The sharing of cross boundary water resources in south Asia: a Bangladesh India case study

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THE SHARING OF CROSS BOUNDARY WATER RESOURCES IN SOUTH ASIA: A BANGLADESH-INDIA CASE STUDY

by

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Abstract

Over almost 25 years there existed an equitable water sharing problem between Bangladesh and India which has been partially resolved under the Ganga treaty signed in December 1996. The thesis analyzes this example of cross boundary water sharing using the existing literature and the data which is publicly available. The study covers the geo-physical background, the water disputes, the environmental impact on Bangladesh and the extent of known damage. In the process it also discusses the existing international legal regime and the efforts made by the United Nations on this subject.

Finally, an attempt is made to highlight the present situation between Bangladesh and India and the possible future courses of action for sharing the other 53 international rivers. Short term and long term solutions to national and regional cross boundary water resource sharing and management are suggested.

Declaration

No part of the material in this thesis has previously been submitted for a degree in this or any other university. The work of others has been fully acknowledged and quotations and paraphrases suitably indicated.

Copyright

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CHAPTER 1

INTRODUCTION

From time immemorial fresh water from surface and underground sources has nourished life and habitation on the earth. As civilization flourished, water played a vital role in the economy and prosperity of humankind. Abundance and scarcity of water is one factor responsible for prosperity or poverty, depending on the management of the water resources available. The earth's supply capability of fresh water is unevenly distributed geographically. Presently 26 countries of the world have a serious water deficit. According to Lean (1993) the number of people affected will grow from the present figure of 300 million to 3 billion *in the next thirty years.*

Increasing development will multiply demand for water and further environmental pollution may contribute to shortages. However, demand for water varies from region to region depending upon the population distribution, levels of socio-economic and technological development and climatic variations, including seasonality. The structure and location of demand will also depend upon the relative importance of water use by different economic sectors, and it is evident from the figures of the World Resource Institute that, of the world-wide withdrawal of water, irrigation, industry and other uses account for about 68, 24 and 8 per cent respectively (UN programme 1991).

The use of fresh water resources is often shared by different nations because of topography, and features such as rivers and lakes are frequently utlised as boundaries. It should be no surprise, therefore, that increase in water demand and decrease in supply may lead to international disputes and perhaps even conflicts. In particular, the layout of the river basins put the upper riparian populations in an advantageous position to enjoy the resource as well as to be in control of it, even dictating the environmental and economic consequences of their lower riparian counterparts. To highlight this point Dr. Butros Butros Ghali (ex-Egyptian foreign minister and former Secretary-General of the United Nations, quoted in Lean 1993) said that:

`the national security of Egypt lies in the hands of eight other African countries in the Nile basin'.

In 1948 India and Pakistan were about to start a war on water sharing issues when the ex-President of World Bank Eugene R. Black (quoted in Bindra 1989) commented on the impact of water dispute on India- Pakistan relations by saying:

`five long years after partition, Indian and Pakistani troops were still facing each other behind sand bags and barbed wire at irrigation headworks along the frontiers...this was most likely the lead to all out war'.

Between 1940 and 1980 the use of global water has doubled and it can be calculated from the population growth that it will have doubled again or even tripled by the beginning of the next century. From the available statistics, about 214 rivers/river systems are shared by different countries, out of which twelve are shared by five or more states (Swain 1993). Disputes have taken place concerning water sharing of rivers such as the Jordan, Litani and Yarmuk (Israel and Arab countries), Nile (Egypt, Sudan and Ethiopia), Colorado (United States and Mexico), Euphrates (Turkey, Syria and Iraq) and Danube (Hungary and Slovakia). Controversy also developed regarding Indus water sharing among the South Asian states.

The South Asia region consists of seven countries lying in the southern part of the Himalayan range. The Himalayan mountain range dominates the meteorology of the region, creating the vast water resources from snow, ice and abundant rainfall. It gives rise to innumerable streams and large rivers, forming major drainage systems of the region. Moreover, the geographical location of the region in relation to the ocean has a profound effect on climatic conditions, including the seasonality of rainfall. This rainfall plays an important role in the river flows and flooding, resulting in devastation and the destruction of life and resources.

The sub-continent's river systems have been the basis of civilization and of the way of life of the people since ancient times. The Indus river originates in Tibet and flows south-west from India and Pakistan to the Arabian sea, and a change in its course was perhaps a contributory factor in the extinction of the Indus valley civilization. The river Ganga originates in the Himalaya and flows south and eastward through Nepal, India and Bangladesh to the Bay of Bengal. The River Brahmaputra, originating in Tibet, also flows north to south through China, Bhutan, India and Bangladesh to the Bay of Bengal.

It is important to note that the region only accounts for 3.31 per cent of the world's area but it accommodates 20 per cent of the world's population. In other words the region's population density is 185 persons per sq km compared to world's average of only 30 persons (Bhatnagar 1985). This density of population requires a substantial amount of water for various purposes. However, the density of population is not uniformly distributed within the region. For example, the density of population is highest in Bangladesh at 755 persons per sq km.. Bangladesh is predominantly an agricultural country with 80 per cent of its population engaged in this sector. Rivers are the lifeline of 112 million people of the country within an area of 147,570 sq km., and any fluctuations in the flow of water are not only a major economic threat but also a danger to the fragile ecosystem of the country. The high density and growth of population in the country has added tremendous pressure on agriculture for more production, and this is predominantly dependent on irrigation by river water.

Proper utilization of its natural resources for economic development is extremely vital for Bangladesh. But the utilization of these resources, especially the water resources, is constrained by its geo-political situation. Bangladesh, being a lower riparian state, and located at the estuary of numerous rivers is surrounded by a neighbour which is politically more powerful and economically stronger. As such it has hardly any control over its water resources. The river courses of Bangladesh originate outside the country, and more than 90 per cent of their catchment areas remain outside its territory, mostly in India. This situation makes Bangladesh vulnerable, both politically and economically, and the control over her water resources remains tenuous. The aim of the present research is, therefore, to analyze the geo-political situation between Bangladesh and India, taking water sharing as a case of cross boundary conflict.

Scope and Objectives

Many examples of water sharing disputes can be cited from the region, such as the Sutlej river between the Indian states of Haryana, Punjab, Rajasthan and the Union Territory of Delhi. The dispute over the Ganga's water between the states of Uttar Pradesh, Bihar and West Bengal is another such example. Controversy also exists over water sharing of the Cauveri river between the Indian states of Karnataka and Tamil Nadu. Similarly in Pakistan there has been dispute over the sharing of the Indus between provinces. In all these cases the upper and lower riparian powers have been justifying their present and future water requirements by showing the needs of increasing development, agriculture and other important uses. These examples illustrate that demand for a scarce resource can be a major geo-political issue whether it is inter-state or inter-provincial within a country. There are present and past historical examples of changing boundaries between states or the creation of new states, so one could never say that state boundaries and existing patterns of water sharing are fixed.

Considering all these factors it can be said that there are now and there will arise in future serious issues concerning the sharing of the natural flow of rivers. However, it will not be possible to discuss all such disputes in the limited scope of this research. The study will focus on issues related to cross boundary water sharing between Bangladesh and India as a case study, with the following specific objectives:

a) to identify the nature and the causes of the problem which prevent a peaceful solution to this long standing issue;

b) to find out an alternative approach to initiate new strategies towards the amicable settlement of the problem.

The study will, however, not make any hypothesis or test any theory as such. Rather it will involve an in-depth survey of the problem from available sources and make some recommendations.

Methodology

The research will be based on secondary sources. In support of the above objectives, a survey of available literature will be carried out. Technical data on water discharge, siltation, salinity, formation of islands (**chars**), changes in the bed level etc. will be involved. Figures and maps will be used to highlight the issue and photographs to substantiate the realities of the effects of seasonal levels of water flow. Relevant documents from different regions of the world will also be consulted to emphasize the issue. The research is expected to provide information relating to the management and sharing of cross boundary water resources for national and international organizations engaged in the implementation of regional cooperation plans and programmes for the interest of greater human welfare.

Postscript

The reader will note that estimates of environmental change and consequent economic loss mentioned in this study are drawn from a wide range of sources, including informal estimates in the press. These are recorded because, as yet, there are no full and reliable series of statistics is published by the government.

The estimation of economic loss from environmental change is anyway fraught with methodological difficulties. Western environmental economists have at last made a start at calculating the cost of pollution and of the degradation resulting from soil erosion but unfortunately little has yet been done in Bangladesh in the way of rigorous estimates of the economic impact of the Farakka Barrage.

A problem with some of the data adduced in this research is that the environmental damage suffered by Bangladesh in the last twenty to thirty years is difficult to partition according to the following three effects:

- The natural cycle of climatic and other environmental changes over various time scales which affect all parts of the earth but seem to have a particularly heightened impact in this low-lying deltatic terrain;

- Long-term human-induced environmental changes which are the result of such processes as global warming. One thinks here especially of rising sea levels and of the increased energy of atmospheric circulation affecting the monsoons and cyclones in the Bay of Bengal:

- The Farakka Barrage.

The author believes that the barrage has had a substantially greater effect upon the environment of Bangladesh than any other human intervention, but other, natural cycles are very difficult to quantify and all that we can say at this stage is that Farakka seems to have had, at the very least, a substantial role in enhancing any trends in hydrological instability and the exacerbation of salinity. It is hoped that future research will allow us to be more precise in our conclusions.

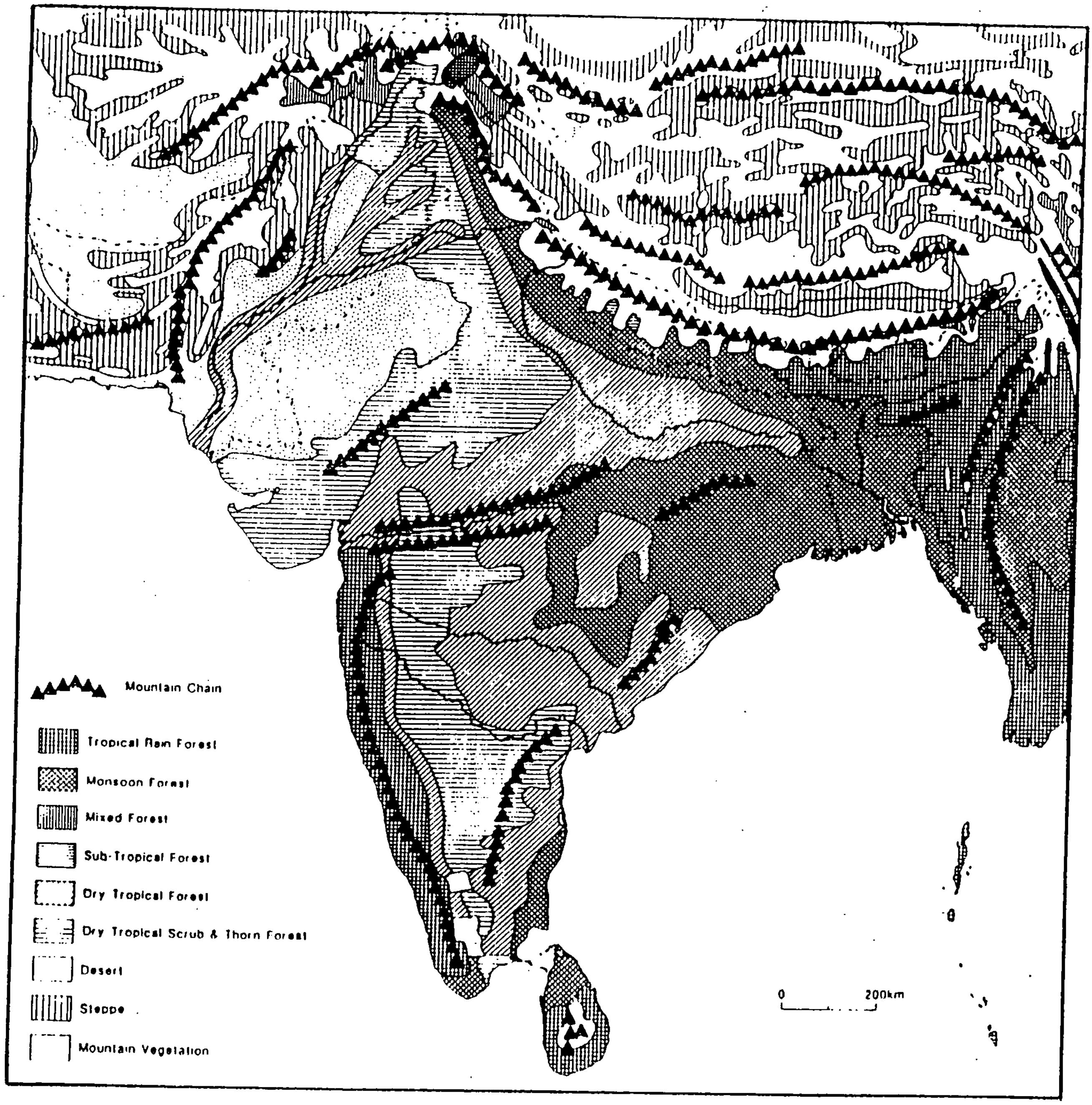
CHAPTER 2

THE HYDRAULIC CONTEXT OF BANGLADESH: PHYSICAL SETTING AND HUMAN INTERVENTION

South Asia has great physical diversity. Each of its nation states has its own characteristics related to structure and relief, soils, climate and above all water availability. South Asia may be divided into three broad structural regions namely the Himalayan mountain ranges of the north, the plains of the Rivers Indus and Ganga in the centre, and the Peninsula in the south. It has been formed by a geosynclinal trough filled by alluvium from the rivers of Himalayan mountains (Map 2.1). The alluvium depth of about 3,000 metres gradually decreases from east to west resulting in absolute flatness near the Ganga delta region. An important feature is the aquifer stretching from Bangladesh in the east to Pakistan in the west which contains over 90 per cent of the sub-continent's ground water. It is the combination of relief and structure which dominates the peninsular region. The ancient granites and the crystalline rocks which make up much of the peninsula are almost impervious, which has limited their ground water potential. Along with its physical diversity, the sub-continent shows a marked variation in terms of rainfall. The mountain ranges have heavy rainfall with the least falling on low ground not favoured by the monsoon. The Bengal basin receives quite heavy rainfall which becomes sparser towards further north and west (Map 2.2). Considering the scope of the study, this section will focus on the river basins to the south of the Himalaya, with especial emphasis on the river basins of Bangladesh and water resource potential upstream.

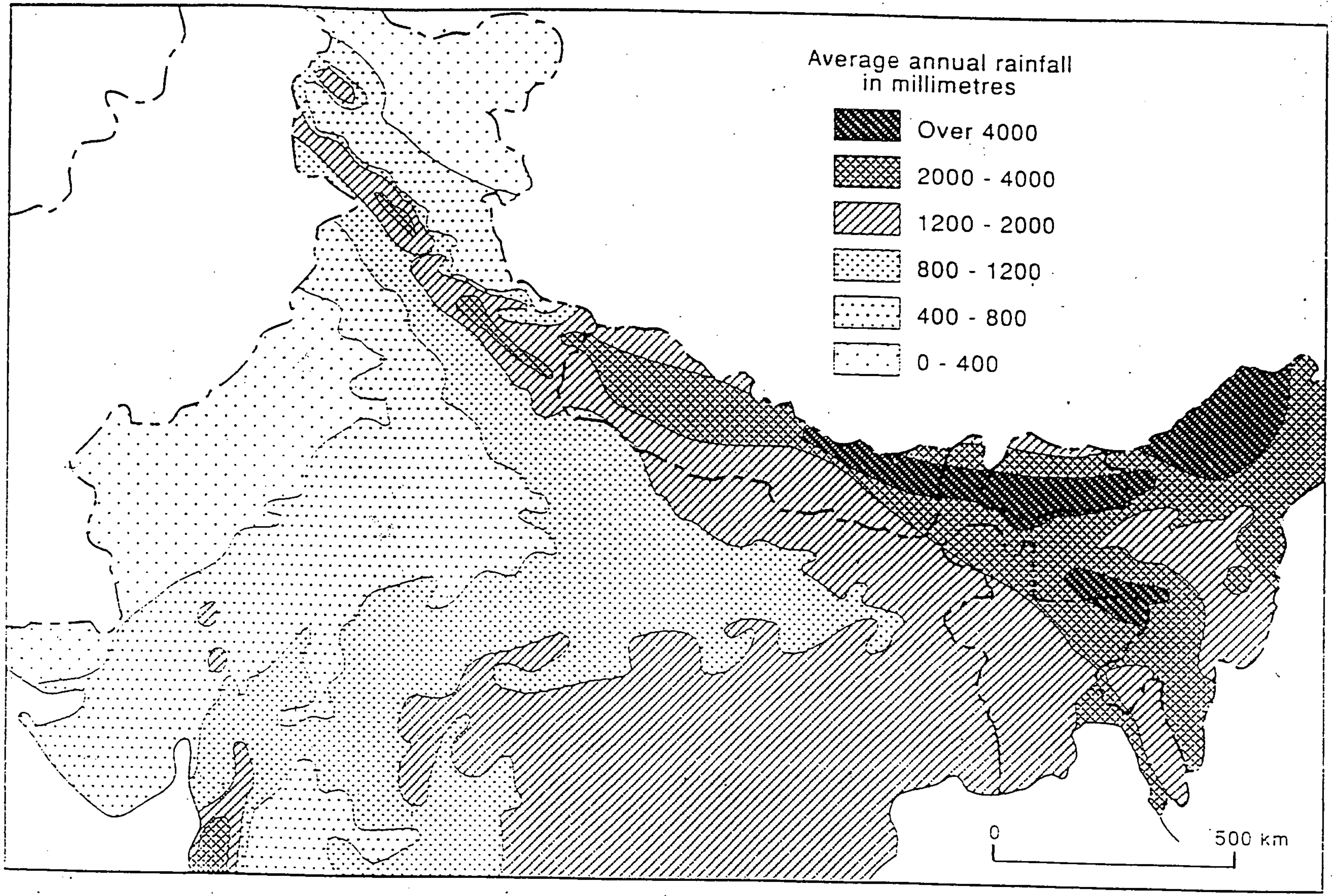
The river basins

The mighty rivers in South Asia have played an important role in the evolution of the culture, heritage and socio-economic development of the region. Since the historical past, travellers, warriors and traders have all moved along the river courses for their respective interests. The water basins of South Asia are composed of the watersheds of three major rivers of the region, the



Map 2.1 The physical background of South Asia.

Source : Adapted from Chapman, 1995



Map 2.2 Average annual precipitation in northern South Asia.

Source : Adapted from Chapman, 1995

the Ganga, the Brahmaputra and the Meghna which support about 500 million people or nearly a tenth of the world's population. These three basins cover an area of 1,758,000 square kilometres, of which 62 per cent lies within India, 18 per cent in China (Tibet), 8 per cent in Bangladesh, 8 per cent in Nepal and 4 per cent in Bhutan. The three basins exhibit considerable variation in terms of topography. While much of the portion of these basins covering Nepal, Bhutan and China comprises steep hills or arid plateaux, most of Bangladesh is flat alluvial plain, and about three quarters of the Indian section is also plain (Rogers, et al. 1989).

The areas of major hydrological potential in South Asia may be divided into two broad zones namely the Indo-Ganga plains and the coastal fringe (Bradnock, 1984). The following section describes the river basins of the eastern Ganga plains.

Three major river systems dominate the eastern parts of the Indo-Ganga plains, a large part of which is known as the Bengal Basin, falling mostly within the territory of Bangladesh. Each of the river basins has its own features. The soils, though showing some variations, are basically characterized by rich alluvium. To the east, the Chota Nagpur plateau and Rajmahal hills mark the southern boundary of the Ganga plain as it opens up into the Bengal Basin. The Sunderbans on the south-western estuary of the basin is the biggest surviving mangrove forest in the world, again mostly within Bangladesh. It has an interesting network of inter-connected waterways in what is the largest delta formation in the world.

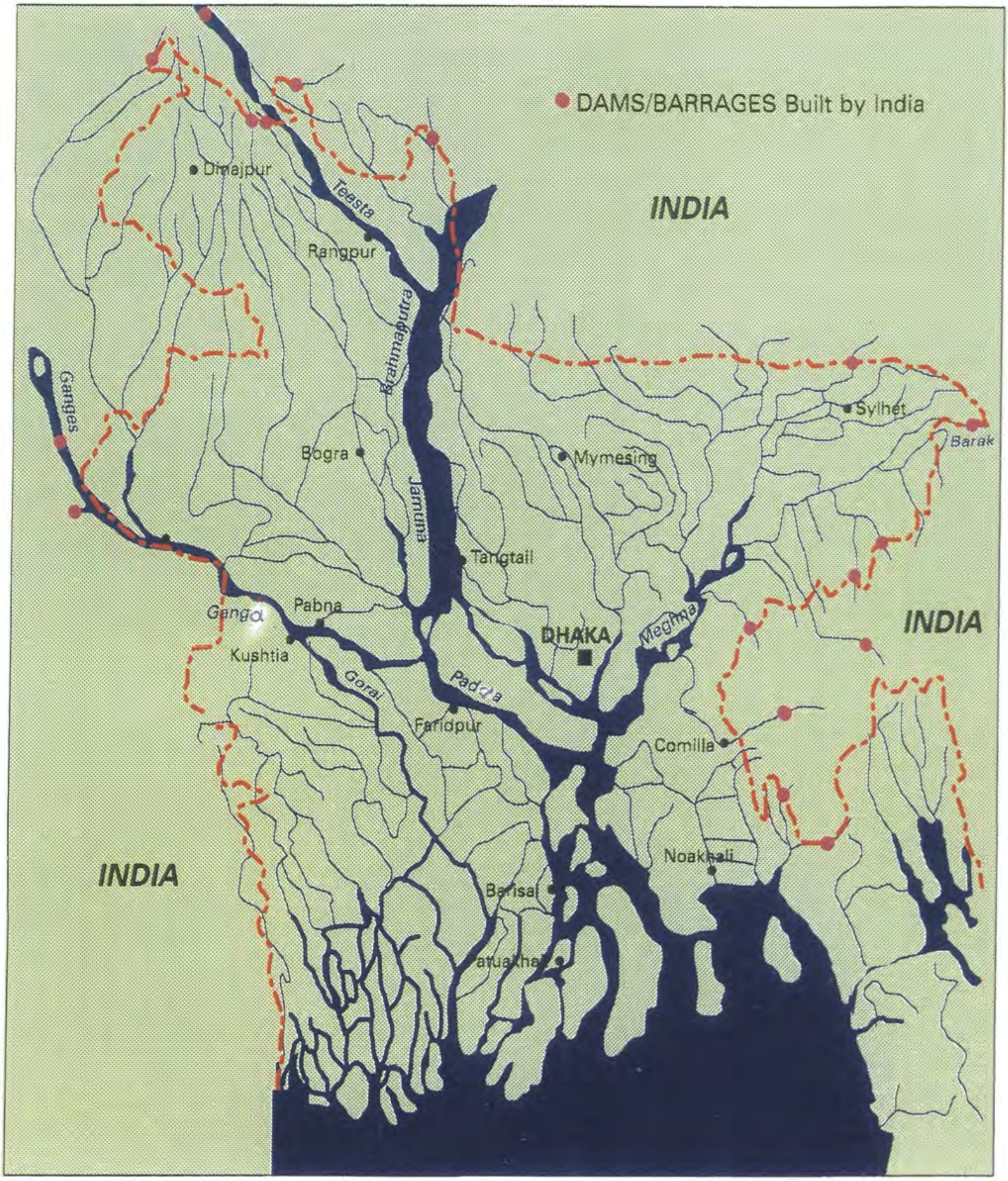
The lower regions of Bangladesh comprises the flat deltaic alluvial plain made by the Ganga-Brahmaputra-Meghna system which is unique in terms of its immense discharge and sediment load. There are 57 border or common rivers out of which 54 (nearly 94 per cent) of the country's rivers flow from India. The land of Bangladesh lies in the deltas of the three great rivers, the Ganga, Brhamaputra and the Meghna. The main catchment of the Ganga is in Nepal, India and Bangladesh; that of the Brahmaputra is in China, India and Bangladesh; and the Meghna's is in India, including some of the places of highest rainfall in the world. The Ganga and the Brahmaputra bring down enough sediment every year to cover the Isle of Wight to a depth of seven feet (Holt 1992). The rivers flood in summer: the Meghna in the month of May, the other two during the months of July to October. In Autumn they recede, the water levels drop, the delta dries up and the country can suffer a drought until the following April and May.

