technocrats apprehended that the earlier proposal of augmentation by building storage reservoirs in the upper reaches of the Ganga would increase, by more than 30%, the existing water body of Nepal and submerge the scarce land of Nepal, particularly the farm land in the plains. Moreover, implementation of these schemes would take a long time, during which India's demands, or the Ganga's upper reaches would be stronger and leave no scope for increasing the dry-season flow at Farakka.

Dhaka's new approach for augmentation by joining the Brahmaputra with the Ganga within Bangladesh resembled India's proposal of 1978, which it had been rejecting so far. It had vehemently criticized it, dismissing it as India's hostility toward Bangladesh. The new thinking of Dhaka, which was similar to India's 1978 proposal was, therefore, 'betrayal and treachery' of India. The proposed scheme was under wraps and an abiding solution of sharing and augmentation issues gradually emerged. In an interview in 1987, Bangladesh Water Minister, Anisul Islam Mahmud clarified that there were two parts in this new approach – one was official and the other unofficial. The official approach had three main elements:

i) The Government of Nepal should be brought into the negotiations.
ii) Negotiations should cover all common rives, not just the Ganges; and
iii) The two issues of sharing and augmenting the dry-season flow of the Ganga should be separated and priority be given to the issue of sharing water.

However, Mr. Mahmud did not disclose the unofficial approach and kept it a secret, probably to ward off the supporters of the old approach. Circumstantial evidences and future developments clearly indicated that the demand for a tripartite understanding, or an agreement by inclusion of Nepal, gradually faded out in the unreality of the situation.

A new impetus from India under Prime Minister Rajiv Gandhi, reciprocated by Bangladesh President H. M. Ershad and his Water Resources Minister, Mr. Mahmud, brought into focus a settlement. President Ershad made Mr. Mahmud the chief Bangladesh negotiator with India, over-ruling objections by the hardliners in his country. A lot of changes had occurred by this time in the Joint Committee of Experts (JCE) in Bangladesh. B. M. Abbas, a water resources engineer, and a senior negotiator on the issue and a staunch supporter of the old line for more than two

decades, was out of the government. Key diplomatic and technical positions went to strong believers of the new line. Also, by this time, funds flowed to Bangladesh from the World Bank for a pre-feasibility study of constructing a barrage over the Brahmaputra at Bahadurabad. A team of foreign engineers, who were examining alternative options, was inclined to support the new line.

The JCE and government-level discussions supported this new approach, particularly on utilization of the Brahmaputra water for augmentation of the dry-season flows of the Ganga at Farakka. India's representatives indicated three possibilities and asked Bangladesh experts to consider them, so as to place some concrete proposals before the ministerial-level meeting but the latter did not accept them. The three Indian proposals were

a) Construction of a barrage over the Brahmaputra at Jogigopa in Assam with a link canal through India, northwest Bangladesh and back to India to join the Ganga upstream of the barrage;
b) A barrage over the Brahmaputra at Bahadurbad and a link canal from upstream of barrage joining the Ganga near the Hardinge Bridge, all in Bangladesh; and
c) To utilize the waters of the Brahmaputra to meet some requirements of Bangladesh which were being met, or were to be met, from the Ganga without necessarily linking the two rivers with a canal.

When Bangladesh official put up these proposals to Mr. Mahmud, he endorsed the second which was consistent with the new approach. Ramswamy Iyer, the Secretary of the Indian Ministry of Water Resources, who led the Indian team held that the feasibility of a barrage and the gravity link canal within Bangladesh could be discussed on the condition that Bangladesh would not claim the minimum Ganga flow of 34,500 cusecs, as reflected in the 1977, 1982 and 1985 agreements / MOUs and India would not bring down to zero the flow at Farakka. He proposed about half a dozen possibilities which were accepted by Bangladesh. Mr. Mahmud proposed that his country be guaranteed a minimum dry-season flow of 25,000 cusecs from the Ganga in the last 10 days of April (21–30), 75% of the Brahmaputra flow and 50% of the flow of other common rivers, which Indian negotiators did not commit, causing a setback in the discussions.

In the ministerial-level meetings in 1986, two different attitudes surfaced. Shankaranand, India's Water Resources Minister, wanted the meeting to take up the two issues together, but Mr. Mahmud insisted on dealing with the sharing issue first. India reiterated its rejection of Dhaka's proposal for augmentation of the Ganga water by constructing storage dams in Nepal and stressed on reaching a long-term accord on the two issues but did not guarantee share of water of all common rivers, which Dhaka demanded. Bangladesh argued that sharing was an immediate bilateral problem, while augmentation was a long-term issue, requiring her co-operation with India and Nepal. Bangladesh also took the stand that it would not consider the augmentation proposal, unless India assured a definite share of the water of all common rivers. In short, India stood for sharing along with augmentation of the Ganga water

but Bangladesh did not agree to go for augmentation unless New Delhi guaranteed share of the principal common rivers.

In 1986, the two countries agreed to discuss the issue with Nepal but meanwhile, Dhaka added a rider to New Delhi that discussions with Kathmandu would not be a precedent for any trilateral understanding. In October, that year, JCE delegates of two countries went to Kathmandu and called on its Water Resources and Foreign Ministry officials but the discussions yielded no solution. The delegates could not tell Nepalese leaders, how their country would be benefitted and what cost. Nepal gave no data on water-related issues but insisted on knowing 'mutual benefits' before parting with them. India and Bangladesh insisted that the data sought was needed for a preliminary study and the mutual benefits could be decided and disclosed later but Nepal stuck to its gun, rendering the meeting a waste of time and money. India's desire for involving Nepal as a party to a tripartite agreement on the augmentation issue made no headway and no approach paper, as per agenda, could be prepared.

The situation forced Bangladesh to rethink. Dhaka was convinced that building of storage dams in Nepal was a Utopian idea and could never materialize. Kathmandu would never agree to such a thing and India would not compromise on its policy of bilateralism. Mr. Mahmud veered to his new proposal, under which two barrages would be constructed over the Brahmaputra and the Ganga with a link canal, connecting the two, all within Bangladesh. Though discussions on this in 1987 were incomplete, Mr. Mahmud brought the matter to the surface for the first time.

In 1987, the relation between the two governments worsened again over mass migration of tens of thousands of Chakma refugees from the hill tracts of Bangladesh to India. They fled, following Army actions in the hilly regions of Chittagong and insurgency in the hilly tracts of Tripura, an Indian province. In the latter, Bengalees were ousting tribal people so that they could settle in their places. To sharing the Ganga water, the 'hard-liners' in Bangladesh were stiffly opposed and her Foreign Minister and Water Resources Minister appeared to be at loggerheads. President Ershad and Mr. Mahmud thought that a joint visit by teams of India and Bangladesh to Nepal could ease political pressures within Bangladesh on the 'old line' and encourage the 'new line'. Mr. Mahmud once said that he did not believe that Nepal would really provide a solution and that the Brahmaputra, not the Ganga, could ultimately meet Bangladesh's need for additional water. Ben Crow quoted an Indian official in the JCE on the situation:

> My personal view is that we could have done something, if Anisul Islam Mahmud had been backed politically and if Humayun Rashid Chaudhury had not taken a different line. I think, a long-term agreement could have been negotiated, not on Anisul Islam Mahmud's figures, but we could have compromised.

The severe floods of 1987 and 1988 in Bangladesh got a lot of international media coverage and heightened concern within and outside the country. This gave a new scope for further negotiation between the governments of India and Bangladesh. Mr. Ershad travelled to another riparian country, China to know, how they were solving their problems and to discuss regional cooperation in river development. Meanwhile, the floods were so severe in Bangladesh that the government machinery

was busy tackling them. The Ganga returned to focus after 1988. The old-liners blamed India and the Farakka Barrage Authority in particular for releasing all waters from the reservoir and for creating flood havoc in Bangladesh.

Even senior politicians and government officials pursued this line of thinking, ignoring the functions of a barrage and its difference from a dam. Even engineers who should know better said in a chorus that complete flood control lay not with Bangladesh alone but with the region too with cooperation of India and Nepal. A French consortium, the United Nations Development Programme (UNDP) and the World Bank disagreed with them and advised building embankments on the Ganga and the Brahmaputra along most of their courses to prevent floods, as far as possible and to train people to live with them, as they have been used to. The UNDP recommended zoning of flood-prone plains, adopting judicious protection measures and controlled flooding in some areas as well as river training.

Discussion on flood-control measures with India continued without any effective solution. The agreement of 1985 expired after the dry season of 1988. The tenure of the JCE also expired in November of 1985 and was not extended. The new line of thinking on augmentation and dialogue on other river development issues between the two countries did not also go further.

Developments between 1988 and 1996

There had been no agreement between India and Bangladesh on lean-season sharing of the Ganga water at Farakka after 1988. Even the issue of water-sharing of all common rivers between the two countries got no further momentum because of rigidity in their approaches.

In end-1989, President Ershad visited Nepal and China and discussed the water-sharing and augmentation issue with their heads of governments but he could not make any headway either. The political situation in India and Bangladesh had also changed. Through a general election in 1989, Viswanath Pratap Singh of the Janata Party became India's Prime Minister after Rajiv Gandhi in May 1991. Mr. Gandhi was killed by a suicide bomber of the LTTE during his election campaign near Chennai. President Ershad was also overthrown in December 1990 by Begum Khaleda Zia who later became the Prime Minister of Bangladesh. Efforts made by the heads of two Governments to solve the issues were stalled again. The Joint Rivers Commission resumed the dialogues on the issues after years of gap.

In May 1991 election in India, P. V. Narasimha Rao of the Congress party became India's prime Minister. He and Begum Zia met in New Delhi and agreed to forge a comprehensive and permanent plan on developing water resources within a specified period but without exacerbating political problems in either country. In August 1991, foreign ministers of two countries met in New Delhi and discussed long-term solutions. India proposed a package on the line of the Indus Treaty, involving the Ganga, the Brahmaputra, the Meghna and the Teesta. It included use of the Brahmaputra and the Meghna waters and constructing barrages across the Ganga and the Brahmaputra, but as before, Bangladesh did not agree.

Another minister-level meeting was held in August 1992 in Dhaka, where a new Joint Committee of Experts (JCE) was formed. It met many times in New Delhi and Dhaka between 1993 and 1996, but there was tardy progress toward an understanding of the twin issues of sharing and augmentation of the Ganga water at Farakka, to which was added Dhaka's plea for sharing of water on all other common rivers by India and Bangladesh.

In the dry seasons from 1989 to 1996, without a formal agreement, India continued to release water to Bangladesh from the barrage, as before, as per a superseded sharing formula in the spirit of mutual cooperation and understanding (see Table 8.1). India also continued observing the discharges, downstream and in the feeder canal and maintained records. In 1992 and 1993, the total flow in the lean period, between January and June, was much less than in earlier years. There was acute shortage of water in those two years, both in the Ganga and the River Bhagirathi. The Hooghly's reach in the vicinity of Calcutta port was heavily silted, decreasing the depth for incoming and outgoing vessels and raising the cost on dredging. Some units of India's National Thermal Power Corporation (NTPC) at Farakka had to be shut down, as production fell to all-time low in April. The entire reach of the Bhagirathi-Hooghly from Jangipur to Diamond Harbour was also severely affected by siltation.

There was hue and cry in Bangladesh, as water became scarce in the Padma too in 1992 and 1993. Newspapers reported that the discharge recorded near the Hardinge Bridge in March 1993 was only 276 cumecs, or 9,761 cusecs, the lowest ever. The Gorai was affected too and the Ganga-Kapotaksha irrigation-cum-power project had to be closed for a few days. Khulna industrial belt on its bank as well as jute and paper mills in the region were affected and had to cut down production. Crops dried up as ground-water level went down, affecting supply of drinking water. Salinity intruded in the river and ground water of the Gorai's hinterland. Jammat-I-Islam organized a big protest rally of over 25,000 people on the dry bed of the Padma, near the Hardinge Bridge in April 1993. Bangladesh government expressed its helplessness and disappointment over the slow progress of talks in the JCE but stuck to its stand of involving Nepal.

The flow increased in the Ganga from 1994 to 1996 and discharge was sufficient at Farakka in the lean season to facilitate equitable distribution as per the earlier understanding. Public resentment in Bangladesh also disappeared and the two countries reiterated demand for a permanent solution.

Politics in India was in turmoil formal since 1996. In that year's general election, the Congress party lost again but no other party or group got absolute majority to form a government. The President called Atal Behari Vajpayee of the Bharatiya Janata Party (BJP) and its allies to form a government but after only 13 days, it fell in a trial of strength in Parliament. Some political parties came together to form a government, led by H. D. Deva Gauda of Janata Party, who became the Prime Minister with the support of the Congress in June 1996.

Bangladesh too went for poll in March 1996, in which the Awami League, led by Sheikh Hasina, daughter of Sheikh Mujibur Rahman, the founder President of Bangladesh, became the Prime Minister by defeating Sheikh Khaleda Zia's Bengal Nationalist Party.

From the beginning, both the governments revived interest in a solution, clearing the air of suspicion and mistrust. In Bangladesh, farmers were groaning for water for irrigating farm land; towns and industries on the banks of the Gorai suffered for lack of adequate water. The new government resumed dialogues on water-sharing of the Ganga and other common rivers. India took the initiative on 5th July 1996, when New Delhi sent its foreign secretary, Salman Hyder to Bangladesh to hand over a letter from the Prime Minister to Bangladesh premier on the issues. In Dhaka, he discussed the matter with Bangladesh foreign secretary and assured him of India's interest in an abiding solution before the next dry season of 1997. The JCE came up with a proposal on the subject. In October 1996, India's and Bangladesh's foreign ministers visited Dhaka and New Delhi (and Kolkata), respectively came closer in their views. Jyoti Basu, the then Chief Minister of West Bengal also visited Bangladesh on 27th November 1996 and reached an understanding with Dhaka on water-sharing issue on a permanent basis. Returning to Kolkata, Mr. Basu hinted at signing a short-term agreement with Dhaka for two to three year, but it was seen later that he was really in favour of a long-term agreement.