The Ganga-Padda basin

The Ganga has played an important part in successive civilizations from the days of Emperor Asoka in the 3rd century B.C. and has become an historical symbol of cultural, social, economic life for the people, especially in the spiritual life of Hindus for whom the holy waters of the river Ganga have the redemptive power to purify them from all sin. The Ganga is a perennial river formed by the confluence of two smaller rivers namely the **Bhagirathi**, originating at Gangotri glacier at 7,010 metres above sea level and the **Alaknanda**, originating in the Sapta Tal glacier. It rises from a height of about 4,000 m. above sea level in the Himalayas and falls into the Bay of Bengal, draining about 861,404 sq. km (1,050,000 sq. km if we include Bangladesh, Nepal and China) and nourishing almost half a billion people. Cutting canyons of 220 km in the Himalayas, it penetrates into the plains at Haridwar and then meanders over a distance of about 2,550 km in the plains of Uttar Pradesh, Bihar and West Bengal and enters Bangladesh with the name of the Padda near Rajshahi. From this entry point in Bangladesh it flows another 121 km before joining the Brahmaputra-Jamuna system at Goalando. It meets the river Meghna near Chandpur and the combined flow travels down to the Bay of Bengal under the name of the lower Meghna (Map 2.3). In India the Ganga basin drains eight states, namely Himachal Pradesh, Punjab, Haryana, Uttar Pradesh, the Union Territory of Delhi, Rajsthan, Madhya Pradesh, Bihar and West Bengal.

The entire Ganga basin shows a wide range of diversity regarding its terrain, from hilly terrain in the north up to Haridwar, to low alluvial plains in the middle and deltaic regions in the east around the Bay of Bengal. The river Ganga is also constituted by the concourse of a number of tributaries

BANGLADESH RIVER SYSTEM



LEGEND

International Boundary

Rivers

Works done by India on the Border/Common rivers

Map 2,3

Source : Adapted from local atlas

namely the Yamuna, Kali, Karnali, Ramganga, Gandak and Koshi, all of which rise in the Himalayan mountains and are basically snow-fed. The tributaries joining the Ganga from the south are the Chambal, Betwa, Tons, Ken, Sone etc., all starting in the highlands of the Vindhyan range in the Central part of India.

The three Himalayan tributaries, namely the Karnali, Koshi and Gandak, entering from Nepal provide 71 per cent of the total dry season flow and 41 per cent of the annual flows of the Ganga at Farakka in India. The river Ganga before entering Bangladesh bifurcates into one channel called the Bhagirathi-Hoogly and the other called the Padda in Bangladesh. The peak flow during the monsoon in the Padda is about 76,000 cumec (1987), causing floods, and a minimum about 261 cumec (1993) in the dry season, causing a scarcity of water.

The river becomes mighty during the monsoon season for about 4 to 5 months (May to October) due to heavy rainfall. The average wet season flow of about 2,830 cumecs meet the requirements of the basin people of all the countries. The average dry season flow (November to April) of about 1,560 cumecs falls far short for the requirements of the two countries of India and Bangladesh. It may be noted here that about 80 per cent of the population of the basin is rural, hence there is enormous pressure on the land and water resources of the region. The demand for water for all types of irrigation is ever present and the seasonal contrasts in surface water are very important. The seasonal flow varies directly with rainfall and the ground water level also fluctuates accordingly. Irrigation is the chief element of the farming economy of the region, and the demand for more food production to feed millions of people of the region has forced farmers to adopt modern technologies like high-yielding varieties (HYV) of seed which are water-intensive and demand the addition of chemical fertilizers. These may be damaged if the water supply is deficient. Irrigation is also seen to be an essential insurance against crop failure.

The basin contains some 100 million urban dwellers and the cities need a significant and growing quantity of water and power. The increasing industrialization of the basin on the one hand has put pressure on the water resources while the discharge of their waste into the river on the other hand is polluting the river water at an alarming rate. The Ganga is the drain for agricultural, industrial, urban and human waste during its path as it collects surface runoff, domestic garbage, sewage, industrial effluent and pesticides, etc.. The waters of the Ganga contain germs of cholera, typhoid, other water-borne diseases and also contains toxic metals like cadmium, chromium, copper, mercury, lead, nickel, arsenic, antimony and zinc, etc.. It is a polluted river due to over- use by too many people in the basin (Banerjee 1989).

This river basin sustains more than one third of the total population of Bangladesh in the basics of life. The river provides for agriculture, fisheries, forestry, navigation and, finally, balances the fragile ecological system of the south western region of the country. River water from Ganga's flow through the **Gorai**, the major tributary of Padda in this region, and prevents saline intrusion from the Bay of Bengal. As explained earlier, this basin is one of the most populated areas in the world where on the average 8 to 10 people are dependent upon every hectare of land.

Bangladesh has a few large projects in the Ganga-Padda basin and the largest, called the Ganga-Kobadak irrigation project, covers about 141,700 ha of land. Within the Indian section of the Ganga, 25 dams have been constructed in different states for the purpose of irrigation, hydro-electric power, flood control, navigation, water supply and recreation (Table 2.1) which has affected the lower Ganga valley and the moribund deltaic region in particular.

The Farakka project. In 1957 India planned to construct a barrage at Farakka, 18 km upstream from the India-Bangladesh border, to augment the Bhagirathi Hoogly river flow and improve the navigability of Calcutta's port. It was estimated that about 1130 cumec of the dry season flow would be required to be diverted to remove the siltation of the port. Construction of the barrage started in early 1965 and was completed in 1975. The features of the barrage is listed in Table 2.2. This project in turn has become the navigational route from Calcutta to Alahabad and gives access to the main double line rail road and road link NH (national highway) 34 between north east India and remaining parts of India.

Table 2.1 Dams (30 m height and above) built on the Ganga

States	Completed up to 1979	Under construction	Total
Uttar Pradesh	7	7	14
Bihar	9	1	10
West Bengal	1	-	1

Source: Chaphekar & Mhatra, 1986, p. 4.

Table 2.2 Salient Features Of The Farakka Barrage

Total length	7,363 ft.	2245 m
Number of gates	109	
Width of gate	60 ft.	18.3 m
Design flood discharge	2,700,000 cusec	76,455 cumec
Pond level	72 ft	22 m
Crest level		
Gate 1-24	47 ft	14.3 m
Gate 25-109	52 ft	15.85 m
Head regulator		
Full supply level	72 ft	22 m
Crest level	59.3 ft	18 m
Number of gates	11	11
Width of gate	40 ft	12.2 m
Feeder canal		
Design discharge	40,000 cfs	1,133 cumec
Total length	24 miles	40 km
Width, bottom	495 ft	151 m
Depth	20 ft	6 m

Source : Murthi (1975), p. 11.

The rapid economic development that has taken place in the state of West Bengal in India within the lower Ganga plains has generated a series of complex problems in India as well as in Bangladesh. Intensive urbanization and industrialization along the Hoogly estuary has damaged the ecosystem of the entire delta. The river system receives huge quantities of domestic and industrial waste throughout the year, and there are about 96 industries along the rivers in West Bengal itself, nearly 80 per cent of which industries discharge their untreated waste into the river (Chaphekar & Mhatra, 1986). The seriousness of the problem has been noted by Banerjee (1989):

> 'Despite the building of the Farakka barrage 250 km upstream, the silting continues along with a poor flow, thus increasing pollution and contamination. The idea of saving Calcutta after Ganga's lethal change of flow towards the Padma has obviously remained a fantasy'. (Banerjee, pp 146).

According to him the Farakka barrage project is also threatening the state of West Bengal with erosion and nearly 30,000 hectares of land stretching up to an area of about 94 km along Ganga down stream of Farakka barrage has already been lost. The cause for this erosion may be explained by the fact that prior to the Farakka Barrage, the Ganga used to flow along two channels on its right and left banks below the barrage. The left channel, which carried more water, was abandoned by the river after the construction of the barrage and it now flows entirely through its right channel, causing serious erosion.

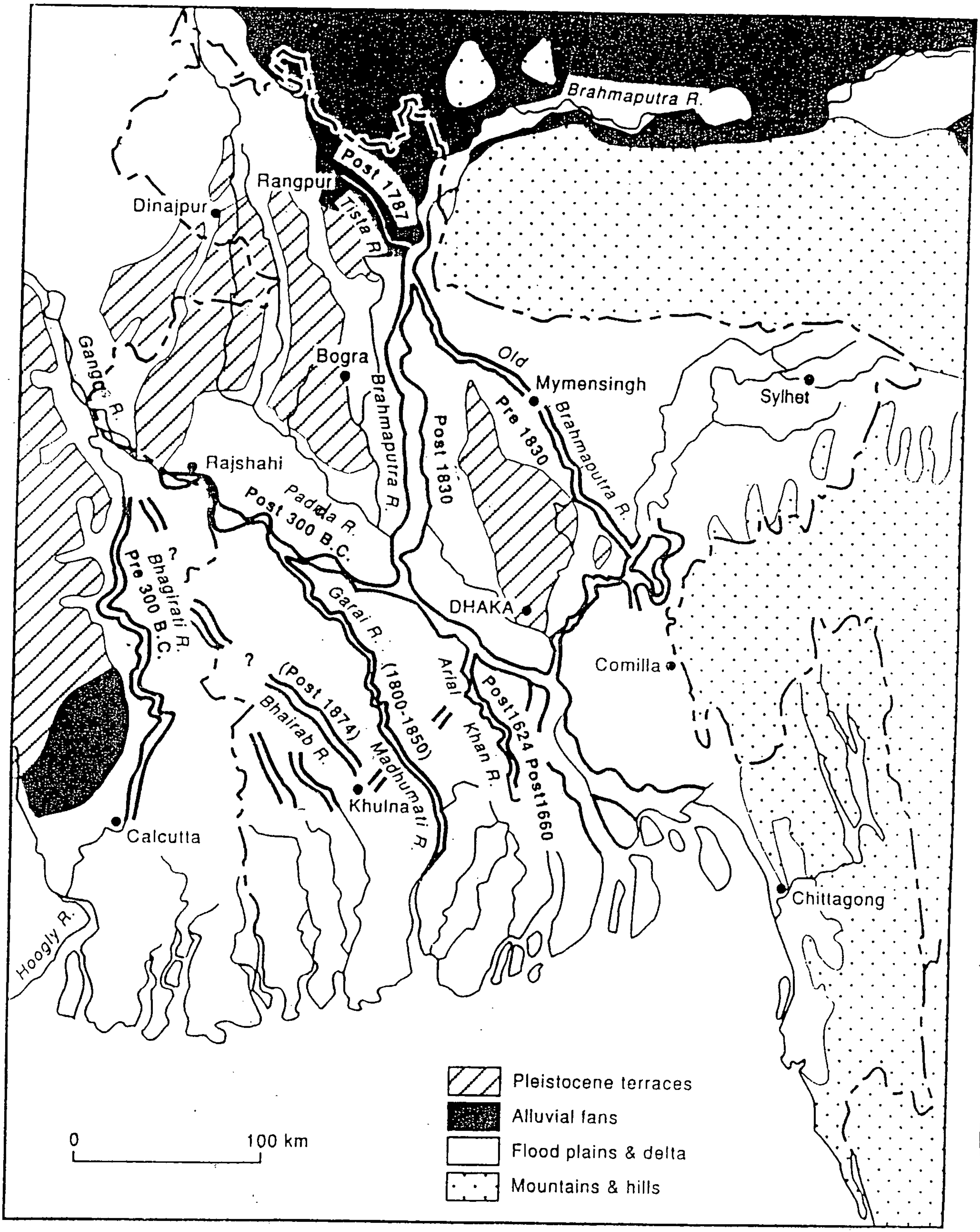
Brahmaputra-Jamuna basin

Brahmaputra is another major river with a length of about 2,700 km, originating from Mount Kailas and Mansarover lake in the name of the **Tsangpo** in South West Tibet at an altitude of 5,150 metres. It flows in an easterly direction north of the Himalayan range up to a distance of about 1,750 km before turning towards to the southern slopes of Kailas and other ranges. It then flows to the west down the Assam valley in the name of the **Brahmaputra** for a distance of about 720 km, entering Bangladesh in Kurigram district. As it enters Bangladesh it takes on the name **Jamuna** and about 65 km further on, at the confluence with the **Tista**, the river was divided following the great flood of 1787. The Jamuna flowed to the south in what became the main channel while the **Old Brahmaputra** became a left bank distributary (Map 2.4). The river Jamuna flows south east, joining the Padda at Goalando and together they subsequently join the **Meghna** near Chandpur. The total length of Tsangpo-Brahmaputra-Jamuna is about 2,700 km, and the total drainage area up to Aricha is about 580,000 sq.km. Of this drainage area about 293,000 sq. km is in Tibet, 240,000 sq km in India and only 47,000 sq. km is in Bangladesh (Rashid 1991). The Jamuna has a typically braided channel and it becomes gigantic during the monsoons when its breadth ranges between 6-12 km or more, making it one of the largest in the world. Its discharge during the monsoon season on an average is about 40,000 cumecs by which measure it ranks the seventh largest in the world.

The Brahmaputra's annual run off at the Bahadurabad ferry point in Bangladesh is 610,505 million cubic metres, its maximum flood discharge is 98,300 cumec and the annual silt run off is 747 million tonnes. The dry season discharge (November-May) is about 138,766.5 million cubic metres. This basin has a cultivable area of 3.12 million hectares, of which 0.61 million hectares are presently irrigated and about 1.67 million hectares have potential for future irrigation (Nazem 1982). Numerous embankments have been made on the Brahmaputra, amounting about 3,400 km in India. The nature of the river is quite complex and both banks under constant threat of erosional. Chauhan (1992) has outlined the characteristics of the tributaries of river Brahmaputra as follows:

South bank tributaries:
(a) have very steep slopes and shallow braided channels;
(b) they have coarse sandy beds and carry heavy silt charge;
(c) and they cause flash-floods because of the proximity between the source in the hills and the confluence;

North bank tributaries:
(a) have comparatively flatter grades and deep channels right from the foothills;
(b)have beds and banks composed of more clay particles which makes them more stable;
(c) and they carry a comparatively low silt charge.



Map 2.4 Changes in river courses in Bengal. *Source:* Umitsu (1985).

Barak-Meghna basin

The headwaters of the Meghna are made up of the several streams draining from the Naga-Manipur watershed. Numerous streams rising in Manipur form the Barak, which flows through Cachar in Assam and enters Bangladesh as the **Kushiyara** which meets the **Surma** from Meghalaya; and they unite at Ajmiriganj in Bangladesh to form the main channel called the **Meghna**. The Surma receives a number of tributaries from the Khasi and Garo Hills while the Kushiyara receives the tributaries from the Tripura Hills. The Meghna then flows in a south-westerly direction to meet the Padda at Chandpur. Below Chandpur the combined river is known as the lower Meghna. The total length of the river is about 902 km, of which 403 km is in Bangladesh. The total catchment area of Barak/Meghna is 82,000 sq km of which 47,000 sq km falls in India and rest in Bangladesh. The annual average discharge of the Meghna at Bhairab Bazar point is 46.93 million cubic metres per year while the dry season flow is only 6.19 million cubic metres and the maximum flow of the Meghna is about 58.67 million cubic metres annually (Nazem 1982).

Similar to the Brahmaputra, a roughly 700 km long embankment is under construction along the river Barak within Indian territory. India has constructed a multipurpose project dam at the state boundary of Mizoram and Manipur on the river Barak immediately downstream of confluence of river Tuival at a place called Tipaimukh, for flood control and electricity production at a cost of Rs 21 billion. The dam has a catchment area of 12,758 sq km with average annual rainfall of about 226 cm and the design flood discharge is 16,964 cubic metres per second (Indo-Bangladesh JRC report, 1985). After the completion of the project, 9,000 million cubic metres of water will be available (to India) for other uses like irrigation, flood control and navigation, and supplementing water flow in the dry season, as well as the production of hydro-electricity. This project (Table 2.3) will adversely affect the lower riparian areas, namely Zakiganj in particular, the greater Sylhet district, Mymensingh, Comilla and Dhaka districts in Bangladesh, involvng the livelihoods of over 20 million people. The drastic reduction of the flow of rivers in the dry seasons will also adversely affect the Manu project (built at a cost of US$ 20 million, or about Taka 805 million, in 1985 values).

Table 2.3 Salient Features of The Tipaimukh Dam Project Reservoir

Gross storage	15.9 milliard metres
Live storage	9.0 milliard metres
Dam	
Length	161 metres
Width	85.3 metres
Spillway	
Length	90.6 m
Average discharge intensity	95.80m/sec per metre
Design discharge	8680m /sec
Number and size of gates	6 @ 12.5m x 15m
Diversion tunnels and discharge	2 Ncs(13mdia)and 4200m /sec
Power House	
Location and size	Right bank, 296m x 55m
Maximum and minimum head	127m and 107m
Design head	125m
Installed capacity	1500 MW (10 x 150 MW)
Firm power generation	412 MW
Cost	
Total cost including flood control and power	Rs. 1050 crores
Cost of civil works	Rs. 600 crores
Cost of electrical works	Rs. 450 crores
Benefits	
Annual firm power on 90 per cent basis	3609Gwh (at 36 paise/kwh)
Flood moderation, augmentation of irrigation and navigation	

Source : Compiled from the report of Indo-Bangladesh Joint River Commission, Dhaka May 1985, p. 123.

The Manu River project. The primary objective of the Manu project (Table 2.4) is to increase the agricultural production through irrigation, drainage and flood protection. The project covers an area of 22,680 ha encircled by the Rivers Manu and Kushiyara and the Bhatera Hills in the District of Maulovi Bazar. Presently 15,552 ha are under cultivation mainly producing rice whose intensity of cropping is 126 per cent. The total length of the embankment is 59 km with an average height of 3 m to cover the whole project area. The drainage pumping facilities for the monsoon run off at the peak rate is 34 cumec.

Table 2.4 Salient features of river Manu project

Diversion barrage	
Design discharge	905 cumec
Pond level	11.5 m
No of bays	7
Width of Road Bridge	3.7 m
Main irrigation canal	
Rajnagar canal	13 km
Manumukh	15 km
Branch irrigation canal	
Branches of Rajnagar	45km
Branches of Manumukh	33 km

Source : Compiled from the report of Indo-Bangladesh Joint River Commission, Dhaka May 1985, p. 123.

Other river basins

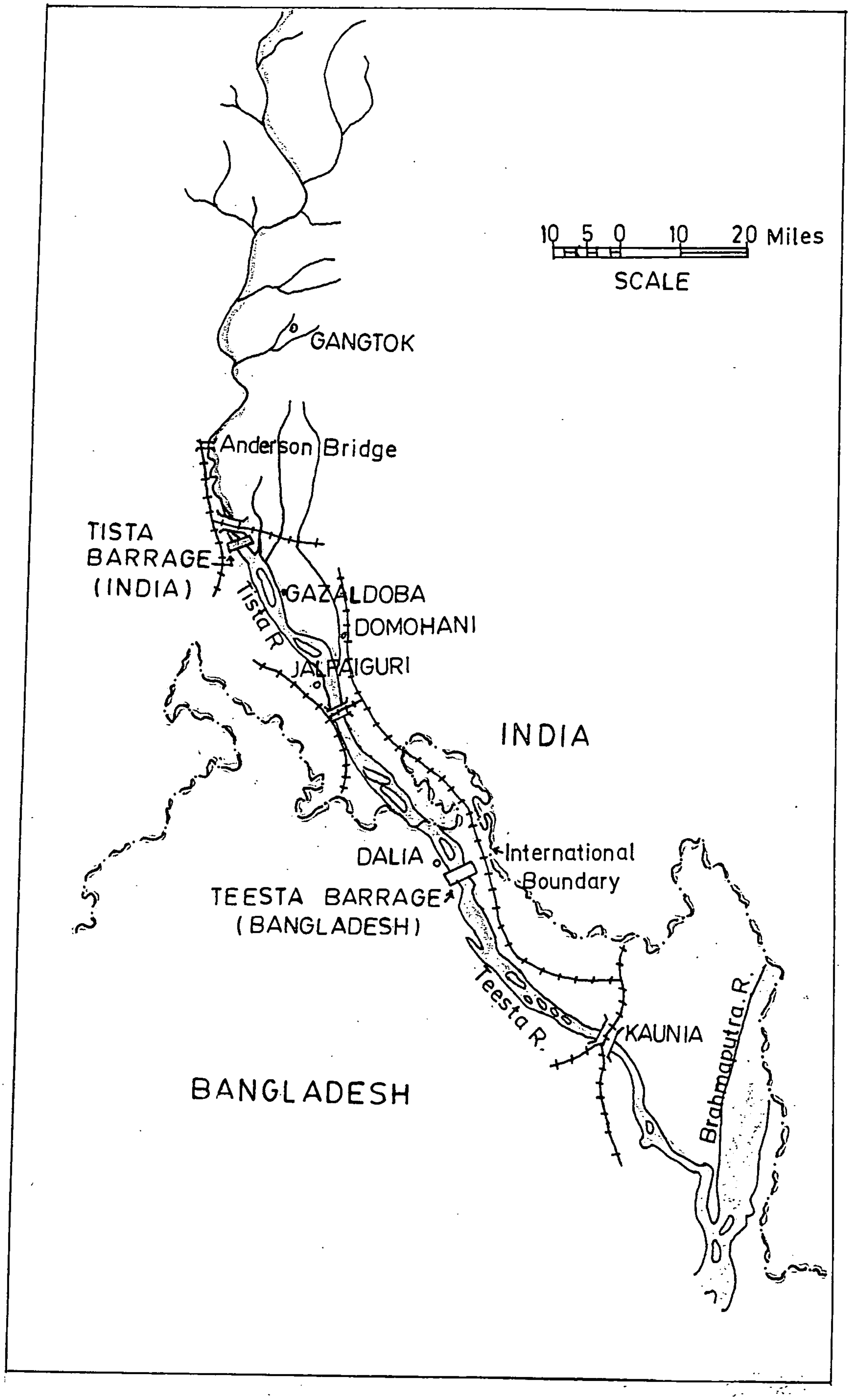
The Tista is another river on which the northern part of Bangladesh is highly dependent for its water supply. The Tista flood plain is one of the largest physiographic units of Bangladesh. Prior to 1787 it was the main river of the northern part of Bengal. Since then the river Tista has changed its course several times. It was a tributary to the river Ganga which changed its southward course and began to discharge into the Brahmaputra near Chilmari. Although scientists have differed regarding the cause of this diversion, it seems likely that it was the great flood of 1787 that forced the abandonment of the old course of the Tista (Chowdhury 1959). Taking a south east turn, it began to flow through Ghaghat and Manas in a bid to meet the Brahmaputra. The **Atrai** channel could not cope with the enormous discharge in 1787 and the Tista took up the **Ghaghat** channel (Majumder 1942, Rashid 1977). Again the vast amount of flood water through a small channel like Ghaghat was beyond its capacity and the result was the ultimate creation of the present channel.

The Himalayan region provides an individual source and network of initial streams for the Tista. In the hilly terrain the Tista is a youthful stream and in the flood plains a mature river. The main characteristics of the Tista river are its quaternary deposits, natural levées and backswamps. Over-bank deposition is the main reason for the large scale flood plain formation and the ridges are predominantly sandy and silty in texture. The Tista has a drainage capacity of a minimum 115 cumec and a maximum of 990 cumec. The average annual flow is about 8,100 cubic meters per second. The Tista basin has to its north and north west poorly drained higher land which is subjected to occasional floods, while the ridges in the south and south east have shallow flooded areas.

Tista Barrage Project: Both countries formulated their projects according to their own parameters. The first study, by East Pakistan in 1960, proposed a barrage at Goddimari, while a second (1968-70) recommended the location of the barrage at Dalia. In the meantime India constructed a barrage at Gazoldova over the Tista at 100 km upstream of the Bangladesh barrage site (Map 2.5). Under the changed circumstances the Bangladesh Water Development Board reviewed the situation, conducted a fresh survey and planned the site of the barrage at Doani. The project is being implemented for irrigation, flood moderation and drainage for a command area of 750,000 hectares of which 540,000 hectares are irrigable. The main objective of the project is to increase agricultural production through irrigation and to create employment for the jobless.

Nepal's water resource potential

The kingdom of Nepal is a land-locked country with vast water resources located in the southern Himalayan slopes at altitudes ranging between 200 and 7,500 metres. The entire area of Nepal is 147,181 km.sq and lies within the Ganga basin. Nepal's contribution to the Ganga flow up to Farakka is about 45 per cent. The country has over 6,000 rivers and streams with a total length of



Map 2.5 LOCATION OF TISTA BARRAGES

Source: BWDB (1986)

the water courses of about 45,000 km. Nepal can be divided into ecological zones from north to south as High Himal (Snows), the High Mountains, the Middle Mountains, the Siwaliks and the Terai. The High Himal has an altitude of over 4,000 metres and is largely unpopulated. The High Mountains cover over one third of Nepal's land area. The Middle Mountains in the central area are heavily populated, covering 30 per cent of the country in an area of deep valleys. The Siwaliks is a region of low ridges and valleys, covering 13 per cent of the country's area. The Terai in the southernmost area of Nepal is a low plain of fertile land having dense forest and accounting for over 14 per cent of the area (Rasheed 1995).