Thirty-Year Treaty on Water-Sharing

Accompanied with her Water Resources Minister, Abdur Razzak and senior officers, Bangladesh premier, Sheikh Hasina came to New Delhi on 10th December 1996 and met Prime Minister Deva Gauda and senior Indian officers. Jyoti Basu was called to New Delhi to meet her. A momentous 30-year Treaty was signed on 12th December 1996 between India and Bangladesh on the sharing of the Ganga water in lean season at Farakka with immediate effect. Under it, each country would receive a guaranteed flow of 35,000 cusecs (991 cumecs) in the lean season, from 11th March to 10th May. It was based on a formula that took into account average availability of water at Farakka to be 70,000 cusecs (1982), during the past 40 years, from 1949 to 1988), on 50:50 basis. If the availability went up to 75,000 cusecs, Bangladesh will get 35,000 cusecs and India 40,000 cusecs through the feeder canal. If it exceeded 75,000 cusecs, India will get 40,000 cusecs and release the balance to Bangladesh.

As provided in the earlier Agreement and the MOUs of 1977, 1982 and 1985, water-sharing under the new Treaty would be on the basis of alternating three 10-daily periods, each month in the lean season, from 1st January to 31st May, although the critical period was from 1st March to 20th May, when the discharge in the river fell to the minimum. If the discharge fell below 70,000 cusecs, each country would receive a reduced quota. The Treaty also ensured that if the flow was less, at least one side would get its guaranteed share of 35,000 cusecs in one 10-daily period.

The Treaty has 12 Articles as against 15 in 1977 agreement. The full text of the treaty is given in Appendix D. A broad indicative schedule, giving the formula of sharing is annexed as I and II. The annexure-I gives a broad indication of sharing and a detailed agreement. These imply that every effort would be made by the upper riparian States of India – Bihar and Uttar Pradesh – to keep flow of the Ganga at Farakka at the 40 years' average of 70,000 cusecs. If the flow at Farakka goes below

50,000 cusecs in any 10-daily period, the two governments would immediately consult each other to make adjustments on an emergency basis.

Under the Treaty, a joint committee was to be constituted to ensure proper implementation of various provisions. It would form suitable teams at Farakka and at Hardinge Bridge to observe and record daily flows below the barrage and in the feeder canal as well as the navigation channel of the Bhagirathi and near Hardinge Bridge on the Ganga-Padma and submit annual reports to the two governments. Whatever differences or disputes that arise, while implementing the Treaty are not resolved by the committee, would be referred to the Indo-Bangladesh Joint Rivers Commission (JRC). If any difference or dispute persists, it would be referred to the two governments which would meet urgently to resolve it by mutual discussion under Articles IV, V, VI and VII.

The Treaty also empowered the two governments to review it after five years from its coming into effect, or earlier, as felt by either country, in the spirit of equality and fairness without harming the interests of the other. It would also be open to either party to seek the first review after two years, to assess the impact and working of the sharing arrangement under Article X; this was not provided in the agreement of 1977.

Unlike the 1977 agreement, the Treaty did not give any importance to augmentation of the Ganga flow at Farakka, except that the two governments recognized the need to co-operate with each other in finding a solution to this long-term problem (Article VIII). The Treaty would remain in force for 30 years and can be renewed by mutual consent (Article XII).

Another important provision was that if the two countries agreed on adjustment after a review, as per Article X, India would release not less than 90% of Bangladesh's share, as per the formula in Article II until mutually agreed flows are decided (Article XI).

The Treaty was signed in New Delhi on 12th December 1996; the signatories were Indian Prime Minister, H. D. Deve Gouda, his Water Resources Minister, Jnaneswar Mishra, Foreign Minister, I. K. Gujral and West Bengal Chief Minister, Jyoti Basu and three associates – D. P. Ghoshal, Secretary, Irrigation and Waterways and R. N. Dey, Chief Engineer of the Irrigation and waterways department of West Bengal government and S. V. V. Char, Commissioner (ER) of Ministry of Water Resources. The signatories from Bangladesh were just two – Prime Minister Sheikh Hasina Wazed and her Minister of Water Resources, Abdur Razzak. Photograph 10.1 shows two leaders Sheikh Hasina and Jyoti Basu engaged in discussions prior to the signing of the Treaty.

To sum up the salient features of the Treaty:

a) India will release water from the Farakka Barrage in the five-month lean season, from 1st January to 31st May, every year;
b) Bangladesh will get a minimum of 35,000 cusecs, or 50% of the Ganga water at Farakka, if its volume is 70,000 cusecs, or less;
c) India and Bangladesh will get guaranteed 35,000 cusecs in three alternative 10-day periods from 1st March to 10th May;

Photograph 10.1 GOOD TIMES: Mr Jyoti Basu and Sheikh Hasina at Banga Bhavan, New Delhi, on Thursday. — The Statesman.

d) Bangladesh will get a maximum of 67,516 cusecs from 1st to 10th January and a minimum of 27,633 cusecs from 11th to 30th April;
e) India will get a maximum of 40,000 cusecs in seven 10-day periods in January and February and from 21st to 31st May and a minimum of 25,992 cusecs from 21st to 30th April; and
f) If the flow at Farakka falls below 50,000 cusecs in any 10-day period, the two governments will discuss adjustments.

After signing the agreement, Sheikh Hasina told a crowded news conference in New Delhi:

> This is a momentous event for the people of Bangladesh, as we mark the 25th anniversary of our freedom. . . .Bangladesh will firmly leave behind the atmosphere of suspicion and distrust that had blighted its ties with India. . . . it is a historic event that will usher a new era of co-operation and friendship with India. Having resolved the most difficult and outstanding issue of water-sharing, we can have legitimate pride in our achievement. For me, it's a moment of high emotion. I hope, our people will consider the signing of this treaty a fair one.

H. D. Deva Gouda, Indian Prime Minister reciprocated:

> Mrs. Wazed's visit to India is a landmark event in Indo-Bangladesh relations, which has opened the way to wider and deeper co-operation between the two countries.

Making a suo moto statement in the Lok Sabha, he said:

> It was a fitting tribute to the special quality of relations between the two neighbours and the spirit of brotherhood would lead to a new era.

Other Reactions

Atal Behari Vajpayee, the leader of the opposition in Lok Sabha (a former Foreign Minister and future Prime Minister), welcoming the Treaty said 'I hope that the national interests of both countries have been safeguarded'. Jyoti Basu, Chief Minister of West Bengal, who was the architect of the Treaty, said:

> The pact which has benefited us and will no doubt benefit Bangladesh would not be without its rewards. To our advantage, the option of the use of Chittagong port by our industrialists has opened up, significantly so, in the context of the State's plans for industrial rejuvenation. No longer will we be in a state of uncertainty over the quantum of water from Farakka. . . . The guarantees (on the allocation of the Ganga water), provided for the first time in such an agreement, should resolve outstanding problems. We too had our experts and those from the Centre when the pact was finalized. For the first time, India had been assured of a minimum of 40,000 cusecs of the Ganga waters in seven of 15 ten-day periods during the loan season. Only once had the State enjoyed this privilege in the past 40 years.

Mr. Basu was particularly hopeful about the proposed Sankosh project in Bhutan, aimed at providing additional 12,000 cusecs of water daily to West Bengal. The project was to be included in India's Ninth Five-Year Plan. He regretted that though a committee of the Chief Ministers of three upper riparian States – Uttar Pradesh, Bihar and West Bengal – was set up during Rajiv Gandhi's tenure to co-ordinate the Ganga's flow, ongoing pilferage by farmers in Uttar Pradesh and Bihar reduced the quantum reaching West Bengal.

A. B. A. Gani Khan Chaudhury, the Congress MP from Malda and a former Water Resources Minister in Government of India was the first to criticize the Treaty.

> It is an unrealistic Treaty. It has not only damaged the interests of Calcutta Port, but could also worsen bilateral relations between India and Bangladesh in future. Calcutta Port Trust will be badly affected, because it needs at least 40,000 cusecs of water to remain operational. Who will measure the quantum of water required to wash out the silt, deposited in the Hooghly basin? Now that the accord has been signed, its (Bangladesh's) representatives in the joint monitoring committee will always blame us of using more water.

Some Calcutta Port Trust officials complained:

> The Port's interests have been badly compromised. They will have to think of a deep draught port, well below Haldia, for the survival of Calcutta Port.

The gloom in the port and shipping circles in India was largely because of the clauses of water-sharing. They felt that the sharing on the basis of 10-day periods, especially in the acute lean-season, between March and April, would aggravate rather than halt the progressive silting of the Hooghly and reduce its navigability.

> In the two cycles of 10-day periods in the crucial month of April, Calcutta port area will get from the Farakka Barrage between 25,000 and 28,000 cusecs, which is too low a head-water flow to flush out silt to the sea. The agreement in no way reverses the process of deterioration of the Hooghly. Heavy siltation will increase the intensity and frequency of

> tidal bores, which will seriously impede navigation. Fall in draught may render the port's 240 million rupee new container terminal inoperative in a decade.

Debesh Mukherjee, the first and former General Manager of the Farakka Barrage Project questioned the sharing formula. He remarked;

> The average data on the water-flow does not reflect the ground reality. Flow of water varies from day to day. Under the agreement, the average flow in April has been shown to be between 60,992 and 63,180 cusecs, whereas the actual average flow during the month for the past decade has been about 54,000 cusecs. It would have been somewhat proper if the average flow had been arrived at on the basis of data of the past decade rather than the past 40 years. Naturally, the basis for the sharing formula is flawed as also the quantum. Calcutta will get much less than what has been stated in the agreement, as the take-off on the upstream, especially in Uttar Pradesh and Bihar, has been growing fast in recent years.

Reactions in Bangladesh

In Bangladesh too, **r**eactions to the Treaty were varied, as in India. The leaders of the Awami League which came to power were expectedly euphoric.

> The agreement is yet another feather in Sheikh Hasina's cap. Nothing could have been more wonderful and better-timed than this. This is the best that could happen to Bangladesh.

A professor of Dhaka University, Ainun Nishat was on a different plank.

> The water available at Farakka is the residue left out, after utilization in upper reaches, [which] . . . is India's own affair, provided the interests of Bangladesh did not suffer. . .. The water made available to Bangladesh should be utilized judiciously, for the protection of environment and its uplift. . .. The upper riparian country would be responsible for gradual increase of withdrawal in the upper reaches of the river". [Translated from Bengali]

Experts as well as common people felt what the manner in which Jyoti Basu and his Finance Minister, Dr. Asim Dasgupta agreed to a 30-year treaty was rather odd, because they thought, India would go in for a short-term agreement for two to three years. A dramatic change in their stance surprised them. It was also intriguing that India's Ministry of Surface Transport, Calcutta Port Trust, Central Water Commission, Central Water and Power Research Station and Farakka Barrage Project Authority as well as the provinces of Bihar and Uttar Pradesh were kept in the dark and not invited to the signing ceremony, unlike in the function of signing the short-term agreement of 1975.

In short, many people, particularly politicians in power in both the countries, welcomed the treaty but opposition parties voiced against the Treaty. India's Bharatiya Janata Party organized a huge rally of nearly a million people from West Bengal and adjacent States at Farakka.

After the Treaty (1997 to 2001)

Immediately after the signing of the Treaty, the procedures for inspection and monitoring of water-sharing, measurements of releases to Bangladesh, India's withdrawals through the feeder canal and flow arrivals at Hardinge Bridge were required to be instituted, for which the joint committee met in New Delhi on 21st December 1996. In this meeting, it was decided to set up observation teams at suitable sites near the Farakka Barrage and the Hardinge Bridge, to work out a method of functioning of the joint committee and submission of daily reports etc. It was also decided that in the lean season, joint teams would measure the discharge in the Ganga downstream and in the feeder canal from eight in the morning to 12 noon and inform the Barrage authorities about the quantum of releases to be made in two directions; they would then operate the barrage and the regulator gates as per the schedule and release water, accordingly. The records would be transmitted everyday in the prescribed format. The same procedure would be followed at the Hardinge Bridge site at Bangladesh.

The implementation of the Treaty started from 1st January 1997. A four-member first observation team from Bangladesh was stationed at Farakka from 1st January to 31st May, that year. Along with the Indian team, joint observation of the Ganga downstream and of canal started. The flows were recorded, every day and gauge observations were taken every 4 h, day and night. Water was released thereafter from 1400 to 1800 h every day in the Ganga and the feeder canal by operating the barrage gates. India's observation team, stationed at Bheramara in Bangladesh and along with the Bangladesh team, they began joint observations in the Padma, upstream of the Hardinge Bridge. Based on field observations, the discharge in the river was computed at both the places and the data were transmitted to various departments as per guidelines.

The lean season discharge, available in the Ganga in 1997 fell below 50,000 cusecs in 1st week of April, necessitating invocation of emergency clause of the Article II (iii) of the Treaty.

The matter was discussed in New Delhi and in Dhaka soon afterward. It was jointly decided that the minimum flow to either side would not go below 15,000 cusecs. Irrespective of arrivals at Farakka and that there would not be any adjustments of flows to either side on account of this arrangement except to the extent, dictated by the gate operations.

The sudden fall in discharge in the feeder canal, from 35,000 cusecs in the end of one 10-day period to 15,000 cusecs, or less, in the beginning of next 10-day period was referred to the Joint Committee. If such falling flows persisted, it would have jeopardized the safety of the unlined earthen channel by causing bank slips. India pointed out that the feeder canal, being earthen, could not be subjected to such sudden and rapid fluctuations of flow. Such low levels should be gradual, particularly at the falling stage. As a result, lesser discharge would be released to either side, in their turn of getting 35,000 cusecs. After discussions, both sides agreed to modify operation and to suitably adjust the shortfall.