Due to a large difference in altitudes, the climate of Nepal varies from Tundra in the High Himal areas to hot sub-tropical in the Terai. The mean annual precipitation is about 150 cm ranging from 20 cm in the north-west to about 400 cm in the eastern side of the country. The south west monsoon, which lasts from June to September, brings most of the rainfall in Nepal and snowfall accounts for nearly 10 per cent of the total precipitation. Nepal's water resource is largely derived from surface water including some ground water from the Terai. The alignment of surface water drainage is towards Ganga in the south. The drainage system of the rivers is the four snow- and glacier-fed Himalayan tributaries of the Ganga: the Mahakali, known as the Sarda in India, the Karnali, Gandak and Kosi. The flow of these four rivers accounts for over 75 per cent of the annual flow during the monsoon and the dry season flow is also substantial. The Rivers Bagmati, Raptai, Mechi, Kauki and the Babai, have their sources in the Middle mountains, are mostly rain-fed and have low dry season flows. The river Mahakali forms part of the Indo-Nepalese border, flowing into India where it meets the Karnali. Nearly 35 per cent of the Mahakali drainage area lies within Nepal. The Karnali river starts in Tibet and has several tributaries in Nepal before meeting the Mahakali in India, where it is known as the Ghagra and joins the Ganga at Patna. The Gandak river drains central Nepal and has many tributaries. The biggest river of Nepal is the Kosi which drains the major portions of eastern Nepal. The Kosi's headwaters come from Tibet and major tributaries are the Arun, the Sunkosi and the Tamur. These tributaries meet at Tribeni, the Kosi (known as the Sapt Kosi) goes through the Siwaliks to the plains near Chatra and joins the Ganga at Kursella.

According to the Nepalese Water and Energy Commission Secretariat's (WECS) 1989 report, only 0.8 per cent of total energy consumption is electricity; and only 11 per cent of the population have access to electricity. Nepal mainly uses biomass: fuel wood (74.5 per cent), crop residues (11.8 per cent), animal dung (8.3 per cent) and the rest is commercial energy (coal 0.5 per cent; oil 3.9 per cent; and electricity 0.8 per cent). According to a World Bank (1992) report, per capita commercial energy consumption in Nepal is only 25 Kilos of Oil Equivalent (KOE) as compared to 57 KOE in Bangladesh and 231 KOE in India. The seasonal nature of precipitation, inter-annual variations of discharge, inadequate local infrastructure and the lack of a market for water power have been the main factors for Nepal's under- and non-utilization of its rich water resource potential in terms of hydro-power, irrigation and navigation.

Table 2.5 Holding capacity of reservoirs in comparison with monsoon run-off

Reservoirs	Metre Cube/ Second			Monsoon runoff	Reservoir	Holding potential of monsoon runoff
	July	Aug	Sept	million m^3		per cent
Sapta-Kosi Basin	4107	4340	3462	30868	13760	44
Gandaki Basin	4167	4925	3390	32353	17830	55
Karnali	3290	4372	3021	27690	34243	123
Mahakali	1579	2332	1489	13996	6040	43
Bagmati	519	491	321	3454	2173	62
Kankai	205	150	110	1208	765	63
Kamala	130	157	109	1026	493	48
Rapti	196	265	274	1905	1770	93

Source: Adapted from Bangladesh-Nepal Joint Study Team (1989) Report on Flood Mitigation Measures and Multipurpose Use of Water Resources.

The water wealth in the Nepalese rivers, with an estimated annual run-off volume of about 17,500 million cumec, is vast (Pradhan and Shrestra 1986). The holding capacity of reservoirs in comparison with monsoon run-off is shown in Table 2.5. The current installed capacity of electricity production is only 227 mw which is only 0.27 per cent of the theoretical potential.

Nepal's development of water power has been slow due to financial constraints and small domestic consumption. According to the Nepal Electric Authority's (NEA) report of 1990, the annual average rate of electric power demand increased 14 per cent from the year 1984 to 1989, and in addition there is a large potential market in the northern Indian states of Bihar, Uttar Pradesh and West Bengal, which is also likely to increase in due course of time. Thus it can be said that hydro-power development may ultimately be a constraint on Nepal's economic progress.

Nepal first constructed a 500 kw hydro-electric plant in 1911, 15 km south of Kathmandu. The scattered nature of the distribution of population in the hills and the availability of a large volume of surface run-off in the river water makes micro hydro-plants very attractive. In 1990 the NEA was running 29 micro plants with a total capacity of 4.2 mw (IIDS 1993) but this electricity can be transmitted only a short distance and this makes it cost-ineffective in the long run. Nepal today faces a power development option from run-off river projects which suits her terrain, rainfall and population location. She can also go for the storage type of power production projects for greater economic gains by generating electricity along with help for irrigation, navigation and the control or moderation of the floods. The water resource potential in Nepal could be well utilized for its own use and also for export to northern India, Bangladesh and, in the long run, to Pakistan. The load forecast by 2005 will be about 35,000 mw to meet the peak load (GOB/HMGON 1989). By maximizing hydro-power use it could reduce the substantial fuel oil imports and fuel wood consumption of all these countries in the future.

It is interesting to note that Nepal and India started cooperation in water power development in 1920 when they agreed to build a barrage on the Mahakali river with a hydro-power plant within Indian territory, and the two countries exchanged land in order to accomplish this (Verghese 1993). Through cooperation India and Nepal built the Kosi barrage project in 1954 (agreement modified in 1966) for hydro-power, irrigation and flood moderation and the Gandak barrage project in 1959 (agreement revised in 1966) for irrigation.

Nepal's possible reservoir locations

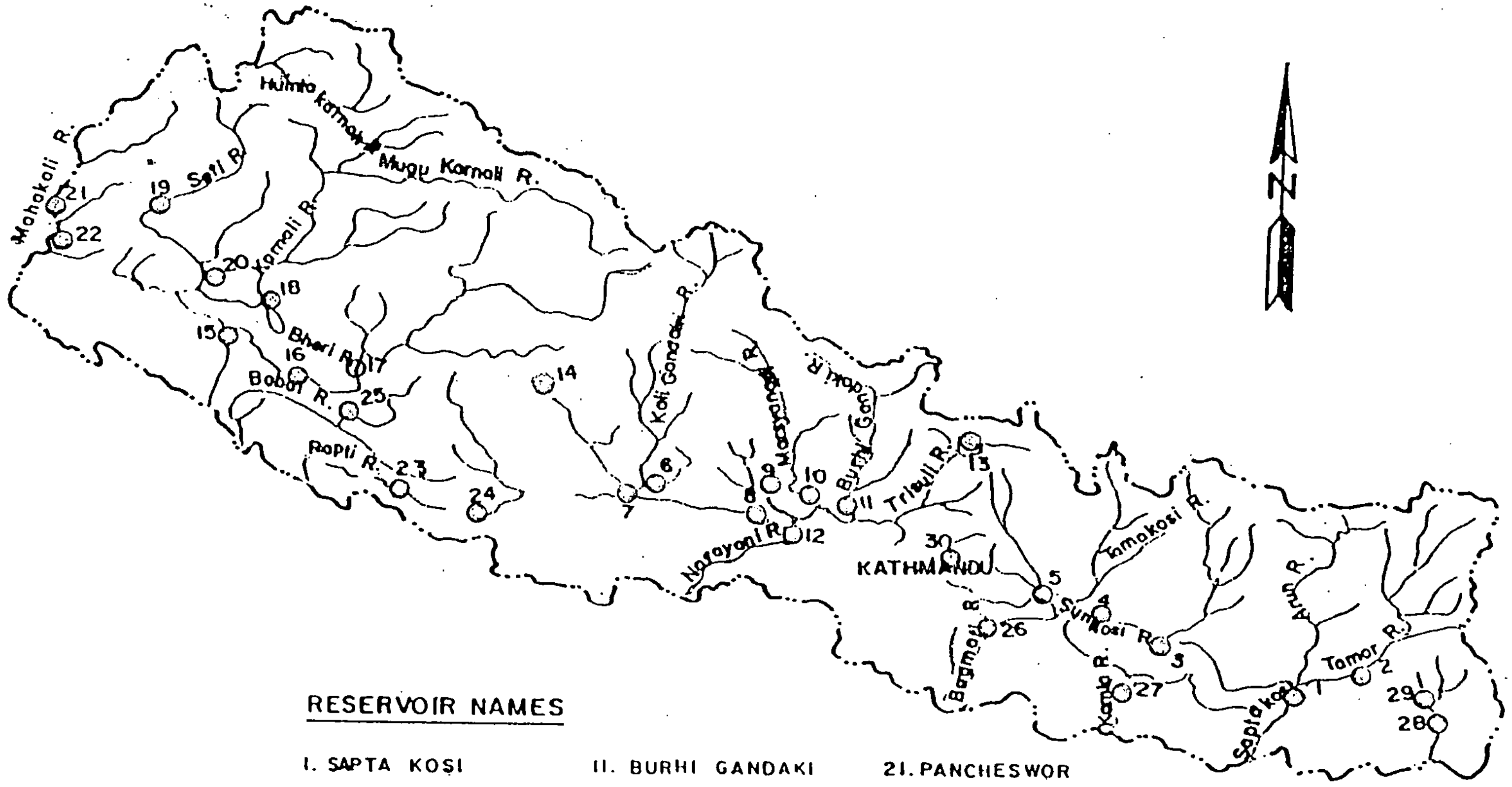
So far 30 reservoir sites have been identified including the Nepal Indian border (i.e the River Mahakali). The total effective holding capacity of these reservoirs has been estimated to be some 77,000 million m^3 (BD - Nepal Joint Study Team Report, 1989). This constitutes about 68 per cent of the total monsoon flow (July to September). The monsoon water stored in the reservoirs will be available for dry season augmentation flow, mitigate the floods, increase the irrigation and improve navigation. Reservoirs and high dams would generate hydro-electricity benefitting Nepal. The main tributaries of the river Ganga where the reservoirs could be made are the Kosi Gandaki, Karnali, Mahakali, Bagmati, Rapti, Kamala and Kankai, all flowing from Nepal. Due to the topographic layout of the country most of the potential reservoirs are located in the Middle Mountain belt of the country. The potential reservoir on the River Arun-Kosi whose upper reaches lie in Tibet may be at 2,200 m above sea level. The other high altitude reservoirs so far identified in Nepal are one in the Lantang Valley with estimated live storage capacity of 100 x $10^6 m^3$ and the other in Uttar Ganga having capacity of 190 x $10^6 m^3$. The location and reservoir capacity are shown in Map 7 and Table 2.5. Of these reservoirs one site Kulekhani-1 has already been utilized for power generation and an irrigation project. Pre-feasibility and feasibility studies have been carried out on the rivers Kankai, Sapta-Kosi, Bagmati, Kali-Gandaki-II, Burhi-Gandaki, Sapta Gandaki, Karnali (Chisapani), Karnali 1B, Seti (West)-1 and Pancheswar.

Based on the report of the Bangladesh-Nepal Joint Study (1989) and other available information, the following are the most likely reservoirs (Map 2.6):

- Five reservoirs in the Sapta-Kosi basin have potential to store 44.6 per cent of total monsoon flow for dry season use.
- Nine reservoirs in Gandak basin could store 55.1 per cent of the total monsoon flow for the dry season use.
- The reservoirs in Karnali basin can be used to regulate the monsoon flow.
- The two reservoirs in the border River Mahakali will be able to hold 43.2 per cent of monsoon flow.

Reservoirs on southern smaller rivers can store monsoon flow of their catchment from 60 per cent to 100 per cent. The benefits and effects of these reservoirs has to be further studied case by case in terms of flood mitigation dry season augmentation, navigation, irrigation and power generation, etc..

In general it can be said that among thirty identified sites for reservoirs the major ones from the point of view of live storage and energy generation will be Sapta-Kosi, Tamur-1, Sun-Kosi-II, Burhi-Gandaki, Marsyangdi, Seti-I, Kali-Gandaki-I and II, Andli-Khola, Mainachully, Bagmati, Bhalubang, Naumari, Pancheswor and all the reservoirs in the Karnli basin. The dry season (December - May) flow augmentation potential of these reservoirs taken together is in the vicinity of $4950M^3/s$ which is over 170 per cent of average dry season natural flow. Regarding hydro power generation potential of these reservoirs (Table 2.6) is about 36.600 MW, while the annual average energy generation potential will be about 118,600 Gwh/annum.



RESERVOIR NAMES

1. SAPTA KOSI	11. BURHI GANDAKI	21. PANCHESWOR
2. TAMUR – I	12. SAPTA GANDAKI	22. POORNAGIRI
3. SUN KOSI – I	13. LANGTANG	23. BHALUBANG (RAPTI)
4. SUN KOSI – 2	14. UTTAR GANGA	24. NAUMURI
5. SUN KOSI – 4	15. CHISAPANI (KARNALI)	25. SHARDA
6. ANDHI KHOLA	16. BHERI – 3	26. BAGMATI
7. KALI GANDAKI – I	17. BHERI – 4	27. KAMALA
8. KALI GANDAKI – 2	18. KARNALI – IB	28. KANKAI
9. SETI – I (CENTRAL)	19. SETI – I (WEST)	29. MAO LOOP
10. MARSYANGDI	20. SETI – 6 (WEST)	30. KULEKHANI – I

40 20 0 40 80 Km.
Scale

Map 2.6 Map OF NEPAL SHOWING LOCATION OF RESERVOIR SITES
Source : ADAPTED FROM BANGLADESH - NEPAL JOINT STUDY REPORT (1989)

Table 2.6 Reservoirs' capacity, showing hydro-power potential

Reservoirs	Live storage in million m^3	Installed capacity (MW)	Dam Height (m)	Energy Generation GWh/annum
Kosi Basin				
Barakschetra (Sapta Kosi)	9370	3300	269	17607
Tmmur-1	760	696	153	2750
Sun-Kosi-1	40	1357	147	4640
Sun-Kosi-2	3040	1110	166	4760
Sun-Kosi-3	550	536	140	2070
Gandaki Basin				
Andhi Khola	800	180	130	788
Kali-Gandaki-1	5200	1600	260	7010
Kali-Gandaki-2	3400	660	177	3470
Seti-1 (Central)	1900	320	165	1402
Marsyangdi	3600	740	235	3241
Burhi Gandaki	2520	600	225	2500
Langtang	100	175	130	767
Uttar-Ganga	190	270	140	118
Sapta-Gandaki	120	225	60	1609
Karnali Basin				
Seti-1 (West)	1290	285	227	2087
Seti-6 (West)	1590	1080	N.A	3618
Bheri-3	6920	2800	N.A	5983
Bheri-4	5900	2925	N.A	5957
Mahakali Basin				
Pancheswor	4800	1250	262	5200
Poornagiri	1240	1000	156	4800
Southern River Basin				
Mainachuli (Kankai)	730	60	85	200
Mao-Loop	35	13	65	57
Kamala	493	32	51	121
Bangmati	2100	180	117	837
Kulekhani-1	73	60	107	211
Bhalubang (Rapti)	970	107	93	663
Naumuri (Rapti)	800	466	208	1410
Sharada (Babai)	220	49	85	215

Source : Adapted from Bangladesh-Nepal Joint Study Team (1989) Report on Flood Mitigation Measures and Multipurpose Use of Water Resources

CHAPTER 3

RATIONALE OF BANGLADESH-INDIA WATER SHARING

The river Ganga, since ancient times has been of economic, social and religious significance to the people of the sub-continent. Nepal, India and Bangladesh all depend heavily on this holy river for agriculture, industry, navigation, fishing, etc. and also for maintenance of the ecosystem. The river has given a distinct cultural dimension to the communities of this region and many small villages, towns and communication/trade centres have grown up along its banks.

Like any other international river, the Ganga has its own flow regime. It is influenced by the melting of ice from the Himalayas and by seasonal rainfall. Over the years the water flow in the wet season from the months of June to November has been sufficient to meet the needs of the people of the sharing countries. Its dry season flow in the months of December to May is insufficient. The abundant wet season flow (more than 80 per cent of the annual flow) drains into the Bay of Bengal.

India and Bangladesh both have undertaken their own development plans in the Ganga basin, for which these countries need to share the available outflow of the river Ganga, especially in the dry season. India has constructed several barrages on the Ganga for various purposes. But the barrage across the Ganga about 18 km upstream from the border of Bangladesh is of particular concern as its purpose is to divert the lean period water supply. A dispute started when the Ganga's water was diverted into the Bhagirathi-Hoogly river in order to flush out silt from the Calcutta port and thereby improve its navigability during the dry season.

The background of the Ganga water sharing

The Ganga's water controversy dates back to October 1951 when it was reported by the Indian press that the Indian government was planning to divert the Ganga's waters at Farakka into the Hoogly river to save the port of Calcutta, which was silting up. Following this newspaper report of 29th October 1951, the then Pakistan government contacted the Indian government expressing its views that the Farakka Barrage project would adversely affect the agriculture of the former East Pakistan, now Bangladesh, and that Pakistan should be consulted before any plan which may prejudice her interests. On 8th March 1952, India responded to Pakistan's concern about the Farakka Barrage indicating that the project was only under preliminary investigation and described Pakistan's concern over possible effects as purely hypothetical. From 1951 to 1971 both India and Pakistan dealt with the Farakka dispute on the basis of hostility and distrust, for their vested political interests kept the issue alive. In 1963, Pakistan for the first time proposed an official meeting on the Farakka issue. India did not respond to Pakistan's request for over two years. In 1965 India and Pakistan fought a war over the Kashmir issue and the dispute over Farakka was neglected and not pursued as strongly by Pakistan as it did for the Indus water issue in 1960. From 1965 until 1970 both the governments of Pakistan and India discussed the Ganga issue many times at different levels from experts up to the heads of government, without any results. In the process, India in 1965 started construction of the barrage without giving prior notice and information about the project in violation of article 7 of the 1933 Montevideo Declaration which provides that 'the works which a state plans to perform in any international waters shall be previously announced to the other riparian state'. Despite protests by the then Pakistan government, India completed its construction in 1970. It should be mentioned that the 1957 Buenos Aires Resolution of the Inter-American Bar Association requires the consent of a co-basin state when that state may suffer damage or injury as a result of a proposed work was also not observed in this case. Pakistan opposed the construction as it had a claim to the waters of the river Ganga which would affect the Ganga Kobadak project within its territory. At that time India claimed that the problem of East Pakistan was not a shortage but an excess of water within its territory.

The Ganga water dispute

The Farakka Barrage was constructed for the purpose of diverting more than 1,133 cumec of dry season flow into the Bhagirathi-Hoogly river to flush silts for improving navigability for the port of Calcutta. In a summit level meeting between India and Bangladesh in May 1974, it was agreed that the Farakka Barrage would not be put into operation before reaching an agreement for the dry season flow of the Ganga water. In April 1975, India requested Bangladesh to allow a test run of the barrage and the feeder canal to check its workability. She sought Bangladesh's permission to divert 312 cumec to 453 cumec of the Ganga's flow for only 41 days from 21 April to 31 May 1975. Bangladesh agreed to the request and India used this opportunity to commission the Farakka Barrage and continued its unilateral withdrawal of Ganga's flow for the entire dry season in 1975 and 1976. Thus, the barrage was put into operation without any formal agreement of water sharing and the dispute started with lack of confidence between the two riparian nations.

However, with a change of governments in both the countries, a water sharing treaty was signed in December 1996. Notably, political opponents in both the countries have kept the issue alive have and used it as a tool to affect the normal good neighbourly relationship between the two states. Since the settlement of the Ganga dispute is a very recent development, there is a need to scrutinise and analyze the treaty for the benefit of the large majority of the people living in the basin. The following section gives an overview of the Ganga dispute and other water sharing issues.

Negotiations for cross-boundary water sharing

After independence in 1971, the new Bangladesh government wanted to negotiate the Ganga issue with the Indian government. As a result, a Joint Rivers Commission (JRC) was formed in 1972 to pursue the matter. Both Prime Ministers of Bangladesh and India jointly declared in May 1974 that, before commissioning the Farakka Barrage project, the countries would mutually agree in sharing the Ganga's water during the dry season. Unfortunately, in April 1975 the Farakka Barrage was put into operation without consulting Bangladesh as had been agreed earlier, causing serious problems in the downstream area, especially the moribund delta region. Bangladesh, failing to resolve the problem mutually, took the issue to the United Nations in November 1976. The General Assembly's **consensus statement** directed India to sit with Bangladesh urgently at Dhaka to negotiate for a solution.

After several rounds of discussion, the two countries signed an agreement in November 1977 for sharing the dry season flows of the Ganga for a period of five years from 1978 to 1982. As per the agreement, Bangladesh would receive 967 cumec whereas India was to divert 580 cumec during the lean period. The important feature in this agreement was a guarantee clause which ensured that in case of exceptionally low flow, Bangladesh would receive 80 per cent of her share of the Ganga water at Farakka. When the agreement expired in 1982, a Memorandum of Understanding (MOU) was signed by both the countries in October 1982 for the period of two years (1983-1984). It is important to note that this MOU dropped the 80 per cent guarantee clause. The MOU directed the JRC to complete the pre-feasibility study on augmentation of the Ganga's dry season flow and to decide upon the optimum solution within 18 months. The JRC considered respective proposals for augmentation as furnished and updated by each side and exchanged views from December 1982 to March 1984. However, because of diverging views it was not possible for the JRC to make recommendations acceptable to both countries. Bangladesh proposed storage dams in Nepal for conservation of the intense monsoon water to augment the dry season flow of the Ganga but this was not acceptable to India. On the other hand, the Indian proposal for the diversion of Brahmaputra water to the Ganga through a link canal was rejected by Bangladesh.

In the mean time the MOU expired on 31 May 1984. Bangladesh requested the extension of the MOU on a long term basis, which India turned down leading to a lack of agreement during 1985. However, in November 1985 another MOU was signed for a period of 3 years (1986-1988). After the failure of the earlier efforts, another Joint Committee of Experts (JCE), headed by the secretaries of both the governments was formed to undertake a joint study and submit a report within 12 months on the Ganga and other rivers common to both the countries. The JCE held several meetings and visited Kathmandu to discuss the issue with Nepalese officials. They submitted their report to the respective governments in November 1986. Even this report did not bring any acceptable solution for water sharing.

The next meeting of the JRC, held in April 1990, decided to expedite the works of the secretaries' committee before the next dry season with particular reference to the Ganga. This also incorporated the issue of river **Teesta**. The secretaries' committee held six meetings regarding the common rivers but failed to reach any understanding of the problem. The committee this time deflected the sole Ganga issue and suggested that priority should be given to the main four rivers namely **Ganga,**

Teesta, Brahmaputra and the **Meghna** so that a sharing arrangement could be made on a long term basis before the commencement of the following dry season. In April 1991 Bangladesh demanded a long term agreement on the Ganga water based on the 1977 accord. After a ministerial level meeting in 1991, the Indian Foreign Secretary briefly outlined his concept of permanent sharing of the flows of the four rivers under a comprehensive treaty on the same lines as the Indus water treaty. Yet India did not adhere to or pursue this proposal.

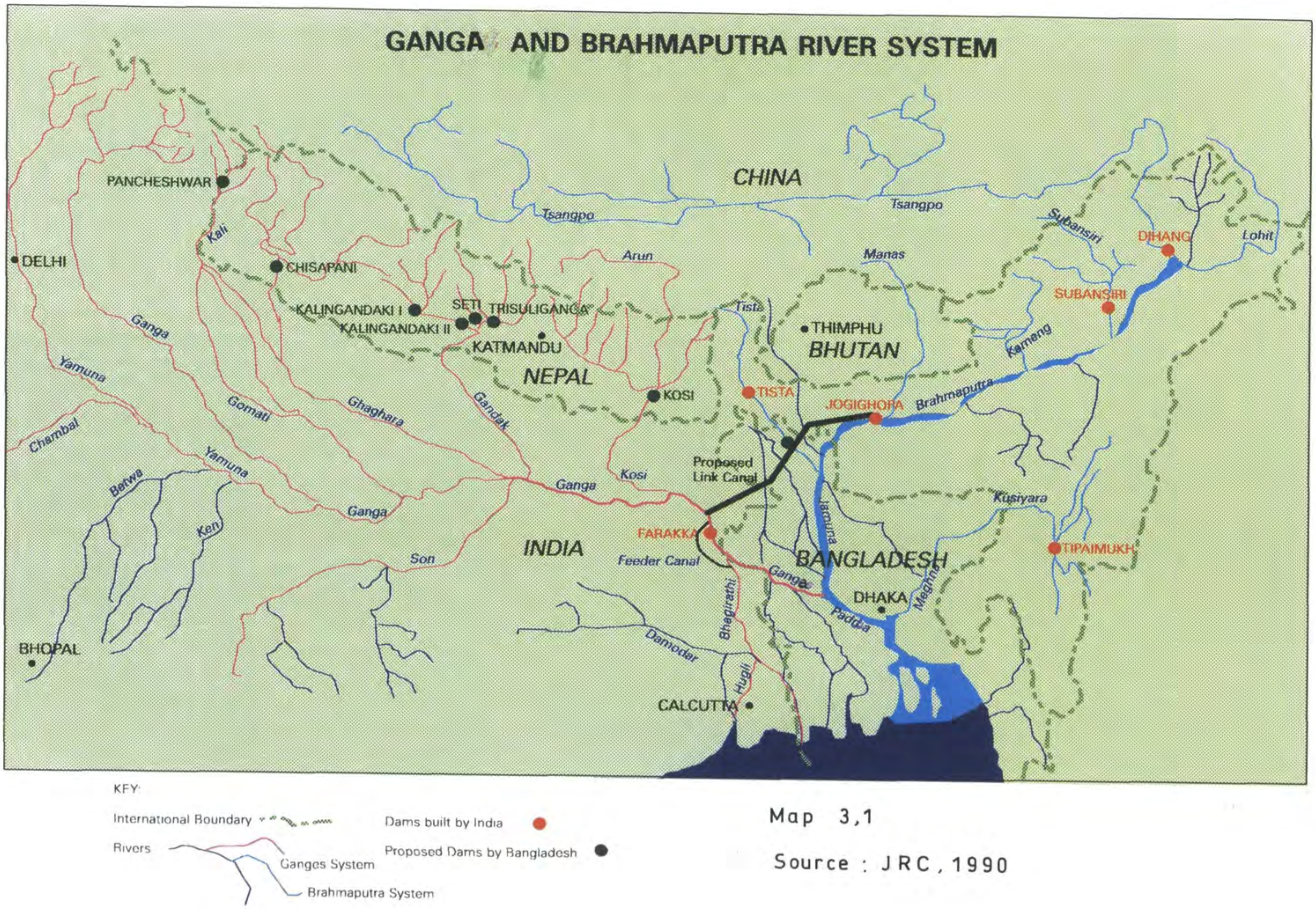
As time passed, Bangladesh in October 1991 proposed an agreement for the Ganga water for an interim period pending permanent sharing. The Indian side, on the other hand, persisted in seeking a comprehensive arrangement of water sharing on a long term basis. During this lengthy process of negotiation and without any water sharing agreement or MOU for the Ganga since 1988, India has continued the unilateral withdrawal of water which is so vital for the 40 million people in the lower riparian region of the Ganga basin in Bangladesh. Using her locational advantage, India carried on dry season diversion, thus bringing down the lean period flow of the Ganga to 261 cumec (March 1993) at the Hardinge Bridge in Bangladesh compared to the pre-Farakka flow of 1,982 cumec at the same point. The Prime Ministers of Bangladesh and India met in New Delhi on May 28-29, 1992 and their joint communique states:

> '.....due to the growing need for waters the flows available in the Ganga and the Tista would fall short of the requirements of the two countries particularly in the lean months. They agreed that equitable, long term and comprehensive arrangements for sharing of the flows of these and other major rivers evolved through mutual discussion would serve the best interest of the people of the two countries' (The Daily Star, Dhaka, 30th May, 1992).