Table 10.9 Variation of discharge in the dry season of 2001 in the Ganga

Year and month	Available discharge variation	Anticipated discharge as per Annexure-II (cumecs)	Approx. percentage shortfall/excess (–)/(+)
2001 January	3,270–2,490	3,040–2,550	(+)3.04
February	2,470–1,760	2,440–2,240	(–)9.62
March	2,010–1,490	2,110–1,830	(–)11.42
April	1,690–1,490	1,790–1,720	(–)9.40
May	1,610–3,450	1,910–2,320	(+)19.62

As mentioned, year 1997 was one of the driest years and the Ganga's discharge on 30th March, that year, came down as low as about 46,000 cusecs. Two 10-daily periods from 21st to 31st March and from 1st to 10th April bore the brunt of low discharge, which had to be shared by the two countries. In fact, the shortage continued for most part of the sharing period of lean season, from 1st January to 31st May. Against the anticipated flow, varying from 74,000 to 65,000 cusecs in March, the available flow varied from 66,000 to 53,000 cusecs. Similarly, against the anticipated flow, varying from 63,000 and 61,000 cusecs in April, the available flow varied from 64,000 to 50,000 cusecs.

From 1998 to 2000, the Ganga had sufficient flow at Farakka; no difficulty was faced in these three years to release water as per the sharing ratio. In those years, the available flow in March varied from 85,000 to 69,000 cusecs against the anticipated flow between 74,000 and 65,000 cusecs. These were much higher than anticipated flow for the entire lean period.

In 2001, scarcity returned, reducing the discharge rapidly from January onward. The discharge variations in lean-season months of 2001 are shown in Table 10.9.

The minimum discharge, recorded at Farakka was 1485 cumecs on 15th April 2001, against the anticipated discharge of 1,773 cumecs. However, the discharge did not fall below 50,000 cusecs (1,416 cumecs) on any day as in 1997. Nevertheless, Calcutta Port faced siltation and less of draught in the navigation channel.

The present treaty will be valid until 2026 and its overall effect is anybody's guess but as morning shows the day, its impact in five years since 1997 when it was signed, has been from bad to worse. A wide and healthy navigation channel from Farakka to Haldia and the future of Calcutta Port would be in jeopardy, unless the flow, available at Farakka, is augmented and India's due share of 40,000 cusecs is not allowed to pass through the feeder canal into the Bhagirathi-Hooghly in near future.

Diversions from Farakka Barrage

In 2009, some 32 years have passed since the commissioning of Farakka Barrage in 1977 and billions of cusecs of the Ganga water have flown through the feeder

canal and the Bhagirathi. Its moribund channel and the tidal channel of the Hooghly have been somewhat rejuvenated. Calcutta Port and the city got a fresh lease of life following voluminous flow of sweet water. Much less than the required and agreed quantity of 40,000 cusecs did pass, which was not enough to restore the navigation channel to the 1935 condition. The overall effect of letting in the Ganga water into the Bhagirathi-Hooghly navigation channel from 1978 to 2000, as against that of 1975, can be seen from the records of the Calcutta Port Trust, as summed up below, in four periods.

i) Period from 1978 to 1982, covered by the 1977 agreement,
ii) Period from 1983 to 1988, covered by the MOUs of 1982 and 1985,
iii) Period from 1989 to 1996, covered by no. agreement, MOU or Treaty, and
v) Period from 1997 to 2000, under the 30-year Treaty of 1996.

The navigation channel can be divided into six parts:

i) Ahiron to Berhampur-108 km (upper reach of the Bhagirathi),
ii) Berhampur to Nabadweep-122 km (lower reach of the Bhagirathi),
iii) Nabadweep to Tribeni-82 km (upper tidal zone of the Hooghly),
iv) Triveni to Kashipur (Calcutta Port area)-63 km (lower tidal zone of the Hooghly
v) Kashipur to Hooghly Point-63 km (upper estuary of the Hooghly), and
vi) Hooghly Point to Sagar Island-84 km (lower estuary of the Hooghly).

An index plan of the Bhagirathi-Hooghly is shown in Fig. 10.11. The effect of the upland discharge on the two reaches of the Bhagirathi in terms of the average Hydraulic Mean Depth (H.M.D), its cubic capacity and the percent variation in different years from 1975 (pre-barrage period) is shown in Table 10.10.

The table shows that the effect of upland discharge on the upper reach of the Bhagirathi is far better than in the lower reach. The average depth increased by

Table 10.10 Effect of Ganga discharge on the river Bhagirathi at dominant stage level

	Upper reach (108 km) (Ahiron to Berhampore)				Lower reach (122 km) (Berhampore to Nabadwip)			
Year	HMD (average) (m)	Percentage variation (+)/(–) w.r.t.1975	Cubic capacity (post-monsoon) (10^6 m^3)	Percentage variation (+)/(–) w.r.t.1975	HMD (average) (m)	Percentage variation	Cubic capacity (post monsoon) ($10^6 m^3$)	Percentage variation (+)/(–) w.r.t. 1975
1	2	3	4	5	6	7	8	9
1975	4.37	–	98.20	–	5.10	–	187.20	–
1982	5.92	(+)35.50	114.40	(+)16.50	4.85	(–)4.90	190.00	(+)1.50
1992	5.49	(+)25.60	128.00	(+)30.30	5.07	(–)0.59	199.60	(+)6.62
1996	6.09	(+)39.40	140.90	(+)43.50	5.15	(+)1.00	192.60	(+)2.88
1998	5.63	(+)28.80	129.20	(+)31.60	5.10	0.00	194.00	(+)3.63

more than 39% up to 1996 and thereafter, fell to about 29% in 1998. The cubic capacity increased by more than 43% in 1996 and thereafter, fell to about 32% in 1998. However, in the lower reach the effect of discharge has been less. The average depth increased by about 1% up to 1996 and thereafter, remained same. The gradual reduction of depth from 1996 could be due to the effect of the Treaty, under which the flow has been fluctuating every 10-day in the lean season. The change in cubic capacity in the lower reach was not significant.

The impact of upland discharge from Farakka on the third reach of the river (upper tidal reach of the Hooghly), in terms of its cubic capacity in both high and low water level is shown in Table 10.11.

The table shows that the condition of the Hooghly reach from Nabadweep to Triveni had been deteriorating in pre-barrage days. The analysis of cubic capacity shows that it decreased from 157 to 148 million cubic meters at High Water Level (HWL) between 1974 and 1975, but in spite of induction of upland discharge of 40,000 cusecs from April 1975 and 1977, the reach did not improve. The cubic capacity showed decline by 8–10% at high and low water levels. Improvement was not expected so soon, as the silt load that was moving down, did not have enough time to move further down and get deposited in this reach. Had there been sufficient discharge of 40,000 cusecs for a longer period, the silt load could move further down gradually, leaving the Port area to the lower estuary region. This did not happen owing to fall of lean-season discharge from 1978 as per the previous year's agreement. A part of the silt load, following the scouring of the Bhagirathi bed, had also deposited in this reach. This process continued up to 1982 and thereafter, as shown in the table. Though the condition improved in 1987 and 1996 over the earlier years, it could never be even that of pre-barrage days of 1975. The improvement was due to the creation of silt-trap zones by yearly dredging of about one

Table 10.11 Effect of Ganga discharge on the upper tidal compartment of the Hooghly (Nabadwip to Triveni)

	Cubic capacity (10^6 m^3)				
Year	H.W.L.	Percentage variation w.r.t. 1975 (+)/(–)	L.W.L.	Percentage variation w.r.t 1975 (+)/(–)	Remarks
1	2	3	4	5	6
1974	157.0	–	134.0	–	Overall adverse effect on the reach.
1975	148.0	–	127.0	–	
1977	136.0	(–) 8.10	115.0	(–)9.45	
1982	124.0	(–)16.20	105.0	(–)17.30	
1987	135.0	(–)8.80	114.0	(–)10.20	
1992	133.0	(–)10.10	114.0	(–)10.20	
1996	142.0	(–)4.05	120.0	(–)5.50	
1997	133.0	(–)10.10 (–6.30)	113.0	(–)11.0 (–5.80)	Further adverse effect
1998	132.0	(–)8.10 (–7.0)	112.0	(–)11.80 (–6.70)	

million cubic metres, near Santipur and at Balagarh below Kalna between 1980 and 1987. The island in the river near Balagarh rose by more than five metres with the dredged spoil. This place has since been selected for the site of a thermal power station.