Even this and many requests by the Bangladesh government, for negotiations at all levels between the countries, did not bring any result. The Indian Prime Minister's assurance of equitable sharing of the Ganga and any undue hardship to Bangladesh was not resolved. The two Prime Ministers again met in April 1993 but the problem remained unsolved. Meanwhile the problems of drought in the dry seasson continued. The average discharge at Farakka is estimated to be 1,557 cumec during the dry season. Of this amount India demands 1,246 cumec while Bangladesh claims that it needs the entire flow for the activities and sustenance of its population and to avoid ecological disaster in the Ganga delta. The available statistics on the flow of the river have convinced both the countries that there is not enough water to meet the dry season requirements and hence, there is a need for augmentation with extra water flow.

India proposed to augment the Ganga flow by diverting water from the Brahmaputra through a link canal (Sharma & Nag 1995). The proposed 324 km link canal would run 128 km through Bangladesh with a width of 75 metres having a carrying capacity of 2,832 cumec of water. India proposed that the link canal should start from a barrage at Jogighopa in Assam and terminate at a point 19 km above Farakka. On analysis, the proposal would have considerable merit for the upper riparian country as follows (Map 3.1):

(i) It could supply some of India's additional water requirements of the northern Ganga plain for its industrial and irrigation needs. This will also compensate for the low flow of water below Farakka.



Map 3,1

Source : JRC, 1990

(ii) This would allow, with the help of the link canal, the control of additional water from the Brahmaputra i.e most of the two major river's water would be controlled from the same barrage i.e. Farakka.

(iii) Building this link canal between the two rivers across Bangladesh would be comparatively cheaper and easier than doing it across Indian territory which would be against the natural gradient of the land and would require a complicated system of locks and pumps.

(iv) This link canal would provide a cheaper, faster and better transportation connection between West Bengal and Assam.

Some of the agreements concluded between Bangladesh and India have yielded short term solutions. But these Indian proposals could not be agreed to by Bangladesh for the following reasons:

(i) The link canal would displace approximately 2.5 million people (The Bangladesh Observer, 14th September 1976).

(ii) It will not be cost-effective in terms of space and money.

(iii) The link canal could cause a loss of about 0.5 million hectares of land to water-logging and canal acquisition and an annual loss of crops of about US $ 500 million. This loss of land and crop cannot be sustained by Bangladesh (The Bangladesh Observer, 14th September 1976).

(iv) The link canal would cut off the north-western part of the country and cause communication and ecological problems.

(v) The canal would involve earthworks equivalent to seven Suez canals and huge expense, and the long construction time would cause inconvenience to millions. The nature of the soil may also make it difficult to maintain the canal along with the running costs over the period of time.

(vi) The withdrawal of water from the Brahmaputra may cause similar problems in the dry period in its basin area.

(vii) Considering the location of the start and end points of the link canal, Bangladesh regards it as a political and economic trap set by India to control most of the water of the region.

In fact India has already approved a plan by the Uttar Pradesh state government to build another barrage on the Ganga at Kanpur, named the Kanpur-Ganga barrage project, for the irrigation of its agricultural land. It is important to note that the states of Bihar and West Bengal have already raised concern about this project. It will in turn hamper the ecological balance of the lower riparian areas.

Instead Bangladesh proposed to involve the upper riparian country Nepal, to build storage dams on the Nepalese tributaries to reserve the monsoon water. This stored water could be released in the dry season to augment the flow. Studies (Swain 1993) have shown that 17 per cent of the Ganga basin lies in Nepal, which contributes approximately 53 per cent of the Ganga's dry season flow and 35 per cent of its total annual flow. Nepal's contribution to Ganga's flow at Farakka is about 45 per cent. Bangladesh argued that by this storage dam Nepal could not only conserve water but also generate significant hydro-electric power which could be exported to Bangladesh and India, earning foreign exchange for the country. Bangladesh also maintained that the dry season flow of Ganga can easily be harnessed by the vast water resources available in the monsoon season in other upstream areas. Regarding the proposed link canal, Bangladesh consequently pointed out that the dry season Brahmaputra flow itself was not enough to meet the present and future needs of the lower Brahmaputra basin. Bangladesh reflected that the proposed link canal was technically unsound, economically unwise, socially unacceptable and potentially ecologically devastating for a poor and populous country like Bangladesh (Asafuddowlah 1995). India's opposition to this proposal shows that India wants to handle water issues bilaterally for its own benefit. Of course, India's fear is that any storage dam built in the upstream will lead to physical and political control of the water flow being in the hands of Nepal.

Importance of Involvement of Nepal

Nepal, being a land-locked country, is dependent on its neighbours for various purposes. As such it wants to be an active partner in the water issue to contribute in the regional co-operation among riparian countries in exchange of mutual benefit. It may be noted that the entire area of Nepal (147,181 sq km) lies within the Ganga basin. India however, desires to treat the water issue separately with Nepal on a bilateral basis. Mr. G.P Koirala, the Nepalese Prime Minister, during his visit to India in December 1991, discussed the water issue and agreed to an Indian proposal of an Indo-Nepal joint venture in four multipurpose projects namely, the **Karnali-Chisapani, Pancheswar, Sapt Kosi** and **Burhi-Ghandaki**. It is important to note here that India always avoided Nepal's involvement in the Ganga's talks with Bangladesh, arguing that the potential of Nepalese dams would not augment the dry season flow of the Ganga. Interestingly, India at present is proposing to go ahead with joint ventures with Nepal for exploiting her water resources for India's own benefit. The Nepalese Prime Minister in his statement to the news media (United News of Bangladesh) in November 1992 stated:

> 'Development of water resources and its management is vital for the development of South Asia as a whole. It will be a step forward if we are able to take a regional agenda for developing water resources'.

The Nepalese minister of tourism Mr. Ram Hari Joshi, while attending the 7th ministerial level meeting of South Asian Association for Regional Cooperation (SAARC) at Dhaka in December 1992, stressed the need for joint efforts for harnessing the waters of common rivers for the benefit of the people of the region. In 1993 northern India was affected by the worst flood of the century, causing extensive damage to lives and properties of her 15 states. The Indian Prime Minister expressed his preference for the construction of more dams in mountainous Nepal to prevent annual these monsoon floods.

However, for any basin-wise cooperation for mutual benefit, trust between the neighbouring states plays a vital role, but this has always been lacking in case of the river Ganga. For example Nepal and India agreed in 1920 to construct a barrage on the river **Mahakali** along with a hydro-power plant. They agreed to exchange land to accommodate the whole project within Indian territory. Under the agreement Nepal was to receive 28.3 cumec of water annually but Nepal only received 12 cumec as the water was under Indian control (Verghese 1993). This may be cited as an example of failure in regional efforts in mutual trust. Similarly, the Kosi barrage project was built in 1954 for power, irrigation and flood moderation between India and Nepal. The agreement was amended in 1966 to ensure Nepal's right in the upstream water uses in the Kosi basin. However, the area covered by irrigation benefiting Nepal from this was only one sixth of the projected total due to locational and structural problems. An agreement made between India and Nepal in 1959 was revised in 1964 on the Gandak barrage on the international boundary primarily for irrigation to about 57,000 hectares of land in the Terai and an even larger area in Indian states of Uttar Pradesh and Bihar. In this agreement too, like the Kosi project, Nepal was deprived of projected benefits. Nepal received irrigation in only 2.4 per cent of the total area (Verghese 1993).

Teesta Barrage Project

The Teesta project was initiated in the early half of this century. The plan was to construct a barrage at Gazaldoba and a dam at Gielkhola in India. With partition of British India it was found that the site of the head works of the barrage fell in India while ninety percent of its command area was in Bangladesh, the then East Pakistan. Since a large part of northern Bangladesh falls within the pleistocene terrace, the need for irrigation for this area was recognized even during the pre-partition days. As such a new project was planned to provide irrigation facilities to this region. Location of the site of the barrage was fixed at Dalia in the district of Lalmanirhat. The project was approved by the Government of Pakistan at that time but no progress for its implementation could be made on account of dispute with India over the sharing of waters of other International rivers.

The Teesta Barrage Project of Bangladesh covers about 0.75 million hectares of land of the districts of Rangpur, Dinajpur and Bogra. Presently 0.58 million hectares of land are under cultivation which is about 78 percent of the total area. About 50 percent of the total cultivated land is double cropped in *Kharif* season. Shortage of rainfall occurs practically every year in pre-monsoon and post-monsoon times resulting in a decrease of crop yield. Winter cropping is limited to 15 percent whereas 85 percent of land remains fallow throughout winter season. The present overall cropping intensity of the project is 168 percent which can be increased to 198 percent. The source of water supply to meet the need of agriculture in the project area is very limited. The majority of the minor rivers, streams and channels of the area originate from within the project area and carry little or no water in the dry season. The Teesta is the only river which has a dependable flow throughout the year (Personal Communication with the officials of the Teesta Barrage Project, June 1997). The construction of barrage was completed in August, 1990. Works related to canals and distributary systems are partially completed and remaining portions are under construction. Irrigation facilities have so far been provided for about 10,935 hectares of land.

The Teesta Barrage Project of India was sanctioned in 1975. The project envisages development of the area in three phases. The first phase, commissioned in 1987, has provided irrigation facilities to 0.923 million hectares in the districts of Darjeeling, West Dinajpur, Malda, Jalpaiguri and Coochbihar in West Bengal, Purnia in Bihar and certain areas in Assam. The Teesta Barrage Project has the following features :

- The barrage is 936 metres long across the river Teesta near Gazaldoba, about 8 km downstream of the Sevok railway bridge in Jalpaiguri District.
- The right bank canal of 540 cumec capacity at head and 295 km long, taking off above the barrage and linking with the river Ganga at Farakka to cater for irrigation of 0.709 million hectares, generation of hydro-power on the falls in the main canal, and navigation in the main canal.
- The left bank canal of 152 cumec capacity at head and 193 km long, taking off from above the barrage and joining the river Brahmaputra near Dhubri in Assam, to provide irrigation to 0.214 million hectares, power generation on the falls in the canal and provision for navigation along the main canal, thus linking the Ganga with the Brahmaputra.

The irrigation system comprises the following:

- A barrage across the Teesta.
- A link canal on the right bank connecting the Teesta with the Mohananda.
- A pick up weir at Dobegram for diverting the flow of the link canal and the **Mohananda** river through the river Buri Balason to be again picked up at the Sonarpurhat barrage on the Mohananda.
- A barrage across the Mahananda at Sonarpurhat with canals on both banks of the Mahananda for irrigating lands in Bihar and West Bengal.
- A control structure on the Mahananda at Bagdobra for irrigating areas in between the two branches of the Mahananda i.e. the Fulhar and Barsoi channels.
- A canal from the link canal for the irrigation of areas of Jalpaiguri and Haldibari in Coochbehar district.
- A canal from the pick up weir at Dobegram for the irrigation of areas in Darjeeling district and Bihar.
- A canal taking off from the left bank of river Teesta linking to the Brahmaputra for the irrigation of 0.215 million hectares in Coochbehar, Jalpaiguri and Assam.

The project would irrigate an area of 4.7, 0.162 and 0.215 million hectares respectively in three stages. The second phase of the project comprises the construction of a dam across the river Teesta near Gielkhola in the district of Darjeeling, 48 km above the barrage. It would store water for power generation, for supplementing water supplies during the dry season, and the moderation of floods. A hydro-power plant with an installed capacity of 720,000 kw capable of generating a firm power of 300,000 kw at 50 percent load factor, is proposed at the foot of the dam. In the third phase, there is a plan to link the river with the Brahmaputra and the Ganga. Presently India has completed the construction of the barrages including some canal networks on the rivers Teesta and Mahananda.

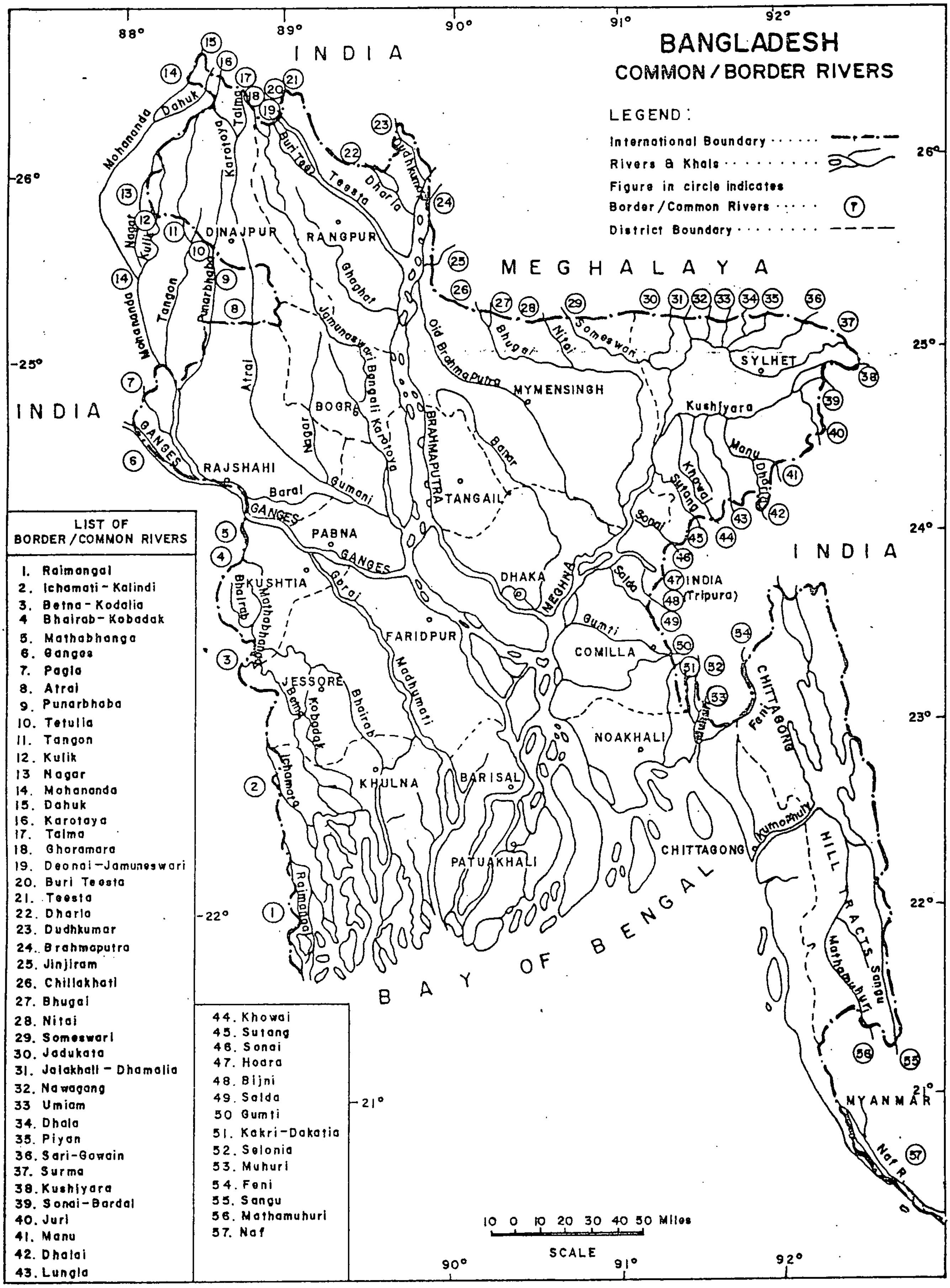
Sharing the Teesta Waters. The Joint Rivers Commission in its 16th meeting held in November and December, 1978 set up a Joint Committee to work out an agreement on the sharing of the Teesta waters between the two countries. Three meetings of the Joint Committee were held in January, May 1979 and in February 1980. In these meetings the Joint Committee exchanged data and information but could not reach any understanding on sharing of the Teesta waters. The Joint Rivers Commission in its 25th meeting held in July, 1983 agreed to an ad hoc sharing of the Teesta waters during the dry season: 39 per cent for India, 36 per cent for Bangladesh and 25 per cent left for the river.

Further meetings of the Secretaries' Committee on the Teesta were held between September, 1983 and September 1987 but could not finalise the sharing of the Teesta waters. The tenure of the ad-hoc agreement expired on 31st December, 1985. In the 29th meeting of the JRC held at New Delhi on 11th May, 1987 the ad hoc agreement was revived for a period up to December, 1987. Since then there have been no arrangements for sharing the Teesta flows. In the context of the Indian construction of the Teesta barrage at Gazoldoba and the Bangladesh construction of a Teesta barrage at Dalia, it is necessary for both countries to reach a mutually acceptable allocation of the Teesta waters in a very short time for the betterment of peoples of both India and Bangladesh.

Present status of other rivers. While dialogue between India and Bangladesh was progressing, India has gone ahead with the schemes of building dams, barrages and irrigation projects on the Ganga and other rivers. Flood control schemes on the Brahmaputra involving 3,830 km of embankments along the main river, 770 km of drainage channels and 44 town protection projects have been in progress in India. Various river channel improvement programmes have also been executed by India. She has proposed the building of two major multipurpose dams on the Brahmaputra at Dihang and on one of its main tributaries at Subansire in Arunachal Pradesh. India's intensified irrigation programme in the Brahmaputra basin will withdraw approximately 1,416-1,700 cumec from this river.

Similarly, the Gajaldoba project is likely to withdraw water from the river Teesta for irrigation in the Mahananda area without any agreement with lower riparian Bangladesh. This will make ineffective the already constructed Teesta barrage irrigation, project in Bangladesh, a lifeline for millions of poor people. India has also constructed cross dams on the rivers **Buriteesta, Khiru, Shangli** and **Goramara;** spurs and weirs on the rivers **Kaljani, Dhalai, Katachara:** a blockage on the river Sonali; embankments on the rivers Manu and **Churi**; and barrages on the rivers **Khowai,** Manu and **Gumti**. All these projects have influenced the flows in the rivers of **Muhuri, Feni, Khowai** and **Ichamati** in Bangladesh. The different types of structure/dam/barrages built in common rivers are listed in Table 3.1 and Map 3.2.

Thus it may be inferred from the above discussions that the Farakka Barrage on the Ganga, the Jogigopa Barrage on the Brahmaputra, the Gazoldoba Dam on the Teesta, the Tipaimukh Dam on the Barak and the other constructions and barrages would enable the upper riparian to control all the river flows especially during the dry season. On the contrary the lower riparian will be at the mercy of the upper riparian who may influence not only water resources availability of the lower riparian but also its agriculture, fisheries, water ways. etc.. which in turn will affect the overall economy and environmental conditions.



Map 3.2 Source: JRC 1990

Table 3.1 Common rivers where India is withdrawing or plans to withdraw water

River	Entry into Bangladesh	Structures
Betna-Kodalia	Jessore	Sluice
Bhairab-Kobadak	Meherpur	Regulator
Ganga	Rajshahi	Farakka Barrage
Punarbhaba	Naogaon	Cross dam
Gukshi Kharee	Naogaon	Sluice
Mahananda	Panchagar	Fulbari Barrage
Ghoramara	Panchagar	Cross dam
Kherua	Nilphamari	Cross dam
Buri Teesta	Nilphamari	Cross dam
Teesta	Nilphamari	Gazaldoba Barrage, Geilkhnola storage dam
Neel Kamal (Dharla)	Kurigram	Sluice
Brahmaputra	Kurigram	Jogigopa Barrage
Barakjora	Netrokona	Cross dam
Barak (Surma-Kushiyara)	Sylhet	Fulertal Barrage, Tipaimukh storage dam
Manu	Maulvibazar	Nalkata Barrage
Khowai	Habiganj	Chakmaghat Barrage
Pagli, Gumti	Comilla	Cross-dam,Maharani Barrage, Dambur storage dam
Ballamukh Char	Comilla	Cross dam
Muhuri	Feni	Kalsi Barrage

Source: JRC Report, 1996.

Photograph 1 The dry bed of the Padda - now a road route for over three-quarters of its total breadth in the dry season
Source: B.W.D.B., March 1993

Photograph 2 The number of migratory birds is reduced every year in the Padda
Source: B.W.D.B., December 1993

Photograph 3 The country boats, formerly the main means of river communication the year round, are now grounded in the dry season
Source: B.W.D.B., December 1993

Photograph 4 Unsuccessful effort to make the Gorai's mouth navigable
Source: B.W.D.B., March 1993

Photograph 5 Another view of the Ganga: Kabadak pump house in the dry season
Source: B.W.D.B., March 1993

CHAPTER 4

IMPACT OF THE WATER ROW

The withdrawal of Ganga water has caused serious disruption in the ecology and environment of Bangladesh. The ecology of the country maintains a balance between the plants and animals and various other factors of environment: climatic, aquatic, biotic and topographic phenomena. The flora and fauna of south western Bangladesh have evolved in response to the natural conditions which is now threatened due to scarcity of water. It should be noted that this region is directly under the influence of Farakka, which has brought remarkable changes in water balance and environment throughout the entire region.

The action which triggered the degradation process of the ecosystem of the area can be analyzed from the two broad categories of soil salinity and increased siltation. Soil salinity has been notably increased by tidal water intrusion made possible by reduced river flow and, there has been accelerated siltation in river channels. The manifestation of reduced flow in the Ganga has adversely affected the salinity level not only of the soil but also of the river itself, which has caused a reduction in agricultural production through the poorer quality of irrigation water. There has also been manifestation of increased aridity and reduction in the navigability of rivers, promoting the formation of small islands locally called 'chars'. The high and frequent occurrence of floods, deterioration and decline of the Sundarban mangrove forest, rapid depletion of soil moisture, worsening of ground water quality and quantity, decrease in variety of fauna, disruption in the maintenance of industries, etc., have also been associated with the reduced flow of Ganga water. All these factors have had a severe bearing on the livelihood of the people, causing the displacement of many from their native areas and increasing their poverty (Hussain 1995). Such an impact can be considered as one of the gross human interventions (including violation of basic human rights) into the ecosystem and the natural water flows of the region.

Impact on environment

Changes in water balance. The analysis of the water flow of the Ganga from 1956 to 1995 at the Hardinge Bridge point indicates that the average annual maximum discharge (August to September) before and after the commissioning of the Farakka barrage ranged between 49,218 and 53,638 cumecs respectively. The corresponding minimum annual discharge (March to April) was 2,013 and 776 cumecs respectively. This shows that average annual peak flow has increased by 8.98 per cent and the average annual low flow has decreased by 61.45 per cent (Table 4.1). In March 1993 the Ganga's discharge reached a record low of 261 cumec.

The major change in the discharge regime of the Ganga may have been promoted by commissioning of the Farakka barrage in 1975. Other contributions to this change have been aided by the implementation of various water resources development works in the upper reaches e.g. Haryana, Uttar Pradesh, Bihar and West Bengal. Evidence of such changes has been noted by Special Studies (1977) which recorded the fall of water level at Hardinge Bridge to as low as 5 metres in March 1976 and concluded that this fall may be due to the upstream diversion. The previous minimum level of 56 years record was 6.5 m in April 1918 (Special Studies 1977, Vol B Chapter IV Para 4.4.4).