From 1997, the river's capacity in high and low water-levels deteriorated further, as the cubic capacity reduced by 6% to 8% of the 1996 capacity, in the aftermath of the Treaty.

It is seen in the above table that the upper tidal reach of the Hooghly from Nabadweep to Triveni was silting up, leading to gradual rise of the river-bed over that in pre-barrage days. The navigable depth also gradually diminished. The upland discharge from Farakka did not improve this reach.

The table also shows the effect of upland discharge on the fourth and fifth reaches, i.e., the lower tidal reach and the upper estuary of the Hooghly-Triveni to the Hooghly Point in terms of cubic capacity variation at mean-tide level (MTL), which determines navigation depths over bars in lean season, the frequency of bores round the year and salinity variation in the lean season. Table 10.12 below shows that the upland discharge from Farakka had some positive effects on the reach between Triveni and Kashipur, upstream of Calcutta Port area up to 1977 when 40,000 cusecs were diverted into the river.

From 1978 water was diverted in the lean season as per the agreement and no improvement was noticed. In fact, the cubic capacity started falling since and continued up to 1996. From 1997, the capacity fell further since the last available records up to 1999. Thus, the limited upland flow could not improve this reach of the river. No dredging has so far been done in this reach but extensive dredging with spoil

Table 10.12 Cubic capacity variation in the river Hooghly between Triveni and Hooghly point in post-monsoon period at Mean Tide Level (MTL)

	Triveni to Cossipore (Calcutta port area)		Cossipore to Hooghly point		
Year	Cubic capacity ($10^6 m^3$)	Percentage variation w.r.t. 1975 (+)/(–)	Cubic capacity ($10^6 m^3$)	Percentage variation w.r.t. 1975 (+)/(–)	Remarks
1	2	3	4	5	6
1975	152.0	–	498.0	–	Before Agreement
1976	152.0	Nil	515.0	(–)3.43	
1977	154.0	(–)1.32	521.0	(+)4.62	
1982	152.0	Nil	526.0	(+)5.62	After Agreement
1987	151.0	(–)0.70	545.0	(+)9.44	
1992	148.0	(–)2.63	533.0	(+)7.03	No Agreement
1996	150.0	(–)1.32	533.0	(+)7.03	
1997	148.0	(–)2.63	540.0	(+)8.43	After Treaty
1998	145.0	(–)4.61	558.0	(+)12.05	
1999	144.0	(–)5.26	543.0	(+)9.04	

disposal over land at suitable locations was absolutely necessary to keep the channel silt-free. If 40,000 cusecs of water were released from 1976 continuously, the reach would have improved and become silt-free. Dredging can be done, even now, to maintain the depth of the channel.

The river reach from Kashipur to the Hooghly Point in the immediate downstream vicinity of Calcutta Port area substantially improved after the induction of upland discharge from Farakka. The cubic capacity of the reach increased steadily since 1976, as can be seen from positive percent variations because of increased tidal influence added with the velocity of upland discharge in this reach. The silt-load mostly remains mobile, not getting deposited. The Port authority resorted to continuous dredging to keep the navigation channel silt-free, although its quantum has been reduced substantially from 1975, as seen in Table 10.13. The percent reduction of dredging is varying, as per requirement; still the improvement is substantial.

In some of the years, e.g. 1982–1983, 1986–1987, 1996–1997 and 1998–1999 and some other years, not mentioned in the table, dredging was nominal, or disturbed following break-down of port dredgers. Mean navigable depths over the bars in the lean season, from January to May, every year and over the crossings have increased substantially after the induction of upland discharge, as seen in Table 10.14.

The table shows the increases in mean navigable depths over six bars below Calcutta Port area in the lean season since 1975; percent increase in depth was as under:

(i) Panchpara 13–32%
(ii) Sankrail 40–101%
(iii) Lower Munikhali 47–84%
(iv) Pirsareng 5–36%

Table 10.13 Quantum of dredging in the Hooghly river from port area to Hooghly point

Year	Quantity of dredging (10^6 M^3)	Percentage variation w.r.t. 1975–1976 (+) or (–)	Year	Quantity of dredging (10^6 M^3)	Percentage variation w.r.t. 1975–1976 (+) or (–)
1	2	3	4	5	6
1972–1973	1.92	–	1986–1987	0.28	(–)75.0
1973–1974	2.02	–	1987–1988	0.56	(–)50.0
1974–1975	1.12	–	1991–1992	0.75	(–)33.0
1975–1976	1.43	–	1992–1993	0.95	(–)15.20
1976–1977	0.88	(–)21.40	1995–1996	0.32	(–)71.40
1977–1978	0.84	(–)25.0	1996–1997	0.06	(–)94.60
1981–1982	0.46	(–)58.90	1997–1998	0.30	(–)73.20
1982–1983	0.21	(–)81.30	1998–1999	0.09	(–)92.0

Table 10.14 Mean navigable depths over six different bars below Calcutta port during lean season

Year	Panchpara	Sankrail	Lower Munikhali	Pirsareng	Poojali	Moyapur
1	2	3	4	5	6	7
1974	5.20	4.99	6.11	6.27	5.52	3.91
1975	4.80	4.71	5.18	6.33	5.24	4.24
1976	5.48	5.77	6.72	6.45	6.00	4.18
1977	5.42	6.58	7.61	6.65	5.77	4.02
1982	6.33	8.27	8.64	7.69	6.68	4.38
1987	6.09	8.86	9.43	8.13	7.55	4.20
1992	6.23	8.34	9.09	7.76	5.74	4.39
1996	6.00	8.35	9.52	8.23	6.54	4.57
1997	6.27	8.68	9.32	8.06	6.13	4.55
1998	6.35	9.42	9.24	7.99	7.15	5.24
1999	6.17	9.46	9.17	8.58	6.26	5.07

(v) Poojali 10–44%, and
(vi) Moyapur 8–24%

Before 1975, all the bars below Calcutta up to the Hooghly Point needed regular, annual maintenance dredging of varying quantity, for movement of ships. In 1976 and 1977, the quantum of dredging was substantially reduced. In 1976, lower Munikhali, Pirsareng and Poojali bars did not require any dredging; from next year, Sankrail also needed no dredging. From 1978, all these bars except Moyapur did not require any dredging. The upland discharge had maximum positive effect on Sankrail and lower Munikhali bars, but compared to the year 1996, most of the bars except Sankrail have considerably deteriorated.