In the monsoon season the sudden influx of water to the highly silted rivers contributes to the intensity and frequency of floods. Along with Farakka, India has also constructed another barrage with a cross regulator across the Bhagirathi-Hoogly river system at Jangipur above the outfall of the feeder canal. This prevents the excess water of the Ganga flowing into the Bhagirathi-Hoogly river system and the floods are therefore confined to the main channel (Personal communication from JRC Officials, Dhaka, December 1997).

Table 4.1 The Ganga's maximum and minimum discharge at the Hardinge Bridge (in m^3/s)

Year	Maximum	Minimum
1956	57439	2166
1957	43658	2245
1958	53939	2286
1963	58222	2023
1964	42233	1954
1968	44346	1705
1969	54747	1719
1970	48700	2030
1973	38200	1930
1974	50700 (*49218)	2081 (*2013)
1975	50700	1430
1976	51100	657
1977	65400	857
1978	51100	1314
1979	67900	1040
1980	36900	890
1981	57800	882
1982	47900	1167
1983	61600	693
1984	60000	888
1985	56500	689
1986	50600	1138
1987	76000	825
1988	72000	890
1989	33000	438
1990	50000	559
1991	56000	528
1992	41900	383
1993	44800	261
1994	46100	406
1995	49100 (*53638)	363 (*776)

Source: *Annual Report on Ganga's Discharge, Surface Water Hydrology*, BWDB (1991) and updated.
* = Mean value

Table 4.2 Loss Due To Dredging and Excavation (million Taka)

Year	Dredging of GK Intake Channel	Excavation of Gorai Offtake
1976	7.4	12.3
1977	9.1	29.1
1978	24.3	32.9
1979	5.8	11.7
1980	10.8	17.9
1981	14.4	NA
1982	14.3	NA
1983	21.3	5.2
1984	22.8	15.2
1985	15.2	15.6
1986	9.7	NA
1987	12.0	NA
1988	9.7	NA
1989	12.2	18.0
1990	15.1	4.1
1991	18.1	NA
1992	12.7	NA
1993	12.5	38.4
1994	13.6	2.2
1995	17.5	NA
TOTAL	>278.5	202.6 (Grand total >481.1)

Source : Compiled from the documents of the G.K. Project (1996)

Impact on the Gorai's flow. During the dry season, the reduced flow in the Ganga has adversely affected the course of the River **Gorai,** a main distributary of the Padda, causing gradual silting at the offtake. It has been estimated from the recorded data of the Bangladesh Water Development Board (BWDB, 1991) that the discharge of the Padda to the Gorai during the period between January and March has reduced significantly. It decreased from 10-12 per cent before 1975 to 0.15 per cent during the period 1990-1994 (Personal Communication from Director of the DK Project, Mr Saifuddin, Dhaka, December 1995). This river plays significant role in the South Western parts of Bangladesh. It regulates the agriculture, environment, saline intrusion through tides, as well as the overall economy and ecology of the region. Due to the deteriorating hydro-morphological condition of the Ganga and its distributaries, Bangladesh has been forced to incur huge expenditure in the dredging of the Ganga-Kapatak (G-K) irrigation project intake channel and the excavation of the Gorai offtake. The losses incurred in this sector during the period 1976 to 1995 are shown in Table 4.2.

River Bank Erosion, Shifting of River Bed and Siltation. If the natural river course is not allowed to flow downstream, there will be siltation of the river bed. This activates shifting of channel including river bank/bend erosion especially when deposits are of an alluvial nature. Along with this, human-made changes or diversions against the natural flow may aggravate or accelerate the bank level erosion.

The Ganga flow in Bangladesh can be viewed from satellite images (Figures 4.1, 4.2 and 4.3). Figure 4.1 shows that the width of Ganga flow on 20th October 1990 is more or less uniform at both the upstream and downstream areas of the Farakka barrage, indicating non withdrawal of water. On the other hand figure 4.2, dated 11th November 1990, shows a sharp variation of surface water both upstream and down stream of the Farakka Barrage due to withdrawal effects. From the evidence of these two satellite images the Ganga surface water in the area bordering Bangladesh and India at the downstream of the Farakka Barrage decreased by 63 per cent as against a change of only 29 per cent upstream of the barrage (calculated by SPARS Bangladesh, 1990).

The erosional and depositional features of the river Ganga are also seen from the satellite images, confirming the random shifting of the river bank. The increase of the number of islands/chars is also clearly visible. The increase in **charlands** as a consequence of the expansion of siltation has been noted by superimposing two images (one dated 29th December 1972 and the other 27th December 1981), in Figure 4.3 in an area at the junction of the Ganga and the Gorai. The increase of the charland has been calculated by the SPARS, Bangladesh to be about 235 per cent.

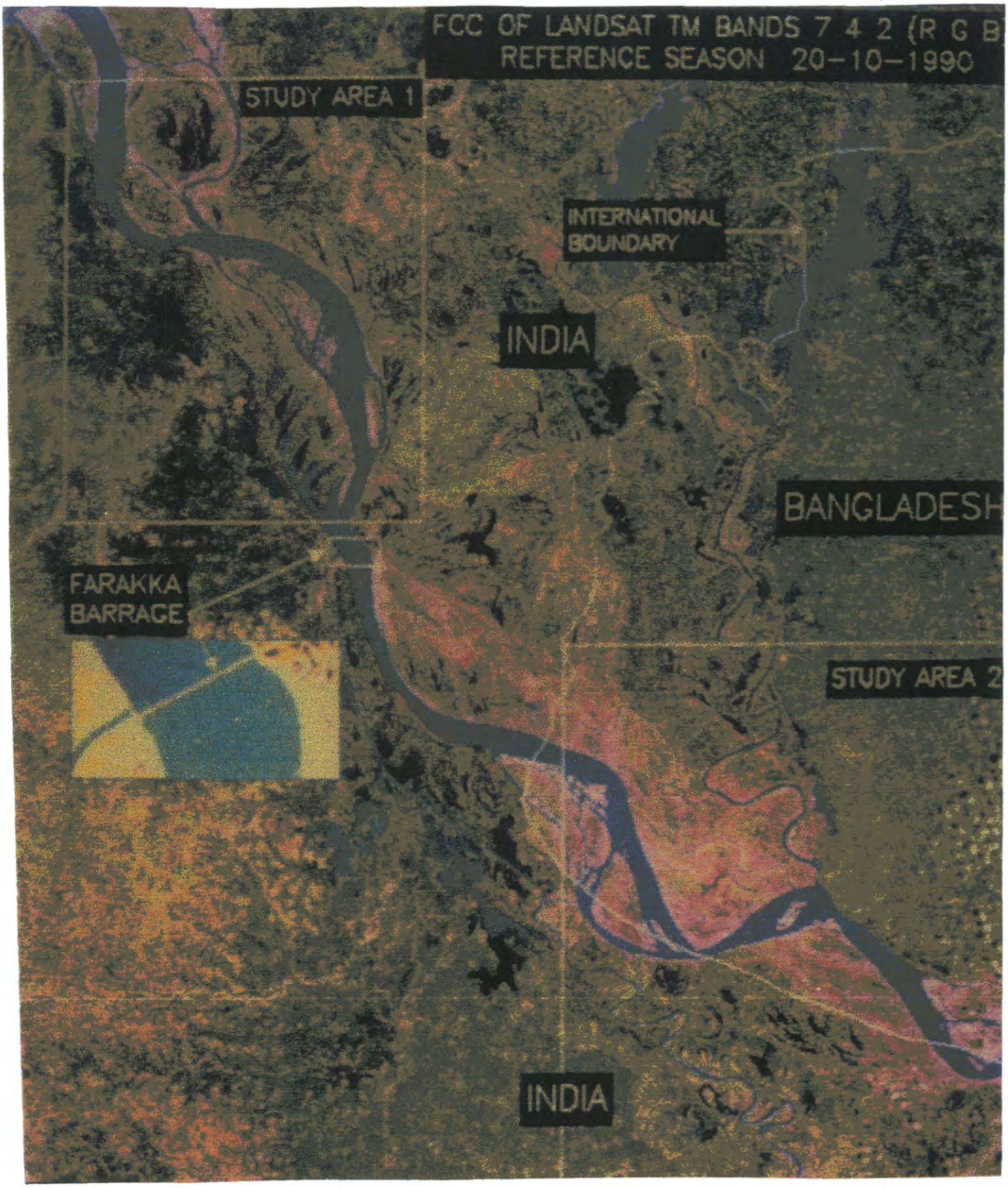


Fig. 4.1 WATER FLOW IN THE GANGA (20-10-1990)

Source: Space Research and Remote Sensing Organisation, Dhaka, 1990.

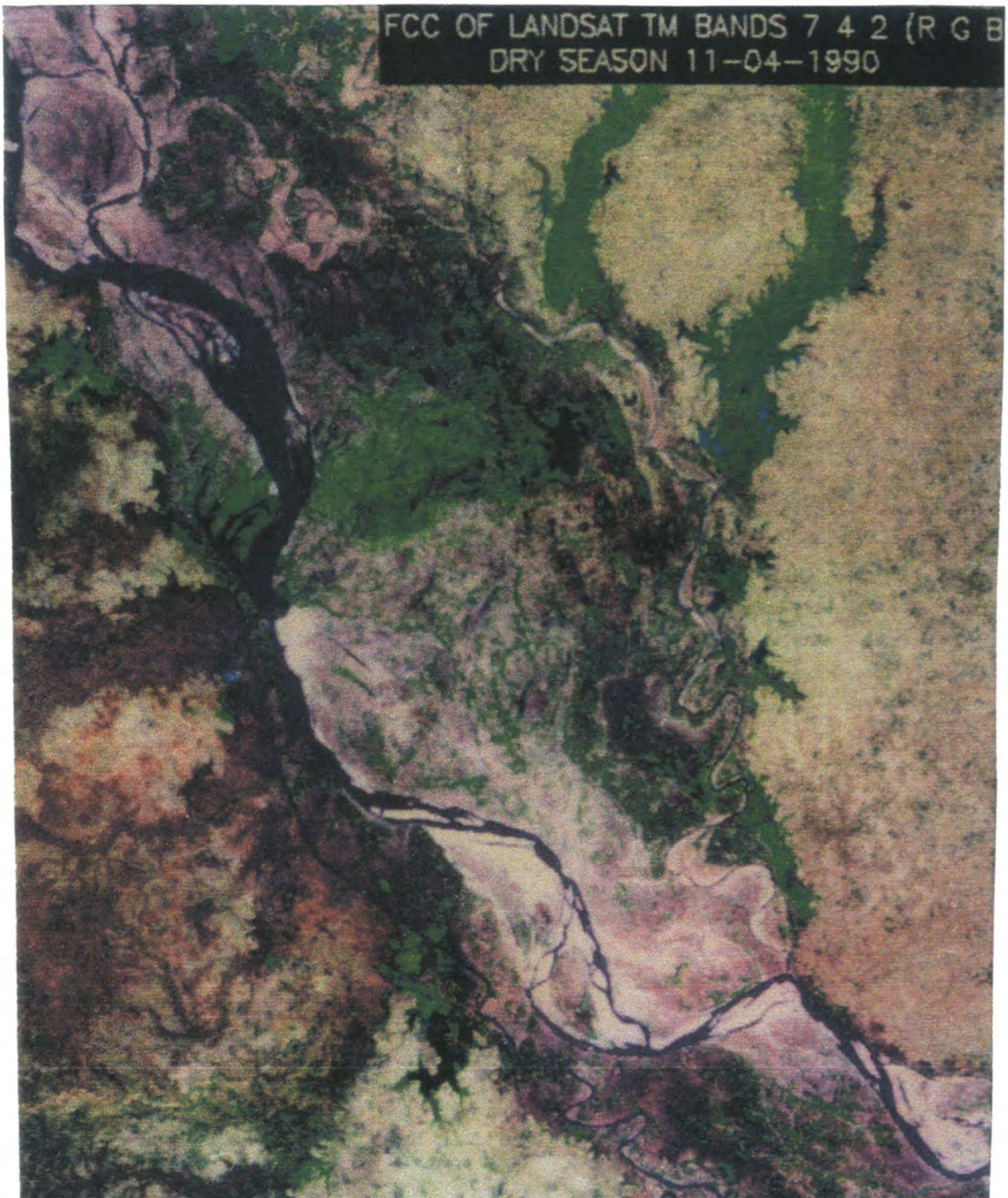


Fig. 4.2. WATER FLOW IN THE GANGA (11-4-1990)

Source: Space Research and Remote Sensing Organisation, Dhaka, 1990.

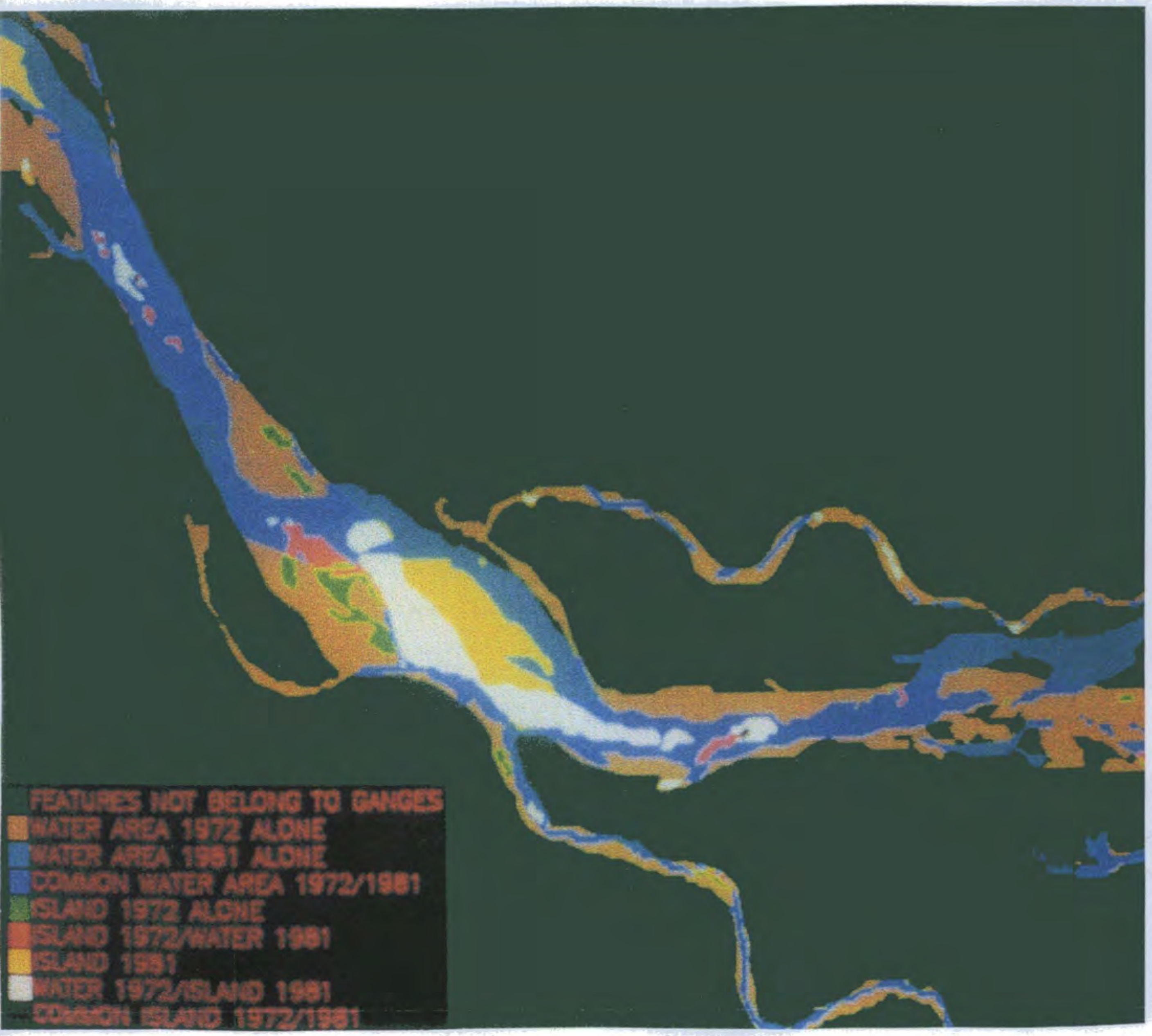


Fig. 4.3. Over lay of 1972 and 1981 Farakka barrage GIS layers, Showing increase of char lands

Source: Space Research and Remote Sensing Organisation, Dhaka, 1981.

The fragile bank line erosion can also be observed from Figure 4.3 from the position of 1972 and 1981 river banks.

The shifting of the river has adversely affected the livelihood of millions of people living on the banks of the river. People became landless due to erosion and were forced to migrate. Reports (*Bangladesh Observer,* Dhaka, 4th August 1992) indicate that nearly 19 per cent of the slum dwellers in Dhaka have migrated to the city due to this particular factor. In Patuakhali District, villages Kakchira and Dhulia are on the verge of extinction (*The Morning Sun*, Dhaka, 24th November 1993, and the *Bangladesh Observer,* Dhaka 27th November 1993). In Barguna, about 50 per cent of the farmers have become landless (*The Daily Star*, Dhaka, 9th December 1993 and *The Telegraph*, Dhaka 9th December 1993) as a result of river bank erosion. The bank erosion has also adversely affected the agricultural pattern of the area and made many local people jobless and homeless as they moved to different places for survival (Elahi 1991).

The mean bed levels for the year 1974 and 1989 show that there is a trend of bed level rise due to siltation in the reach between the Bangladesh-India border and the *Padda-Brahmaputra* confluence. In order to transport this huge sediment load, a slope increase from 5.18 cm/km to 7.99 cm/km has also taken place. The amount of deposition of silt during this period has been calculated by as approximately 426 million cubic metres. The longitudinal bed profile of the river Ganga from the confluence of the Brahmaputra to the Indo-Bangladesh boarder for the years 1974 and 1989 have been plotted in Figure 4.4, indicating bed level rise due to siltation.

Impact on Calcutta port. The diversion of Ganga water for flushing silts of **Hoogly** river has given rise to other serious questions. According to some (Kuldip Nayer, Journalist and former Indian High Commissioner in the U.K, *Annanda Bazar Patrika*, 11 May 1995, Calcutta) 'this is not only wastage of water, money and effort but is also depriving the lower riparian country of its due share at the cost of good neighbourly relations'. In the last 20 years the average annual dry season

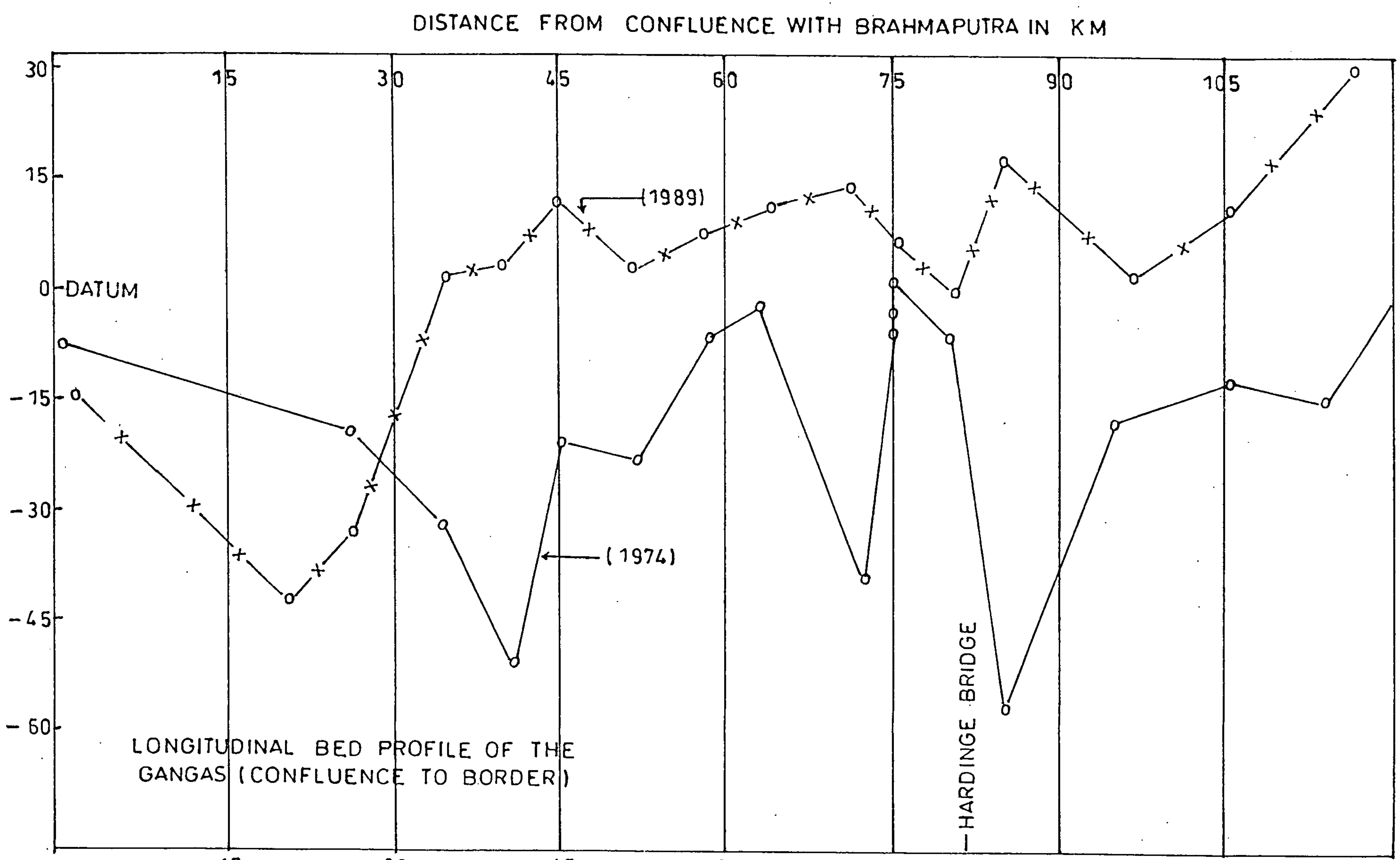


Fig 4.4 Bed Level Rise due to Siltation
Source: Adapted from JRC Report (1996)

diversion of more than 40,000 cusec of Ganga water has in no way improved the navigability of the Calcutta port as was hoped. Even the Indian press (*India Today*, February 16-28, 1981) commented on the issue saying that 'Farakka or no Farakka, Calcutta port is doomed'. Another newspaper (*The Telegraph*, 22 July, 1993) remarked 'it is time the authorities acknowledge that Calcutta port is doomed to extinction. The Calcutta port is 180 km up the river. It needs to face the grim truth that it has outlived its utility'. According to Crow (1995, 158):

> `The sad reality of the Farakka Barrage is that it was heroic piece of engineering design to solve the wrong problem. It is difficult to tell how far it has contributed to the increase in the draught of the Hooghlys but it has not rescued Calcutta Port. The decline of the port was not caused by physical constraints on the river, but by the slow rate of industrial growth in the hinterland of the port.'

Impact on public health and livelihood. The river Ganga is the main source of domestic and municipal water supply to the basin area where more than 40 million people live. Due to the reduction in natural flow of river, the people have become more dependent on ground water. The availability and quality of the ground water is also facing constraints due to the lowering of ground water table and increased salinity. The surface water fetched from the rivers for domestic use during the dry season is now more bacteria-infested due to the decrease in the flushing capacity of the Ganga and its distributaries. This is a potential threat to health which has already made the bulk of the population susceptible to several diseases in most parts of the basin. Increased salinity has also adversely affected the general health of the people in the area promoting the incidence of various ailments especially dermatological diseases related to saline water. Other water borne diseases like typhoid, infectious hepatitis, diarrhoea, cholera, dysentery, high blood pressure, kidney related diseases, etc., among the inhabitants of the south western region have been increasing substantially. Thus the cumulative effects of the reduced flow of dry season Ganga have created health hazards and threatened public health in the region.

Ground water in this region underwent depletion with the level of water falling constantly in most places. The ground water level dropped from 43 cm to 56 cm (Islam 1991) as a result of lower water levels in the river. The environmental implications have been demonstrated in the dry season condition of the ground water table when some deep tube wells of more than 6.35 metres fetched no water. People from certain areas have to walk miles to get drinking water. Sources in the Ministry of Agriculture of Bangladesh (press release on 12th February 1995) claim that there was a sharp fall in the surface and underground water levels in the summer of 1994 which seriously affected 36 Districts. A government-initiated task force has estimated that 83 per cent of the manual tube wells, 21 per cent of the low lift pumps and 41 per cent of the shallow tube wells were affected during February-April period in 1994. Innumerable numbers of tube wells became inoperative and had to be replaced by deep tube wells entailing an additional cost of Taka 250 million (JRC 1996). Studies carried out as early as 1977 have also recorded the fall of ground water levels. Special Studies (1977, Vol. B, pp V-33 and 34) recorded that:

> `Ground water conditions during recent dry seasons 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 recorded in many of the wells in the study area.'

This study also stated that hand pumps and tube wells operating at 7.62 m to 8.84 m depth (the water table along the Padda and Gorai was about 7.62 m depth) were reported to be inoperable during the 1975-76 dry season (Special Studies Vol. B, p. V-34). However, the Special Studies did not specify the cause of the fall of water level to be the diversion of water flow of the Ganga. This may be due to the fact that the study was carried out very quickly within a short period of time.

Industrial toxic wastes and other water pollutants from upstream are carried by the Ganga through Bangladesh to the Bay of Bengal. It has been noted that there are about 134 large industries namely, 81 jute mills, 18 cotton mills, 7 tanneries, 5 paper mills, 7 fertilizer factories, 8 distilleries and thermal power stations, in the upper riparian country, all of which are constantly polluting the river waters and causing serious environmental degradation and deterioration of water quality (Banerjee 1989). Similarly the upstream withdrawal of the water of the Rivers **Brahmaputra, Tista, Dahok, Tangon, Karotoa** and **Gumti** have caused a drastic reduction of surface run-off and of the ground water table. The drinking water quality of the surrounding area also deteriorated due to an increased concentration of total dissolved solids (TDS), chlorides, sulphate, etc., affecting the overall quality of water. People are now forced to drink water with 1,200 ppm although the WHO prescribed limit is only 500 ppm (TDS) and 200 mg/litre of chlorine content. It is to be noted that the highest chloride concentration recorded in the Khulna newsprint mills was 1,126 ppm in 1974 and 8,220 ppm in 1992 (Table 4.3). Before the diversion, the water quality was well within the permissible limit but this has been continuously degraded with the reduction of the Ganga's flow. The TDS figures of 200-300 ppm during the pre-diversion period rose to more than 2000 ppm at many places in 1993.

Table 4.3 Chloride Concentration, in parts per million (Khulna Newsprint)

Year	1974	1976	1980	1988	1992
Chloride	1126	4550	5300	6500	8220

Source: Compiled from DPHE (1993)

The Department of Public Health Engineering (DPHE) in September 1992 summarized the nature of problems in public water supply as a result of the Ganga water diversion at Farakka as follows:

- Lowering of static water level in hand pump wells;
- Increase in pumping cost;
- Saline intrusion in river side shallow tube wells; and
- Effects on surface water treatment plant.

The DPHE also conducted a survey on the status of the 1992 ground water level in 3,300 Unions (smallest administrative unit). This confirmed that the water table dropped down to 7 metres from pre-Farakka days (100 per cent in areas of Rajshahi, 80 per cent in Pabna, 64 per cent in Faridpur, and 36 per cent in Kushtia). Thus, it may be said that with the current trend of lean period water flow, ground water in the Padda basin will be less available and of a lesser quality for domestic and irrigational use in the dry season.

In order to maintain the potable water supply for the rural population in the Padda basin, the DPHE in conjunction with UNICEF has initiated the installation as well as replacement of normal suction pumps by deep-set force-mode Tara pumps. The changes from normal suction-mode to force-mode deep-set Tara pumps involves a substantial increase in expenditure, as the cost of construction of the latter mode is 3 times higher (Tk. 12,500 per pump) than the former (Tk. 3,800 per pump) mode. The DPHE have estimated that to maintain the existing coverage of 115 persons per tube-well, an additional cost of Tk.1210 million would be incurred due to the installation of 96,759 new deep-set Tara pumps in the area. In addition, in some parts of Chapainawabganj and Naogaon Districts even the new version pumps are gradually becoming ineffective and inoperative due to lowering of water level beyond the capacity of the Tara tube-well. Research and Development work had been undertaken to overcome the problem and a new deep set force mode Tara II pump has been developed. The ineffective Tara pumps (3,000 in number) in these areas would be replaced by Tara II pumps (cost Tk. 15,100 each), costing Tk. 45.3 million.

Reduction of flow in the Ganga is also creating back flow conditions in coastal rivers and as a result, the salinity is increasing upstream as well in the groundwater of coastal districts (Khulna, Bagarhat, Satkhira) making the availability of fresh water scarce (Personal Communication with officials of the DPHE, 1996).

The low ground water level is also one of the reasons for the increasing arsenic content in the ground water, causing health problems for consumers of such water. For example, the Atomic Energy Commission Dhaka has analysed water samples from 113 tube-wells collected from the affected border Districts since 1993. Out of 113 samples, 24 showed arsenic contamination higher (0.015 mg/litre) than the WHO standard of 0.01 mg/litre. Of the 24 samples having higher arsenic content, 20 were from Rajshahi, Chapainawabganj, Kushtia, Meherpur, Satkhira and Chuadanga Districts. Moreover, arsenic presence has been detected in areas of neighbouring West Bengal in India in alluvial soils. The reason for this, as explained by the DPHE officials, is a fall of the level of ground water which has oxidised arsenic-rich minerals (Arsenopyrite). A recent study undertaken by the School of Environmental Studies of Jadavpur University, India and the Dhaka Community Hospital mentioned that in a village (Samta) of Jessore District having 279 tube wells, 265 were tested for arsenic contamination. The study indicated that as many as 91 per cent of these yield water with more than the accepted level. Of the total 5,000 people of the village, 334 were examined and 97 of them were found to be positive for high levels of arsenic poisoning (*The Daily Star*, 10 June, 1997, pp 4). However, further study/research has to be undertaken immediately to find out the exact cause and to plan remedial measures for the region on both sides of the river Ganga.

Impact on the Economy

The reduced flow/withdrawal of Ganga water has adversely affected the national economy. Industries, navigation and agricultural output in the western and south western part of the country have been badly affected. The industrial plant and its machinery in this region is suffering from progressive damage due to increased corrosion in boilers of power plants and newsprint factories. In other words industries dependent on fresh water have to arrange/bring water from a distance, incurring additional expenses to keep them operative. The alternative of desalination plants would also increase production costs. The impact of the Farakka barrage can be traced in several other economic sectors as discussed below.

Impact on agriculture. Agriculture is the backbone of Bangladesh economy. In the year 1975 about 75 per cent of the labour force were employed in agricultural sector contributing about 56 per cent of GDP (Gross Domestic Product) (Bangladesh Planning Commission, *The Two Year Plan 1978-80,* pp 71). As reported in the Dhaka Metropolitan Development Plan (1995-2015), agriculture accounts for 38 per cent of the GDP and 65 per cent of the country's employment. The reduced dry season flows have affected the agricultural sector drastically. The Special Study reported a loss of agricultural products of 650,000 tonnes costing about US$ 2 million (Vol. C, Table VII-36) alone in one year i.e. 1975-76. Estimates from the Ministry of Agriculture, Government of Bangladesh (1993) indicated that out of the 2.77 million hectares of total net cropped area, 0.64 million hectares are fully or partially affected by dry season flow. At present about 53 per cent of the irrigation network in the south western parts of Bangladesh dries out in the lean period, causing an annual loss of approximately 0.24 million tonnes of rice production worth about US$ 70 million per year (Islam 1991). Acute shortages of water supply and decreases in water levels delay the plantation of crops, shorten the growing season and reduce production. Ground water level changes have caused substantial reductions in the yields of summer season crops and fruits like **aus** paddy, mango, lychee, jack fruit, etc. due to shortage of required water. This setback in agriculture is in a sector which presently accounts for about 41 per cent of the gross domestic product and affects approximately 55 per cent of the labour force (Hassan 1991).

Early drying of the floodplains has accelerated the quantum of wind-blown sands deposited on surrounding land, causing serious reduction of the fertility of the land and in the yields of various crops. The Ganga-Kobadak (GK) project, the largest irrigation project in this area has suffered so much that its pumping capacity has been reduced by about 60 per cent, becoming virtually non functional. Soil moisture deficiency in the south western region causes late sowing of seasonal (Kharif) crops leading to yield reduction and late harvests which are sometimes too late to avoid damage by the floods occurring in July/August. Late harvest of Kharif-I in turn delays Kharif-II and in the same way causes yield reductions and sometimes planting is impossible as the flood depth exceeds seedling height.

It has been indicated to the present author by Ministry of Agriculture officials (1996) that the direct agricultural losses due to soil moisture depletion, delayed planting and increased salinity exceeds about US$ 180 millions annually, while the indirect losses in financial terms resulting from additional benefits that could accrue are about US$ 500 millions per year. The Ministry of Agriculture, Government of Bangladesh has estimated that the people of this region have been deprived of an additional crop yield exceeding 3 million tonnes annually, worth approximately US$ O.5 billion per annum. A Government of Bangladesh Agriculture Ministry source (press release on 12th February 1995) stated that about 0.45 million hectares of Boro cultivation has affected rice cultivation output. This has a shortfall of about 0.6 million tonnes due to shortage of irrigation water in the period between July-October. The overall direct damage in agriculture is shown in Table 4.4.

Table 4.4 Direct Damage to Agriculture

Year	Area (000 ha)	Production loss (000 tonnes)	Area (000 ha)	Production loss (000 tonnes)	Area (000 ha)	Productio n loss (000 tonnes)	Total Production loss (000 tonnes)	Cost in million Taka (1995 values)
1976	129	111	443	405	63	132	647	4,104
1977	32	53	116	80	NA	NA	134	859+
1978	33	19	23	41	NA	NA	60	385+
1979	168	423	204	134	NA	NA	557	3,584+
1980	275	478	119	129	NA	NA	607	3,907+
1981	368	502	172	142	NA	NA	644	4,143+
1982	316	614	NA	NA	95	185	798	5,134+
1983	105	111	NA	NA	61	76	186	1,197+
1984	250	149	74	103	32	38	290	1,863
1985	194	174	368	391	34	29	593	3,809
1986	153	112	114	104	66	67	284	975
1987	102	101	232	163	38	35	300	1,929
1988	54	53	202	89	10	40	182	1,235
1989	95	108	NA	NA	34	49	157	1,183+
1990	58	84	27	35	13	23	142	891
1991	17	16	NA	NA	23	14	31	253+
1992	21	32	12	19	4	8	59	488
1993	263	382	120	148	24	35	565	4,700
1994	299	311	208	185	127	119	615	4,055
1995	308	378	261	304	149	153	835	6,797
Total							7,475+	51,490+

Source: Compiled from the documents of the Ganges Studies, BWDB, 1996.

Impact on Industries. The increase in the salinitly of the river water has affected the operation and maintenance of almost all the industries of the Khulna division because they have to acquire fresh water from other sources with additional cost. The operation of the newsprint mill at Khulna is severely affected in the dry season. This is because the river **Bhairab**, a distributary of the Ganga, cannot provide the necessary 40 tonnes (per day) of fresh water due to high salinity (Swain 1996, 67). The industry operates on a limited scale by using fresh water brought by road tanker from distant places in the dry season causing extra expenditure to the factory. A similar problem is faced by all other industrial units due to their location in this region. For example, the Goalpara thermal power plant situated on the bank of river Bhairab has almost been closed down. The salinity problem has forced the plant to depend on deep tube well water and extensive use of chemicals for its operation during the dry season with extra cost. A local weekly (*Dhaka Courier* dated 9 April 1993 p. 15) reported closure of another paper mill at Paksi as a result of high salinity in the river water.

The losses in the industrial sector are increasing at a cumulative rate every year, threatening the survival of such industries. Table 4.5 shows the effects of salinity on the industrial units and other organizations around Khulna in the year 1976 alone. Major difficulties and problems faced by such units have been shown in Table 4.6, and table 4.7 depicts the approximate financial loss in these factories due to salinity problem.

Table 4.5. Estimate of industrial losses for the year 1976

Industry	**Water Demand (million litres)**	**Lost Production**	**Cost (million Taka)**	**Reason for Lost Production**
Goalpara power station	454	73 MW	39	increased consumption of chemicals, cost of water
Khulna newsprint mills	114	24,000 tonnes	0.7	increased corrosion of boilers etc.
Jute mills in Khulna (16)	3.2	2928 tonnes	18	power failures
Other factories	6.1	various	6	increased corrosion
Chalna port authority	-	-	50	design change due to saline intrusion
GK pumping station	-	-	3.7	clearing intake channel
Total loss			117.4	= US$ 8 m

Source : Special Studies (1977), pp. VI-39-41.

Impact on fisheries. The rivers in Bangladesh have about 200 varieties of fresh water fish and 20 types of shell fish. Due to the short supply of water in the dry season, fish cultivation has been seriously affected. In the first year of the Farakka withdrawal, three places namely Khulna, Goalondo and Chandpur observed a reduction of fish production by 75 per cent, 34 per cent and 46 per cent respectively from February to June 1976, compared to the previous year (Swain 1993).

Table 4.6 Industries affected around Khulna by increased salinity

Industries	Effects
Khulna Hardboard Mills	Damage of hardware materials
Goalpara Thermal Power Station	Damage to the machineries, power failure, additional repairing, replacement of the damaged machineries, water treatment plant
Bheramara power station	Ditto
Khulna News Print Mills	Cost for water treatment, corrosion of machinery, production loss
North Bengal Paper Mills	Ditto
Bangladesh Match Co	Additional cost for water
Khulna Municipal Water Supply	Cleaning of pipes, water treatment
Bangladesh Cable Shilpa	Corrosion in pipes and machineries
Other Industries	Corrosion on machineries, extra expenditure
North Bengal paper mills	Corrosion on machineries, boiler, extra expenditure, production loss
Different Jute Mills (16)	Corrosion on machineries, early replacement, boiler cleaning, water treatment, extra use of chemicals, extra expenditure, health hazard, power failure, loss of production, increase of production cost, over all loss in all the factories.

Source: The Daily Star, Dhaka, 26th May 1997; The Daily Janakantha, Dhaka, 18th March and 16th July 1997.

Fish being the main and cheap protein supply (80 per cent of protein intake) for the people of Bangladesh, there is a threat to the nutritional intake of the millions living in the Padda basin. The per capita fish consumption in Bangladesh appears to have been reduced from 11.7 kg in the year 1972 to 7.5 kg in 1988 (Department of Fisheries, Government of Bangladesh,1989). The Fisheries Department (1992 report) indicates that production in the Padda basin has declined from 277 thousand metric tonnes in 1974 to 175 thousand metric tonnes in 1991, amounting to a loss of about US$ 100 million (at 1991 prices). The overall fish production has been adversely affected due to changes in hydrological and hydro-biological conditions. The water flow, velocity, TDS, water turbidity and salinity on which fisheries of the region flourished have all been affected. The reduced flows have seriously affected particular species like Ruhi, Katla, Mrigel, etc.. The losses

Table 4.7 Losses in industry

Year	During the year	1991 price index
1976	26.49	65.40
1977	25.63	63.17
1978	0.74	1.83
1979	6.68	16.47
1980	0.71	26.40
1981	5.99	14.77
1982	37.33	92.02
1983	29.56	55.81
1984	66.86	126.23
1985	19.03	35.92
1986	15.87	19.30
1987	14.030	17.06
1988	21.16	25.73
1989	26.39	32.08
1990	97.00	117.95
1991	83.68	101.75
1992	122.42	122.42
1993	48.85	48.85
1994	69.89	69.89
1995	204.97	204.97
Total (million Taka)	1257.92	

Source: Compiled from Ministry of Industries report (1996)

incurred in the production of capture fisheries is 1,602 thousand tonnes and in financial terms about Tk 81,430 million from 1976-95 (A report by the Government of Bangladesh, Ministry of Water Resources, 1996).

It should be mentioned here that a total of 3.6 per cent of national production and more than 13 per cent export income comes from fish resources. About 1.2 million people directly and 10 million people indirectly earn their livelihood from fisheries (Census 1991). In areas around the river banks of the **Gorai** and the **Ganga** in Kushtia district, several fishing villages have been left abandoned due to non-availability of fish. The locals say that over 3,000 people have left these villages from 1975 to

1996 in search of food and employment and have not returned. Ashok Swain (1996, 72) in this respect writes:

> `A Bangladeshi fisherman living on the Ganges described it: "Now it (Farakka) has stolen everything, my meals, hopes and dreams...The Ganges, whose waves used to make a sound that was compared to the roar of tigers, now lies like a dead python, long and curving, lifeless."'

Impact on communications. The criss-crossing river channels are the main communication networks of Bangladesh. A large number of these are nearly dead now due to the fall in water depth. As such, Bangladesh Inland Water Transport Authority (BIWTA) has re-designated the limiting drafts for lower categories of vessels (Table 4.8). Even in these routes navigation is disrupted due to formation of shoals. The 180 km reach of the four rivers of **Padda, Punarbhaba, Mohananda** and **Pagla** has become non-navigable due to the formation of shoals. According to a survey carried out by the BIWTA (1993), the annual transportation of goods in south west Bangladesh has been reduced by about 11 million tonnes. The decreased lean season flow has accelerated river bed siltation, causing a reduction in conveyance capacity. The average navigational route of 4,000 km in 1976 has shrunk to 1,000 km in 1993, a 75 per cent reduction. The off-take of the river Gorai remains totally dry in the month of January each year making all its tributaries almost dry and non-navigable. The many ferry points became non-operative and even if they function, need constant site shifting due to the changing river regime. This involves constant extra expense. The total waterways available for mechanically propelled vessels have reduced from 25,000 km in 1976 to 5,000 km in 1993. This reduction of both navigational routes and waterways for the vessels has affected thousands of people thriving on navigational related jobs. For instance *Media Syndicate*, a press news organisation, reported on 13th February 1995 that launch and other water vehicle communication within the Khulna region and to the northern areas has been greatly reduced due to an alarming reduction in water levels. River communication towards the south from Khulna now depends on high tides. About 200 launches used to ply in 36 routes before 1974 and now the number of launches have been reduced to 50 and the routes to only 12. River transport is the cheapest source of transportation since one horse power can pull 4,000 kg on water, while the road and rail can move only 150 kg and 500 kg respectively. The affected reduction of draft by continuous shifting of ferry terminals, and the construction of approach roads etc. incurs extra costs. The financial loss up to 1996 is shown in Table 4.9.

Table 4.8 Affected draft due to the withdrawal of Ganga water

River	Reach	Draft in metres		Length of affected reach in km
		1975	1989[1]	
Ganga	Godagari-Paksi Paksi-Aricha	1.38 1.38	Seasonal Seasonal	93 95
Padda	Daulatdia to Tepurakandi	1.83	1.83	16
Gorai	to Kamarkhali	1.38	Seasonal	80
Madhumati	Kamarkhali to Bardia Bardia to Matibhanga	1.83 1.83	 1.38	95 56
Lower Nabaganga - Mojudkhali-Bhairab	Bardia to Khulna	1.83	1.38	45
Kaliganga	Matibhanga to Hularhat	1.83	Seasonal	32
Dubaldia	to Sindiaghat	1.38		64
Madaripur - Beel	Sindiaghat to Manikdah	1.38	1.38	37
Arial Kha	Madaripur to Nandir bazar	1.83	1.83	48
Palong	Janjira to Angaria	1.38	Seasonal	24
Total: 685				

Source : Compiled from BIWTA (1996).

[1] Navigation was disrupted during the dry season due to the formation of shoals.

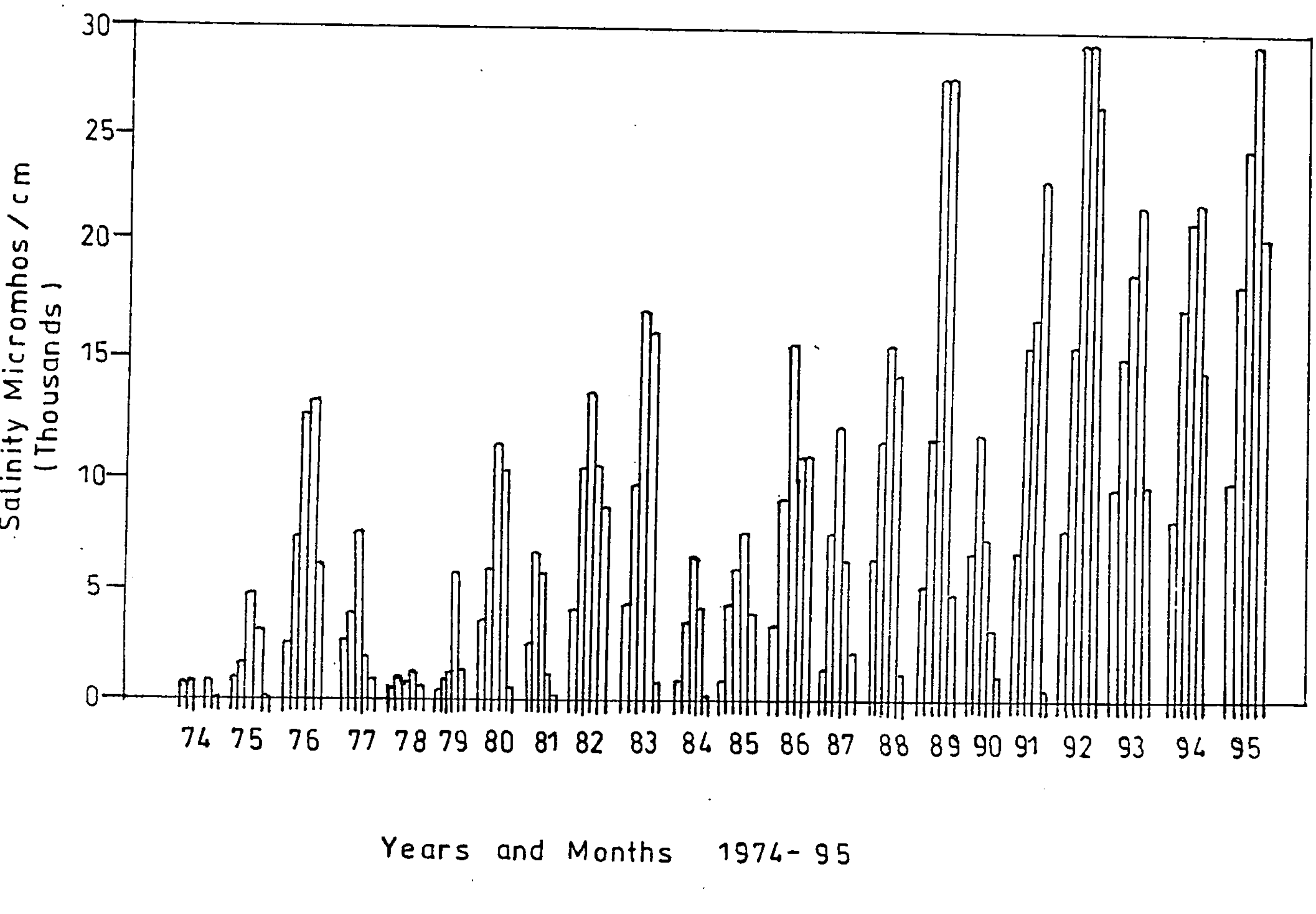
Table 4.9 Financial losses (million Taka) in the communication sector

Year	Shifting of ferry	Dredging	Total
1976	2.85	0.91	3.76 (9.27*)
1977	1.50	2.57	4.07 (10.03*)
1978	1.61	2.92	4.53 (11.17*)
1979	1.45	0.62	2.07 (5.10*)
1980	1.50	2.93	4.43 (10.92*)
1981	1.65	3.05	4.70 (11.59*)
1982	96.40	1.82	98.22 (185.44*)
1983	5.65	10.51	16.16 (30.51*)
1984	4.32	5.41	9.73 (18.37*)
1985	4.82	13.93	18.75 (22.80*)
1986	5.36	8.39	13.75 (16.72*)
1987	6.84	15.12	21.96 (26.70*)
1988	5.11	13.24	18.35 (22.31*)
1989	18.07	23.30	41.37 (50.31*)
1990	4.66	16.43	21.09 (25.65*)
1991	4.84	31.75	36.59
1992	7.64	21.63	22.39
1993	4.25	36.44	40.69
1994	4.68	33.40	38.08
1995	5.05	43.00	48.05
Total			642.69

Source : Complied from BWDB (1996)
* 1991 values

Salinity intrusion. The irreparable consequence of the Ganga's water diversion has caused a marked increase in the salinity level of both surface and ground water in the south western parts of Bangladesh. The salinity of the Khulna area, for instance, has increased from 380 micro mhos in 1974 to about 29,500 micro mhos in May 1995 (Figures 4.5 and 4.6). The salinity front of 500 micro mhos moved through the **Passur** estuary from 145 kms to 220 km inland. Moreover in terms of the area, the salinity level of 500 micro mhos during 1968 affected 186,00 sq. km, increasing to an area of 24,650 sq. km in 1995. The salinity level of 2,000 micro mhos in the same years has increased from an area of 13,500 sq. km to 18,800 sq. km (Map 4.1, Table 4.10).