The mean navigable depths (MND) over other five bars up to the Hooghly Point are shown in Table 10.15.

Table 10.15 shows that none of the lower bars, except Roypur has improved much after upland discharge from Farakka, despite being dredged continuously. Instead, deterioration of Ninan and Eastern Ghat bars was faster since 1997.

The depth over the bars is utilized for calculation of draughts of ships, navigating to and from Calcutta by Calcutta Port Trust. Table 10.16 shows the governing depths, available to Calcutta Port for movement of ships, round the year. Records from November 1984 are shown in Table 10.16.

The table shows that navigable depths in the port area were falling gradually. The depth of 3.5–4 m, obtaining for more than 150 days on an average before 1989–1990 reduced thereafter and from 1995–1996, this depth was not available below Calcutta, even for a day. The navigable depths gradually reduced to less than 3 m for a long time since 1994–1995. The normal available depth below Calcutta was 3–3.5 m only.

Tidal bores in the Hooghly, especially in Calcutta Port area before 1975, was another impediment to smooth navigation. Because of shallowness and restrictions

Table 10.15 Mean navigable depths over five different bars below Calcutta up to Hooghly point during lean season

Year	Roypur	Phalta	Ninan	Nurpur	Eastern gut
1	2	3	4	5	6
1974	4.40	3.50	4.40	3.90	4.35
1975	4.70	4.40	5.35	4.25	4.15
1976	4.30	4.00	4.35	3.70	4.60
1977	4.80	3.80	4.50	4.00	4.20
1982	4.90	4.65	5.00	4.35	3.75
1987	5.00	3.90	3.85	3.35	3.50
1992	5.05	3.60	4.15	3.80	3.75
1996	4.50	4.40	5.20	4.00	3.65
1997	4.55	4.35	4.95	3.80	2.50
1998	4.90	4.15	4.50	4.70	3.50
1999	5.40	4.75	4.10	3.75	3.25

Table 10.16 Available mean depth in days for ships navigating the port area round the year

Year (July–June)	Navigable depth (m) <3.0 m	Navigable depth (m) 3.0–3.50 m	Navigable depth (m) 3.51–4.0 m
1	2	3	4
1984–1985	17	194	154
1985–1986	31	181	153
1986–1987	36	206	123
1987–1988	152	214	–
1988–1989	36	268	61
1989–1990	3	209	153
1990–1991	15	228	122
1991–1992	34	332	–
1992–1993	91	243	31
1993–1994	20	253	92
1994–1995	118	234	13
1995–1996	224	141	–
1996–1997	184	181	–
1997–1998	132	233	–
1998–1999	127	238	–

on the waterway, the tides from the sea dissipate their energy in forming a wave with a high column of water and moving upstream. In the Hooghly, they rise two to three metres high and hazard the movement of ships and damage jetties, mooring bits, sea-walls etc. Few river estuaries in the world experience such phenomena. Before the barrage came up, the Hooghly used to have tidal bores of varying intensity, throughout the year. Afterward, the frequency of bore tides came down because of continuous upland flow, as shown in Table 10.17. The percentage of their occurrence fell to five after the barrage was commissioned from 50 before it.

Table 10.17 Occurrence of Bore Tides in the Hooghly river round the year

	January to June – 181 days		July to December – 184 days	
Year	No. of days	Percentage occurrence	No. of days	Percentage occurrence
1	2	3	4	5
1974	88	49	51	28
1975	74	41	70	38
1976	90	50	61	33
1977	79	44	53	29
1982	24	13	27	15
1987	23	13	13	7
1992	33	18	25	14
1996	10	6	7	4
1997	22	12	5	3
1998	11	6	6	3
1999	9	5	–	–

The effect of upland discharge in the lower estuary of the Hooghly, i.e., between the Hooghly Point and Sagar island was minimal, as tides were quite high and the upland discharge insignificant. millions of cubic metre of water moved up and down along with huge volume of silt load, lending dynamism to the river. The discharge of 40,000 cusecs, or less, does not much affect the river morphology in this reach. The width of the river also varies from 10 km to about 25 km. Therefore, the huge volume of silt-load moving with the tides oscillates and gets deposited in the bed in a favourable environment. The upland discharge helps this process, as the silt load cannot push upland.

As sea-water is saline, flow tides push it inland, over the estuary and the hinterland. Fresh water coming downstream interacts with this saline water and enhances siltation. Sea-water, being heavier than sweet water, moves near the bed and the mingling of two waters creates some associated problems.

Before the barrage in 1975, there was no upland discharge in the lean season. The saline water from sea used to intrude up to as far as Naihati, some 50 km north of Calcutta Port. With induction of upland discharge from 1975 and a perennial flow even in lean season, saline water got mixed with the sweet water upstream and shed some salinity below Calcutta to near about Achipur, about 30 km downstream. Its movement varies from year to year, depending on availability of lean season flow and monsoon discharges from upstream. The longitudinal variation of maximum salinity in 1980, 1987, 1992, 1997 and 1999, i.e., after the barrage came up as against the situation in 1975 (pre-barrage) is shown in Fig. 10.12.

The figure shows that the potable limit of salinity (0.20 ppt) of the Hooghly water extended to about 50 km upstream of Kolkata in 1975; it came down near Budge Budge in 1980 and further down to the reach between Achipur and Moyapur from 1996 to 1999. At the Hooghly Point, the salinity is about 0.5 ppt, at Diamond Harbour about 1.5 ppt and at Haldia 10 ppt. The drafts in the Hooghly depend on

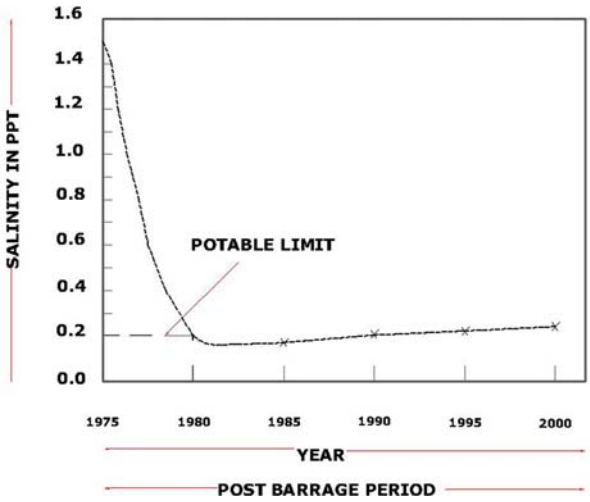

Fig. 10.12 Salinity level of Hooghly water at Palta

upland discharge, fluctuations in water-level owing to flow and ebb-tide and on the condition of the governing bars. In olden days, the river up to Calcutta Port area was navigable in the following periods.

(I) From June to October at high water springs by vessels up to 8.7 m (28.60 feet) draught and at high water neaps by vessels up to 8 m (26 feet) draught.
(II) From October to June by vessels between 6.70 m (22 feet) and 8.20 m (26.90 feet) draught.