Table 4.5 SALINITY KHULNA Area (FEB - JUN)



Source: Drawn from data B W D B (1996)

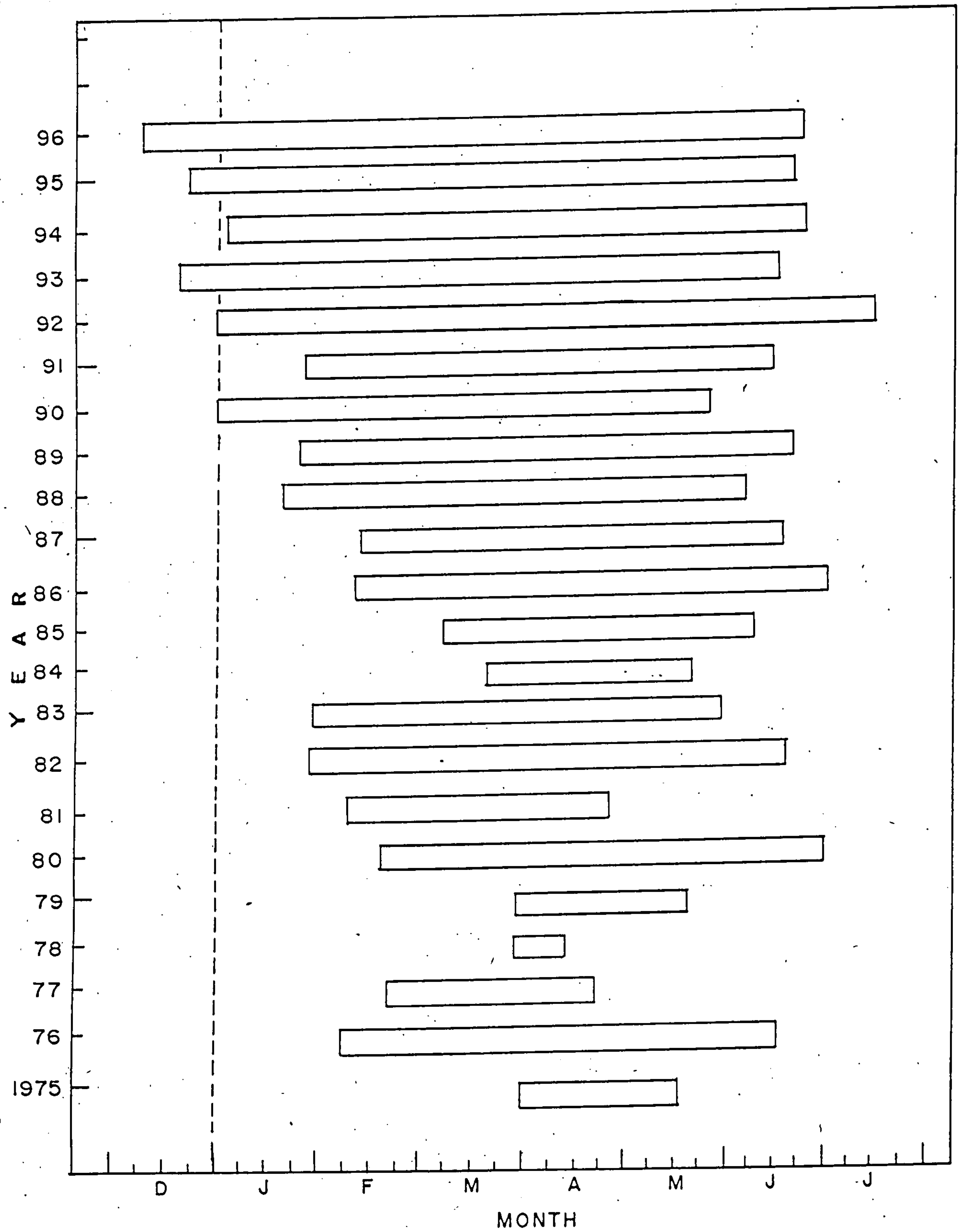
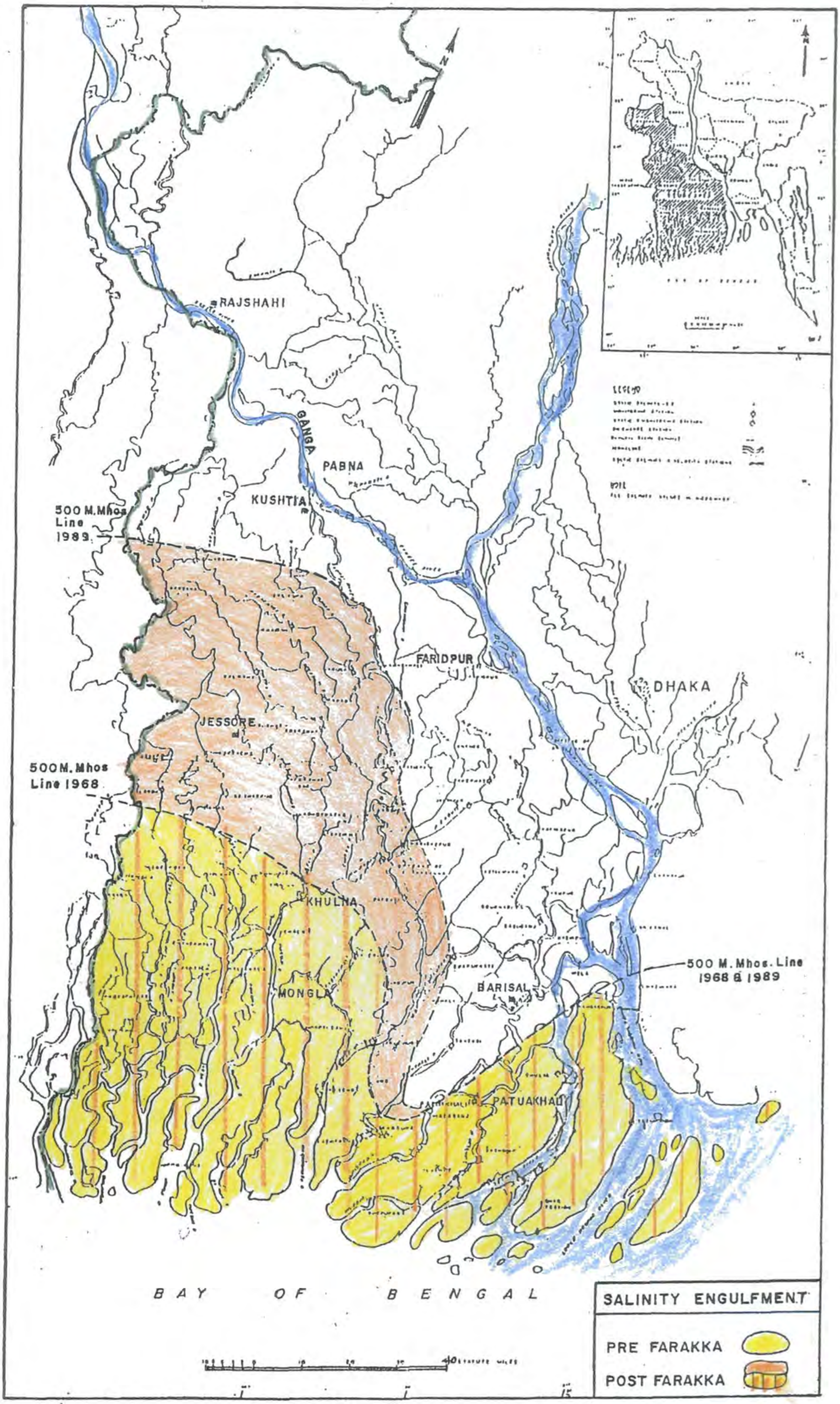


Fig 4.6 Prolonged salinity pollution of the River Rupsha-Bhairab indicating gradual increase & early start

Source Drawn from data BWDB (1997)



RAJSHAHI
GANGA
PABNA
KUSHTIA
500 M.Mhos Line 1989
FARIDPUR
DHAKA
JESSORE
500 M.Mhos Line 1968
KHULNA
500 M.Mhos. Line 1968 & 1989
BARISAL
MONGLA
PATUAKHALI
BAY OF BENGAL
SALINITY ENGULFMENT
PRE FARAKKA
POST FARAKKA

Map . 4,1

Table 4.10 The Saline Front In South West Bangladesh

			Increase (%)
Salinity micro mhos/cm	380 (Mar 1974)	29,500 (May 1995)	7,663
Salinity front (Passur Estuary)	145 km (1977)	220 km (1993)	52
Engulfed Area			
500 micro mhos/cm	18,600 sqkm (1968)	24,650 sq km (1995)	33
2000 micro mhos/cm	15,300 sqkm (1968)	18,800 sq km (1995)	40

Source: Complied from Directorate of Ganges Studies, BWDB, 1996.

The maximum salinity around the Khulna area for the months from February to June for the year 1974 to 1995 is been plotted in Figures 4.5 and 4.6. The prolonged salinity front of the river Rupsha-Bhairab shows a gradual increase and an early start.

Impact on Floods. Floods in Bangladesh are a regular phenomenon. About 60 per cent of the country is flood prone while 25 per cent of the land is inundated by the monsoons in normal years. The factors responsible for floods in these regions are heavy water flows caused by rainfall occurring within a short span of time in the upstream catchments, overbank spilling of the major rivers, surface runoff due to heavy rainfall which is not drained out quickly and heavy melting of snow in the Himalaya. High tides in the Bay of Bengal, including those caused by the south westerly monsoon wind, obstruct drainage of the water flow to the sea and are responsible for flash floods. Deforestation in the region, drainage congestion due to unplanned river training, a rise of the river bed level, the formation of char lands, and the lack of coordination in development activities, also promote flooding.

The nature of floods in Nepal is attributed to glacier lake out burst, heavy precipitation and landslides. The three major rivers **Sapta Kosi, Gandaki** and the **Karnali** are all snow fed. These three rivers also receive monsoon waters from June to September when the maximum rainfall coincides with the melting of snow. The estimated damage due to floods and landslides has increased from US$ 1 million to US$ 100 million in the last 30 years (*The Daily Star*, dated 6th June 1997, p. 4).

In India all the major rivers carry heavy run-off during monsoon due to intensive rainfall in their catchment areas. The floods in the Ganga basin are caused mainly by inundation due to overbank spilling, river bank erosion and changes in river courses. On the other hand serious floods occur in the **Brahmaputra** basin due to conditions related to physiographic factors, meteorological events, earthquake phenomena, landslides and river bank erosion. It should be mentioned here that, after the earthquake of 1950, the regime of the Brahmaputra in the upper catchment changed the depth, duration and the extent of its flood area due to a heavy siltation of the river bed. Floods in India generally occur from June to September. The average flood-affected area is 7.9 million ha. of which 3.7 million ha is cropped. The estimated annual loss from floods is about US$ 500 million.

Bangladesh through its river system drains a catchment of about 1.72 million sq. km, of which only 7 per cent lies within its territory. The flood problem in the Ganga/Padda basin is mainly due to overbank spilling. The flood situation deteriorates when the Brahmaputra adds to the flow of the Ganga. The Ganga begins to rise in May and the period of maximum rise in water level has been recorded in July and August. Sometimes September has also been a month of severe flooding. This takes place in conjunction with overflow coinciding with peaks in the Brahmaputra and the Meghna. Flooding in the Brahmaputra creates large scale innundation of the banks, erosion and brings a heavy silt from upstream. As pointed out by Indo-Bangladesh Task Force on Flood Management (1990), in 1988 the rivers Ganga at Farakka and the Hardinge Bridge and the Brahmaputra at Pancharatna and Bahadurabad remained over danger level for most of July until mid-September. Figure 4.7 shows the discharge pattern during this period at all of these four points between August and September 1988. The loss caused by flood in an average year is about US$ 175 million, but in extreme cases it has exceeded US$ 1 billion (e.g in 1988 flood, Bangladesh-Nepal Joint Study Team, 1989).

Floods and drought are the twin problems of the three major rivers for all three countries. One of the major floods that occurred in 1993 claimed over 2,000 lives and damaged more than half a million ha of cropped area in Nepal. In the same year in India 1,100 people died and there was extensive damage of crops and homesteads. Similarly in Bangladesh 162 people died, extensive damage was caused to crops and housing and 9.3 million people were affected during the same year.

The floods of 1995 in the northern region of Bangladesh destroyed many lives and properties, washed away development programmes, economic achievements and growth. It destroyed standing crops, houses and disrupted transportation. A report of the Ministry of Water Resource on North Bengal showed that floods in 1995 frequently occurred from June 13-14th, July 2nd-20th, August 11-16th and 28th September to 5th October, a total of over one month. On the other hand, the floods in 1996 started in June and continued until August, i.e over 90 days. In 1996, 46 districts were affected, 47 people died and there was heavy damage to crops, houses, livestock, roads and the communication network.

In the historical record there was a severe flood in 1922 in Dinajpur, Bogra, Rajshahi and Pabna Districts. Precious information on floods prior to 1922 is not available but Professor Mahalanabis in his book 'Report on rainfall and floods in North Bengal 1870-1922' has written about floods during 1870-1922 with their causes, severity and effects. There were 25 floods of which 8 were severe. This report said that on an average moderate floods occurred once in every two years while severe floods occurred in every six to seven years. No dependable record is available on floods up to 1953 except for the severe flood of 1931. But it is known that several severe floods occurred during this period. From compiled data it is seen that high floods occurred once in every three

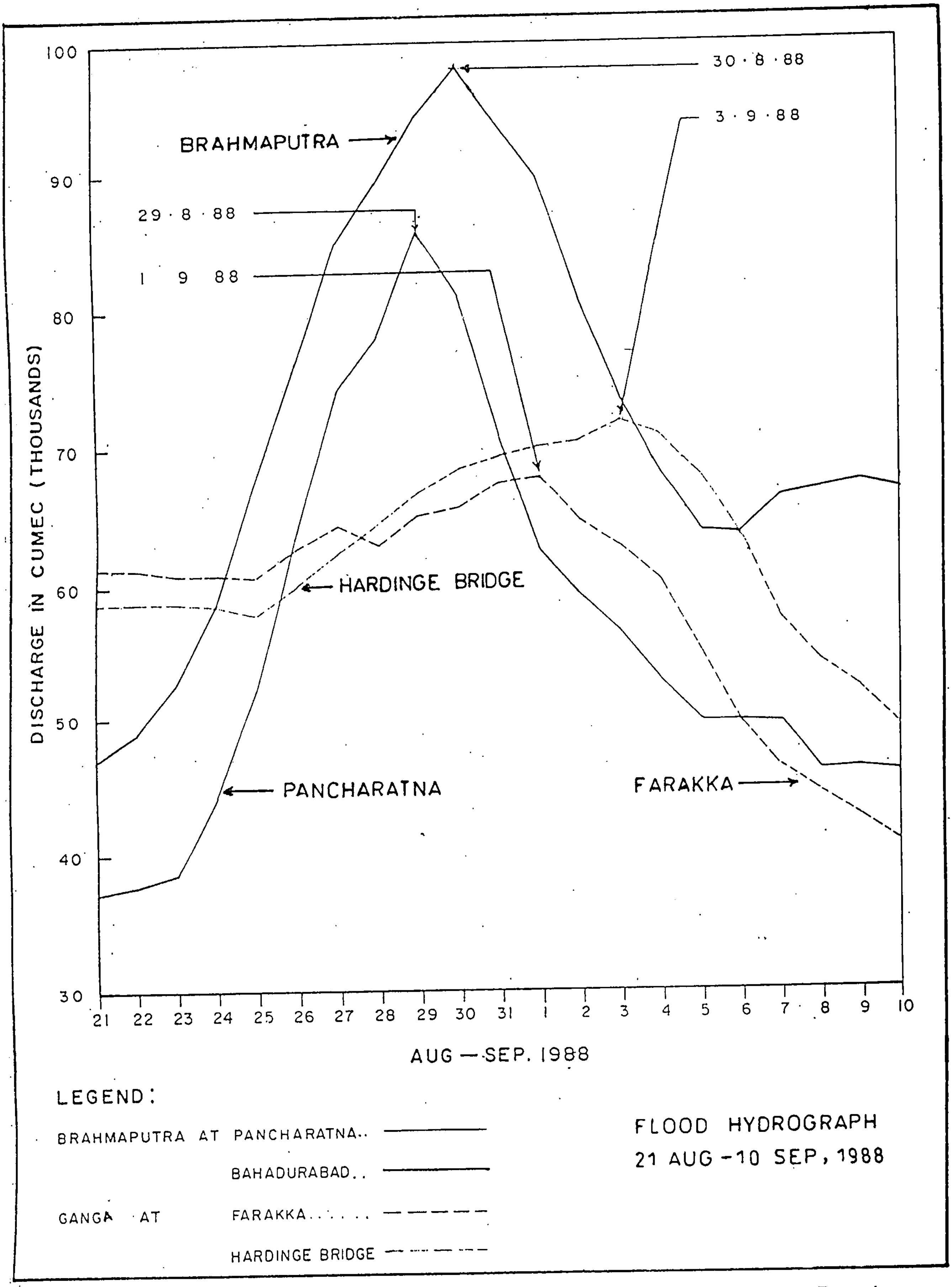


Fig 4.7, Source: Adapted From Indo-Bangladesh Task Force On Flood Management Report (1990)

years, a severe flood every six years while a devastating flood occurred every nine years. On analysis it is evident that there is not much change in the frequency of normal floods over the last century while floods of severe and devastating nature are occurring more frequently in the recent times. The *Far Eastern Economic Review*, 2nd February 1989, also writes that the occurrence of the high floods has increased from three times in the 1950's - 1960's to four times from 1960's to the 1980's.

During heavy monsoons, due to the failure to control the head waters of the rivers Ganga, Brahmaputra and Barak including added waters from other sources, a huge volume of water passes during short span of time through the densely populated areas causing severe flooding and bank erosion. Lean and Billen (1993) in this respect write:

> 'In the past, when the Himalayas were covered in forests, Bangladesh used to suffer from overwhelming floods once in every 50 years. By the 1970's they were happening every four years, and the pace continues to increase...The flooding seems to be becoming more regular: cyclones hit in 1985 and 1986, the rivers flooded two years following that...'.

From the historical data it is evident that from 1962 to 1973 the area flooded in Bangladesh ranged between 28,500 to 41,500 sq. km whereas after 1974 the flooded areas gradually increased to over 77,700 sq. kms (*The Bangladesh Observer* 1988) which is over half the area of the country. In the Padda river basin about 240,929 hectares of land was affected by the 1988 flood, damaging the rice crop alone to the tune of about 1.6 million tonnes.

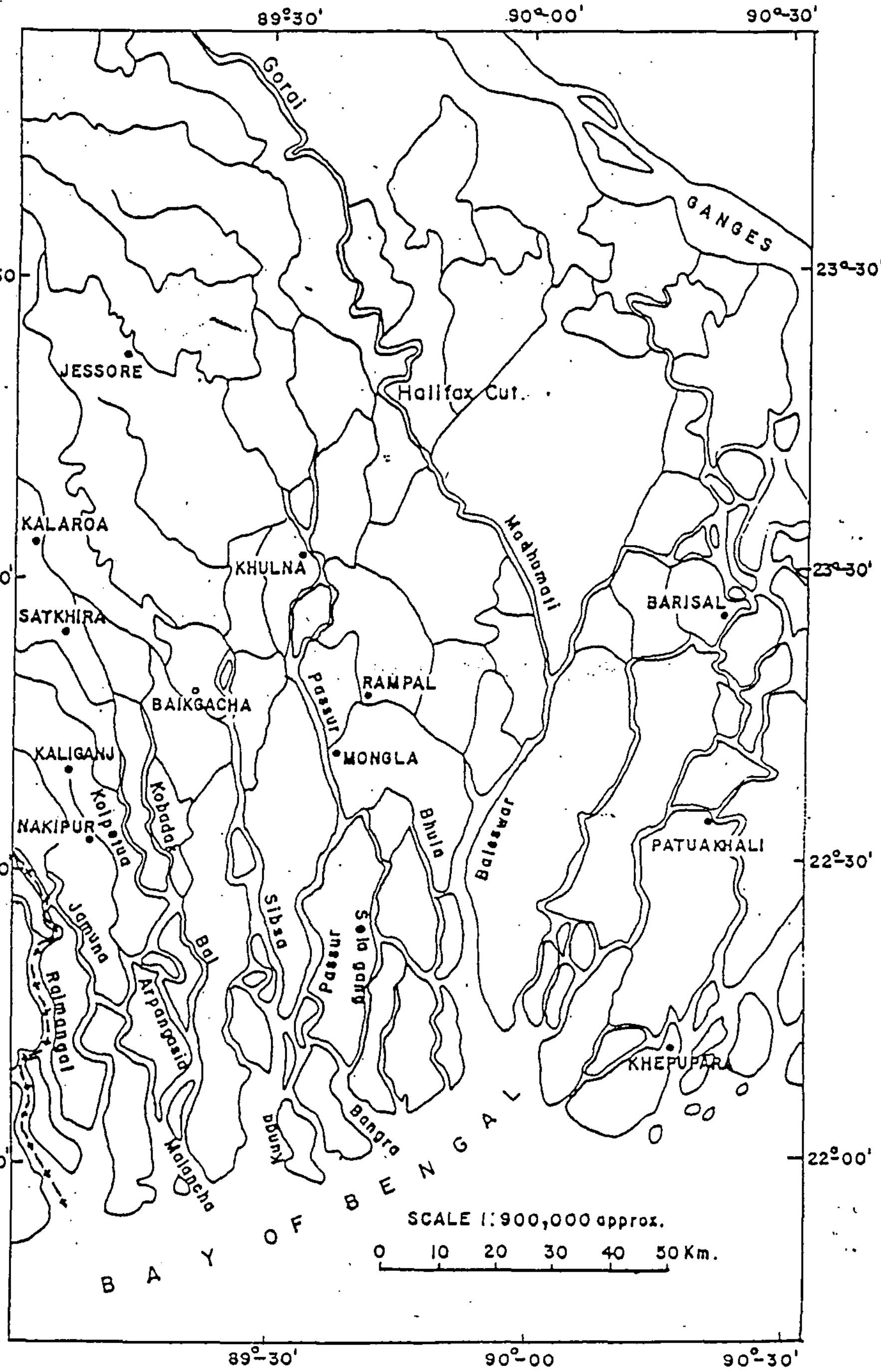
The three countries have their individual plans for flood control to safeguard themselves but these have proved to be inadequate. The individual efforts are not enough to mitigate floods. Thus there is a greater need of exchange of information and regional co-operation for encountering regular and severe floods (i.e. managing excess water to resolve the problem to augment the dry season shortage) for the benefits of the millions of the poor in Nepal, India and Bangladesh.

Impact on forestry. The **Sundarbans** mangrove forests are fed by the Rivers **Baleswar** and **Passur** and their distributaries which in turn receive fresh water flow directly from the **Ganga** (Map 4.2). The river **Sibsa** and others get fresh water from local catchment areas between the Ganga and the northern edge of the forest. These rivers are therefore more susceptible to dry season reduced flow and tidal intrusion of salt water. Due to a reduction in the water flow there has been a change in the hydrological pattern.

The forest industry, which contributes about 5 per cent to the country's GDP, is threatened. The Sundarbans is situated in the south western corner of Bangladesh, bordering the Bay of Bengal on south end and astride the river Baleshari, covering an area of around 5,704 sq km). It is home to about 600 royal Bengal tigers, 700,000 deer, 40 other species of animals, 50 different types of plants and trees, 45 types of birds and many types of snakes (*Dainik Bangla*, 27th January, 1995, p.11). Increased salinity has affected the generation and regeneration of the Sundari tree which accounts for about 60 per cent of the marketable timber of the Sundarbans. Other important species, e.g. *Gewa, Keora,* have also been remarkably retarded. This wood is used for house and boat construction and is a chief raw material in the local newsprint and match industries. A recent estimate of the Ministry of Forestry (1995) indicates that about 45 million trees in the Sundarbans have so far been affected by top drying attributed to accelerated siltation, high salinity and reduced flooding by fresh or river water. The overall loss has been estimated to be approximately US$ 20 million worth of timber (Swain 1993) per year. Researchers (Lean and Billen 1993) have observed that

> 'The reduction in water flow also allows sea water to seep even to further inland, threatening the long term survival of Bangladesh's largest natural forest, the Sundarbans which forms a barrier against cyclones and a refuge for the Bengal tigers'.

The Special Studies (1977) also indicated that the upstream diversion of Ganga water was responsible for the deterioration of the Sundarbans. The variation in the harvest of per hectare of forest is from 105 cubic metres of best quality (class I) in the fresh water zone to 1.4 cubic metres



Map 4.2 THE RIVER SYSTEMS OF SUNDARBANS
Source: BWDB (1996)

of poorer forest (class III) in saline areas. According to the Special Studies, within twenty years all class I and class II forest will be replaced by the class III type of forest. This loss has been estimated to be Tk. 350 million per year, i.e. US$ 23 million annually.

The number of sundari trees has been reduced by about 50 per cent due to the top dying disease as a result of salinity. For normal growth of sundari trees, water should contain 12 ppt of salt and the soil should contain 8 to 10 ppt. Experimental study, however, shows that the water presently contains 28 ppt and the soil 18 to 20 ppt of salt. This is too high for the trees to survive. A team led by Dr Gibson conducted research in 1985 under the aegis of the Forest Research Centre, Chittagong to identify the causes of top dying disease. According to him frequent natural calamities, excessive salinity with massive siltation in the forest zone have been identified as the causes of top drying. As per his recommendation, about 3 million cubic feet of sundari trees have been cut since 1991-92 (Personal Communication with the officials of the department of Forestry, Dhaka 1997). According to a survey by the Forest Department in 1956, sundari trees then covered 60 per cent of the total area of the Sundarbans. In 1983 this had been reduced to 53 per cent and by 1994 to 50 per cent (*The Daily Star*, dated 15th September, 1996). The loss in the forestry sector is shown in Table 4.11.