Before the construction of the Barrage, this draught had fallen to even below 6 m in both monsoon and other months owing to siltation in the bed and governing bars. Afterward, navigability improved and even 8-m draught vessels were coming to the Port with minimum dredging of the channel. However, this situation did not last long and navigability declined since 1997. Presently, it has become difficult even for 7-m draught vessels to visit Calcutta Port in the lean season, in spite of intensive dredging at vulnerable bars and crossing up to the Sagar Island. This is mainly due to the effect of the 1996 Treaty, under the discharge has been fluctuating from as low as 10,000–15,000 and 35,000 cusecs in the lean season. Gradual decline of the navigational channel of the Bhagirathi-Hooghly was noticed from 1997 and therefore, can be attributed to the fault-lines of the 1996 Treaty.

This is another reason for lesser number of ships coming to Calcutta Port. All over the world, ships had changed enormously by the year of the Treaty. Low-draught and small capacity diesel and electric-driven ships were being replaced by electronically controlled, computer – aided ocean-going bulk-carriers of high draughts. Light cargoes were being carried in containers of various sizes and brought to riverine ports like Calcutta, obviating the need for low-draught vessels. Because of limitation of draught and difficulty of manœuvring larger ships in the narrowing

waterway of the Hooghly, the Calcutta Port Trust constructed a deep-water modern dock at Haldia, a new industrial town near the outfall of the Hooghly, about 68 km below Kolkata on the right bank in East Midnapur district. The dock was opened in early 1977, where deep-draught vessels carrying bulk cargoes of oil, iron ore, coal, fertilizer etc. berth. Its index plan of Haldia dock is given in Fig. 10.13.

Fig. 10.13 Index plan of Haldia Dock

To facilitate movement of deep-draught, sea-going ships and prepare a scheme for improving the navigation channel, Calcutta Port Trust made certain studies. These were examined by experts in the University of Hamburg, Germany who recommended certain measures which, having been implemented, increased the navigational depth of the approach channel by 0.2–2 m (averaging 1 m) at different stretches. The scheme envisaged a number of river-regulatory measures, like construction of northern and southern guide-walls, along its two tips, supported by one at the southern tip of Nayachar island and capital dredging of the Jiggerkhali Flat and the Balari bar. Only the northern guide-wall has since been completed, but no significant improvement is noticed. Other elements of the scheme are now under way. The total number of ships handled by the Calcutta Port, before and after the Farakka Barrage is given in Table 10.18.

The volume of cargo, handled by Calcutta and Haldia docks from 1960 to 2000 is shown in the Table 10.19.

Table 10.18 Total number of ships handled by Calcutta port authority

Year	No. of ships handled at Calcutta dock	No. of ships handled at Haldia dock	Year	No. of ships handled at Calcutta dock	No. of ships handled at Haldia dock
1	2	3	1	2	3
1960–1961	1786	–	1992–1993	780	703
1964–1965	1807	–	1994–1995	782	781
1967–1968	1461	–	1995–1996	835	871
1970–1971	1070	–	1996–1997	901	1059
1974–1975	1039	–	1997–1998	1037	1365
1977–1978	963 (approx.)	30 (approx.)	1998–1999	1066	1347
1980–1981	846 (approx.)	300 (approx.)	1999–2000	983	1278
1985–1986	869	557			
1988–1989	840	591			

Table 10.19 Cargo traffic handled by Calcutta port authority (in million tons)

Year	Cargo handled at Calcutta dock	Cargo handled at Haldia dock	Year	Cargo handled at Calcutta dock	Cargo handled at Haldia dock
1	2	3	1	2	3
1960–1961	9.50	–	1992–1993	5.16	13.18
1964–1965	11.06	–	1994–1995	5.80	14.73
1967–1968	8.99	–	1995–1996	6.12	15.39
1970–1971	6.01	–	1996–1997	6.02	17.10
1974–1975	7.53	–	1997–1998	7.95	20.21
1977–1978	7.00 (approx.)	0.55 (approx.)	1998–1999	9.16	20.22
1980–1981	7.50	1.80 (approx.)	1999–2000	10.31	20.69
1985–1986	4.16	7.97			
1988–1989	4.34	9.69			

Tables 10.18 and 10.19 show that the number of ships and the volume of cargo carried by the two docks varied between 1960 and 1989, owing mainly to non-availability of sufficient upland discharge, causing siltation of the river-bed and to the global tendency to switch over to bigger and deep-draught vessels. The tables also show that the Haldia dock became very active after adoption of regulatory measures.

As stated, river regulatory measures have been partly put into effect below Diamond Harbour. The 2.8 km long northern guide-wall above Nayachar was completed in 1991–1992 to isolate the two distinct navigation channels on either side of the island and to stop inter-mixing of the tidal flow into them and prevent excessive siltation in Haldia port area. Dredging of the Jiggerkhali Fiat has also been done; but, the effect of the guide-wall was not felt and siltation in the channel continued. The flat has been extended inside the channel, blocking the channel completely. Thus, instead of giving any benefit, the northern guide-wall adversely affected the channel by creating a *cul-de-sac* and a slack zone in the Flat region. The alluvial and moving silt-load and the river-bed materials added with unpredicted geo-morphological changes in the estuary have aggravated the problem. Vessels bound for Calcutta Port are now plying on the eastern channel on the other side – the Rangafalla; those bound for Haldia port only use the western Haldia channel; this led to gradual improvement of the draft in Calcutta and Haldia port complexes, as shown in Table 10.20.

The table shows that the substantial improvement that has taken place in both Haldia and Calcutta ports has been due to fluctuations in upland discharges. Haldia port improved probably because of fluctuations in annual dredging in the estuary region.

Table 10.20 Draft available in Calcutta and Haldia port area

	Calcutta port		Haldia port	
Year	Above 7.0 m (in days)	Above 7.50 m (in days)	Above 8.0 m (in days)	Above 8.50 m (in days)
1	2	3	4	5
1960–1961	45	18	–	–
1964–1965	60	35	–	–
1972–1973	95	70	–	–
1981–1982	154	69	360	320
1984–1985	105	33	125	26
1988–1989	220	115	305	150
1992–1993	255	143	341	233
1994–1995	297	175	242	102
1995–1996	236	128	236	70
1996–1997	191	72	187	44
1997–1998	233	114	125	16
1998–1999	232	142	258	114
1999–2000	205	120	292	178

The ground-water level has risen too, benefitting agriculture on both sides of the river. Perennial flow raised surface and ground-water levels, facilitating irrigation and supply of drinking water to the population and industries on both sides. Before the barrage was built, crop yield on both sides suffered on account of water-shortage; this has changed dramatically with farmers raising multiple crops with water from the barrage.

Some envisaged secondary benefits of the Treaty have not accrued, e.g., reduction of bores and salinity, increase in the river's capacity etc. but some improvement in movement of vessels, handling of cargo in Calcutta port and reduction of bores and salinity has indeed occurred. After capital dredging of Jiggerkhali Flat, the Haldia channel is likely to reopen. When a hydro-electric project is built at Farakka, as envisaged, the project will be a complete success.