Table 4.11 Loss in Forestry Sector (1991 prices)

Year	Value (million Taka)
1976	5,510
1977	880
1978	890
1979	886
1980-1990	not available
1991	145
1992	145
1993	1,397
Total	9,853+

Source: Department of Forestry, Dhaka, 1996.
Note: The overall losses could not be calculated due to lack of complete data and proper records. The loss could be over two to three times than that estimated in the table.

Violation of human rights

The diversion of the Ganga has adversely affected several aspects of the basic human rights of the people of the *Ganga* dependent area. The farmers, fishermen, boatmen have lost their livelihoods. Such loss of work of these people due to human-made changes has forced them to change their age-old occupation derived from natural resources. This could be said to be a violation of Article 23 of the Universal Declaration of Human Rights and Article 6 of the International Covenant on Economic, Social and Cultural Rights.

Summary

The withdrawal of dry season water from the Ganga since the construction of the Farakka Barrage has forced Bangladesh to suffer losses in agriculture, fisheries, forestry, industry, navigation and water supply. Estimates suggest that direct damage amounts to over US$ 3 billions per year and indirect damage may be beyond estimation due to diverging and cumulative effects. These losses are summarised in Table 4.12 and the overall impact of the Farakka Barrage alone is summarized in Figure 4.8.

Table 4.12 Summary of Damage

Sectors	Annual losses in million Taka
Agriculture	51,490
Fisheries	81,430
Forestry	9,900
Industry	1,260
Public health	1,250
Navigation	640
Dredging of GK intake & Gorai	480
Total	146,450

Source: Other tables in this chapter.
Note: The losses would be much more provided all calculations could be done from proper data for all the years. Losses due to floods have not been included.

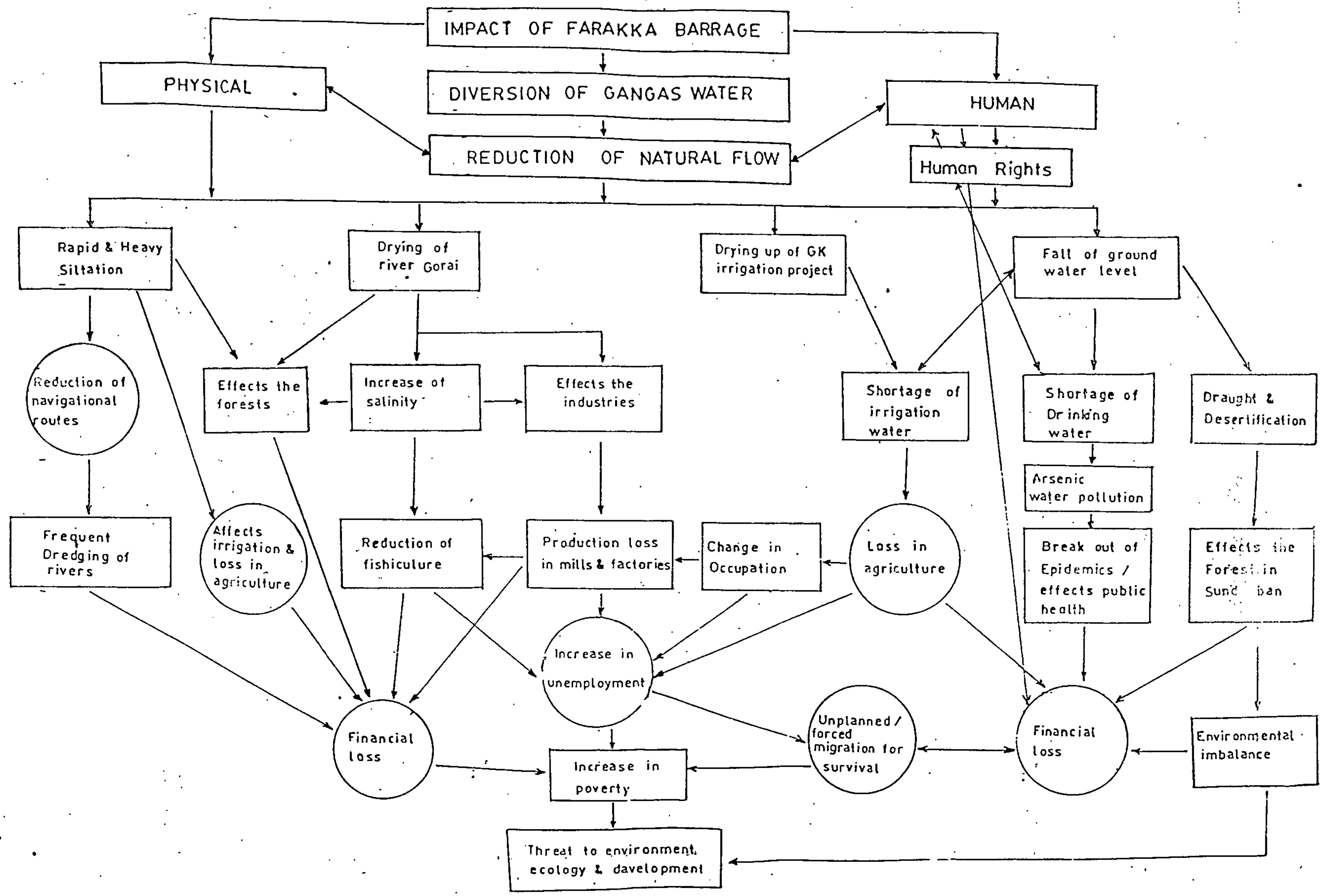


Fig. 4. 4 IMPACT OF GANGAS WATER DIVERSION (1975-1996)

CHAPTER 5

LEGAL REGIMES FOR CROSS-BOUNDARY WATER SHARING

Water was one of the prime commodities that people have always earnestly protected through the ages. Before the modern era demand was small relative to the available resources, yet there is evidence as far back as ancient Mesopotamia of regulated water use. Conflicts over water use have developed between communities and states from time to time, such as the conflict over the **Danube** between Austria and Turkey to 1619 and on the **Rhine** between Germany and France to 1697. These helped to promote the philosophy of water and navigation laws. However, no proper definition of an international watercourse, global conventions or laws for cross boundary water resources have existed until recently.

Throughout the world there are over 240 international river basins and numerous aquifers which are shared by two or more countries (Caponera 1995). Rapid population growth has put tremendous pressure on different sources of water for their domestic, agricultural and industrial use. This has created water shortages in several areas of the world. The distribution of water sources has no link with world's political or geographical borders or population concentrations, therefore it is obvious that any action or plan by a riparian country sharing an international river or basin will affect the other users. For example, the diversion of **Ganga** water at Farakka has affected the natural flow of the river down stream causing human misery as explained in earlier chapters. With increasing water demand compared to supply, problems arise in terms of allocation, management and adherence to laws or agreements for equitable use and distribution. However before analyzing any legal regimes, some of the terms related to it are discussed below.

Definitions, laws and theories

A navigable river is termed as **'international'** from the legal and geographical point, if it flows through the territories of two or more countries (Caponera 1995). The World Bank accepts 'a river canal or a similar water body, which forms a boundary between or flows through two or more countries, as an international waterway'. The United Nations (1997) has adopted a resolution on the Convention on the Law of the Non-navigational Uses of International Watercourses. This convention has proposed some definitions. According to the Convention, a **watercourse** has been defined as 'a system of surface waters and ground waters constituting by virtue of their physical relationship a unitary whole and normally flowing into a common terminus'. An **international water course** means 'a part of water course, parts of which are situated in different states'. A **Water Course State** involves a state in whose territory part of an international water course is situated, or a party that is a regional economic integration organization, in the territory of one or more states where part of an international water course is situated. A **Regional Economic Integration Organization** has been defined as 'an organization constituted by sovereign states of a given region, to which its member states have transferred competence in respect of matters governed by this convention and which has been duly authorized in accordance with its internal procedures, to sign, ratify, accept, approve or accede to it'. Black's Law Dictionary (1975), defined the term **dispute** as 'a conflict or controversy; a conflict or claims or rights; an assertion of a right, claim or demand on one side, met by contrary claims or allegations on the other'. The International law of water resources regulates shared cross boundary water flow.

The International Law Association in 1966 adopted the `Helsinki rules' for the use of cross boundary rivers where co-riparian states are prohibited from polluting international waters. This convention has also stressed that the upper riparian should not cause any adversity to a common river that affects another riparian. The principle was later included in the `Helsinki Convention' (signed in 1992) for cross-boundary use of waterways (Report of the 52nd Conference of the International Law Association, Helsinki, 1966).

The statute of the International Court of Justice (ICJ) [article 38] for arbitration contains:

- international law of treaties (conventional law)
- international customary law
- law recognized by nations and
- international case law (judicial decisions).

The International law of treaties for rivers, were first initiated in 1815 at the Vienna Congress to settle the dispute on the status of the **Rhine** (Caponra 1995). Ultimately, the rivers **Oder, Niemen, Elbe** and **Weser** were declared `international' for the purpose of navigation in the years 1918, 1921 and 1923 respectively. This resulted in the establishment of the Rhine Commission. In 1856 the Treaty of Paris addressed the problems of **Rhine** and **Danube**. The Treaty of Berlin concerning African rivers (**Congo, Niger, Zambezi**) was agreed in 1885. These finally gave rise to the treaties of Versailles in 1919 and the Barcelona Convention in 1921. In 1932 the Geneva Convention was held regarding the development of hydro-power for more than one state.

International customary law or practice provides countries with some rules for sharing water when no treaties exist (Caponera 1995). It encourages them:

- to cooperate in reaching an agreement;
- to prohibit practices that damage other states;
- to consult beforehand; and
- to have equitable utilization.

The general principles of water law in case of a lack of written agreements for cross boundary water sharing indicate (Caponera 1995) that:

- the use of water resources by one state should not impair the rights of the other riparian;
- the rights of any riparian are not to be abused/misused;
- the riparian states should promote good neighbourly relations and consult with each other for any action; and
- the use of water by any sharing state should avoid disputes.

During the latter half of the 19th century, the rapid development of water law for non-navigational use was noticeable particularly in North America. The application of modern technologies of barrage and dam construction and storage for multipurpose use was the main force for such legal development (Verghese 1990).

Theories on Sharing of International and Inter-State Water Resources

Different theories or doctrines have been developed since the late 19th century for the sharing of water resources in international and inter-state basins. These are:

(i) the territorial-sovereignty theory or the Harmon doctrine;
(ii) the doctrine of riparian rights;
(iii) the prior-appropriation theory;
(iv) the natural water-flow theory;
(v) the equitable apportionment theory;
(vi) the community of interest theory; and
(vii) the equitable-utilization theory.

(i) The territorial-sovereignty theory or the Harmon doctrine. In 1896 a conflict developed between the U.S.A and Mexico for sharing the **Colorado-Wyoming** rivers for irrigation rights. The then U.S. Attorney General Harmon, introduced a principle (known as the `Harmon doctrine') to allow riparian countries an absolute right to the water flow in terms of quantity and quality. According to this theory, the upper riparian country is free to utilize the water flowing within its territory (absolute territorial right) without considering its effects or the rights of the lower riparian. Therefore the lower riparian has no right to demand for the continued flow from the upper riparian. Since it protects the interest of one sovereign state only, this theory is no longer valid (Singh 1991).

(ii) The doctrine of riparian rights. Following the Harmon doctrine, the riparian right doctrine has emerged to include the community interest of riparian countries. This created limited territorial integrity over cross-boundary water resources to allow all riparian states an equitable share in the natural water flow. The notion of this doctrine can be traced back in Roman Law and in the English common law structure. This theory allows the rights of individual riparian countries and incorporates strict natural flow for private property rights in water. This also allows each co-riparian the right to have the water flow pass through their lands undiminished in quantity and quality. The theory has applicability to several inter-state disputes e.g the **Narmada**, the **Krishna** and the **Godavari** water disputes in India. Since this theory has not been accepted in any form within the Indian state practice, it could not be applied (Chauhan 1992).

(iii) The Prior-appropriation theory. This theory caters for disputes over inter-state water resources. According to this theory, natural water courses are public property which cannot be owned privately. The right to utilize water may be obtained by appropriation and application for beneficial use. The first user validates a prior right to the water for beneficial use and sets the limit to use the said water. The application of this theory can be seen in the case of the **Wyoming-Colorado** water dispute and the treaty between Canada and the USA in 1961. This treaty recognized the aspirations of both Canada and the USA in developing the resources of the **Columbia** river 'in a manner that will make the largest contribution to the economic progress of both countries and to the welfare of their peoples'. It also recognized 'that the greatest benefit to each country can be secured by cooperative measures for hydro-electric power generation and flood control, which will make possible other benefits as well (Verghese 1990).

(iv) The Natural Water-Flow theory, also known as the territorial integrity theory. According to this, a river is considered as part of the territory of the concerned country and therefore every lower riparian is entitled to the natural flow of the river un-interrupted by the upper riparian. Any interruption by the upper riparian will be considered as a violation of the territorial sovereignty of the lower riparian. The application of this theory can be seen in the case of the **Nile** water dispute between Egypt and Sudan in 1959. Initially, the Nile Water Commission rejected this theory. However, by an agreement between Egypt and the U.K (representing Sudan), Egypt was given the right of veto on absolute utilization of Nile water by Sudan as the upper riparian state, this theory was applied (Batstone 1959).

(v) The Equitable Apportionment Theory. The main theme of this theory is that every riparian country or basin state, or other concerned entity justifies authorization for a share. They are entitled to a fair share of water of the drainage basin treating a particular basin or inter-state river as a single unit irrespective of the political or administrative boundaries. The fair share of the water will depend on various factors and circumstances for each case (Chauhan 1992). The application of this theory can be seen in the cases between Connecticut and Massachusetts, New Jersey and New York and many other inter-state water disputes in the USA. Practice of this theory can also be seen in India, between Madhya

Pradesh, Rajasthan and Gujarat over the use of the **Mahi** water and of the **Krishna** water between Uttar Pradesh and Bihar.

(vi) The Community of Interest Theory. According to this theory an international river defines a state boundary or a river which passes through several states is treated as one unit for the maximum utilization of its water. In this theory the entire basin is taken as a single economic unit under an integrated programme, irrespective of its political or administrative borders. Hence, water works, the dams or barrages or any other planned work, are to be located at the best possible site. The benefits should be shared by co-riparian states which are in demand for those beneficial effects. Some examples of the application of this theory can be observed in the Sudan treaty of 1959 between the United Arab Republic (Egypt) and Sudan on the **Nile** river and the 1964 treaty between the USA and Canada for the joint venture on the river **Columbia** (Utton 1966).

(vii) The Equitable Utilization Theory. This theory involves the equitable utilization of an international drainage system, an international water resource system or an inter-state river. This theory is rather a new development which is yet to prove its worth. However, the application of this theory along with the Helsinki rules may be noticed in the case of the **Krishna** Water Dispute Tribunal in 1973 and the **Godavari** Water Dispute Tribunal in 1979 in India (Report of the Krishna Water Disputes Tribunal, 1973, vol. 1, p 93; Report of the Godavari Water Disputes Tribunal, 1979, vol. 1, p 19).

Various other doctrines exist with respect to sharing of water such as:

- 1919 Madrid and 1961 Salzburg declarations of the Institute of International Law;
- 1933 declaration of Montevideo of the 7th International Conference of American States;
- 1957 declaration of Buenos Aires of the Inter-American Bar Association;
- 1964 New Delhi declaration of the Asian-African Legal Consultative Committee;
- 1966 Helsinki Rules and subsequent rules of the International Law Association;
- 1967 European Water Charter of the work of the Council of Europe.

Implementation, Enforcement and Dispute Settlements

Ensuring compliance by countries with their international environmental obligations has become a matter of concern for everyone today. It will continue to be a problem in years to come with increasing environmental degradation. This is evident from the preparations of UNCED and in the negotiation and implementation of environmental agreements, the 1987 Montreal protocol, the 1992 climate change convention, the 1992 Bio-diversity Convention and the 1992 OSPAR Convention. The growing concern of environmental degradation as a cross boundary issue is related to international peace and security. This concern was reflected in the declaration of the President and members of the UN Security Council (January 1992). They declared that 'non-military sources of instability in the...ecological field have become threats to international peace and security'. Such concern has given rise to the ideas of developing mechanisms for implementation, enforcement and dispute settlements. The decision of the International Court of Justice (ICJ, July 1993) emphasized the need to establish a chamber for environmental matters. The main features for compliance with cross-boundary environmental obligations are as follows:

- Countries must abide by environmental commitments under treaty and obligations.
- Cross- boundary environmental obligations should address fundamental economic interests.

Non-compliance by countries with their treaty and other international legal obligations can be viewed as the failure of those obligations under the rules of international environmental law. This in turn may limit the overall effectiveness of treaties and undermine commitments which have been made under the international legal process. Thus it may lead to political instability in the region at the initial stage and finally lead to a conflict. Developments in environmental matters have close links to advancement in international law and practice. Techniques and practices specific to environmental matters have emerged and are being applied. Despite the recent emergence of the concept of environmental security, the legal issues of environment concerning implementation and conflict resolution are almost similar to those of a hundred years ago. Environmental disputes which emerged, have been submitted to international dispute resolution arrangements in the context of a variety of issues threatening peace and security. These issues include trans-boundary air pollution (arbitration between Canada and the USA, 1941), conservation of fisheries resources (the case between U.K and Iceland, 1974) and the division of the international river flow (between France and Spain, 1957), etc. The current dispute between Hungary and Slovakia over the construction of the Gabakovo-Nagy Maros dam and the diversion of the **Danube** are examples of such threats to environmental and natural resource issues. Hungary explored a range of enforcement for dispute settlement options, including unilateral reference to the ICJ, arbitration, conciliation by the EC commission, and the cooperation in Europe (CSCE) between the two countries. The special agreement of April 1993 indicated that the differences should be settled by the ICJ.

Countries implement their international obligations through:

- national implementation of legislation, policies and programmes;
- ensuring their compliance; and, finally, by
- fulfilling obligations.

The national remedies to challenge acts which are damaging to the environment or violation of environmental obligations may be taken to the international community. In this regard Article 235(2) of ICJ provides an example for domestic enforcement of environmental obligations. Principle 10 of the Rio Declaration (United Nations 1993) demonstrates that 'effective access to judicial and administrative proceedings including redress and remedy shall be provided'. The EC has recognized that individual and public interests should have access to the courts to ensure that their legitimate interests are protected and environmental measures are enforced and illegal practices stopped (EC Fifth Environmental Active Programme 1991).

The 1993 Lugano Convention, which addressed rules of civil liability for damage caused by waste, is the first international agreement. This expanded the rules governing access to national courts to allow enforcement of environmental obligations to the public interest. The question to ensure implementation is difficult when the environmental obligation relates to the protection of a shared natural resource e.g international rivers, oceans, seas, the atmosphere or outer space. These lead to conflicts between states where environmental degradation is detrimental to development and sustenance. The obligations to ensure compliance is not well developed for the environmental issues. In the absence of a specific treaty, the rules governing enforcement jurisdiction is subject to the general rules of international law.

The Judicial decision: some examples. The International Court of Justice (ICJ) stated that countries have legal rights to a shared river, not just a right of passage. It is also the right of all riparian to use the common resource. This excludes any preferential privilege to any one riparian state. Some illustrations are as follows:

- In the case between the Netherlands and the Belgium regarding the diversion of water from the **Meuse**, the ICJ decided that they could modify, enlarge, transform and fill the canals. They could increase the volume of water in a manner so that it does not affect the other riparian (The diversion of water from the **Meuse**, Judgement of 28-6-1937).
- The same principle was upheld in the Helmond River Delta case i.e. the supply of water for irrigation for either side is not to be diminished (Mc Mahon Arbitral Award of 10-4-1905).
- Another case between France and Spain in 1957 concerning the utilization of Lake **Lanoux** decided that protection for all the riparian states should be considered.

Examples of internal water sharing court cases are as follows:

- dispute between Kansas and Colorado in 1902;
- dispute between North Dakota and Minnesota in 1923;
- dispute between New Jersey and New York in 1931;
- dispute between Connecticut and Massachusetts in 1931;
- dispute between Nebraska and Wyoming in 1945.

In all the above cases the US supreme court upheld the theory of **equitable apportionment** to settle the cases amicably. The same principle was upheld in cases of Donauversin Kung (in 1926) and the case between Wurttemberg and Baden in Germany. The equitable apportionment of water sharing was also upheld for sharing the **Indus** waters in settling the case between Sind and Punjab in India (1941).

Even ancient Chinese Law had applied the equality principle and made it binding to ensure equitable distribution of water resources among users. It may be noted from various case studies and historical summaries of different case settlements that **apportionment or equitable** cannot be precisely defined. Its application, however, has been more or less in the spirit of fairness and best settlement of claims and counter claims. Equitable apportionment has been followed peacefully and amicably in treaties between Finland and Sweden in 1971 concerning border rivers. This agreement states that 'hydraulic' works should be carried out with least possible inconvenience and damage to other interests in either state.

Emphasis should be given to proposed future projects that may be affected by the installations. The agreement also states:

- where any person would suffer damage or inconvenience as a result of hydraulic construction works, this should be carried out only if it benefits private or public that substantially outweigh the inconvenience;
- where construction would result in a substantial deterioration of the living conditions of the population, or cause a permanent change in natural conditions, or might entail substantially diminished comfort, or a significant nature conservation loss, or where significant public interests would be prejudiced, waterworks should be permitted only if they are of particular importance from a public stand point;
- compensation should be paid for any damage or inconvenience;
- care should be taken that no pollution occurs that causes significant inconvenience;
- in deciding water projects, conditions in both states shall be given equal weight;
- charges should be paid for the betterment, to prevent or to minimize damage and inconvenience;
- any other special conditions from the stand point of localities and public interests could also be taken into account.

There are other examples regarding recognition of riparian rights e.g. Hungary and Yugoslavia (1955), Albania and Yugoslavia (1956), Bulgaria and Yugoslavia (1958). The Swiss Federal Court, e.g. Argon vs Zurich (1878), Schiff Nansen vs Zurich (1897), and the German Court Wathemberg and Russia vs Baden (1927) asserted that they employed the principles of equitable apportionment and limited territorial sovereignty as established by the principles of international law. Similarly, the Italian Court of Cessation asserted that International Law recognizes the right on the part of every riparian state to enjoy as a participant of a kind of partnership created by the international river.

In other words, any development project in a riparian state should not cause adversity or environmental degradation, changes in water table, or flow conditions or impair navigation, fisheries, water supply, irrigation including the natural balance. The United States-Mexico treaty (1944), was signed with an understanding of cordiality, cooperation and on satisfactory utilization of the water resources. Again, in resolving the Rio Grande dispute the US did agree to provide Mexico with water equivalent to that which Mexico had used before the diversion of water from the **Rio Grande** for irrigation purposes. The 1933 Montevideo Declaration (adopted by the Seven International Conference of American states) limits the rights of utilization of common water by the obligation of not to infringe the legal rights of utilization of other states. The inter American Bar Association, the Institute of International Law and the International Law Association (ILA), the 1977 UN Water Conference at Mardel Plata has also accepted this view of basin states' responsibility for cross-boundary rivers.

Cross-boundary environmental degradation may lead to disruption of the national, regional or global environment. This is one area where impact goes beyond legally defined boundaries. Therefore, the legal limits of cross boundary sharing may have far reaching effects in another nation's territory. Any state has the right to use its resources or carry activities within her territory as required. But the state practices have limited this right if it causes intervention to others (UNGA 1962). The Stockholm Declaration of 1972 clearly testifies :

> ‘ States in accordance with the charter of the United Nations and the principles of international law, have sovereign rights to exploit their own resources pursuant to their own environmental policies and the responsibility that activities within their jurisdiction or control do not cause damage to the environment of other states or of areas beyond the limits of national jurisdiction (Stockholm, 1972)’.

The International Law Association (ILA) has introduced **the concept of the International Drainage Basin** as the total of both surface and ground waters within a given geographic area flowing into a common location or area as adapted in the Helsinki Rules. These rules declare that :

- Each basin state is entitled, within its territory, to a reasonable and equitable share in the beneficial uses of the waters of an international drainage basin without causing any harm or injury to a neighbouring riparian (Article iv);
- Reasonable and equitable share is to be determined in the light of all relevant factors in each particular case;
- Relevant factors to be considered include (but are not limited to):
  (a) the geography of the basin i.e the extent of the drainage area in the territory of each basin states;
  (b) the hydrology of the basin i.e the contribution of water by each basin state;
  (c) the past and existing utilization of the waters of the basin;
  (d) the economic and social needs of each basin state;
  (e) the comparative costs of alternative means of satisfying the economic and social needs of each basin state;
  (f) the availability of other resources;
  (g) to avoid wastage of the waters of the basin;
  (h) the practicability of compensation as a means of adjusting conflicts among users;
  (i) the needs of a basin state may be met without causing substantial injury to a co-basin state;
- the weight to be given to each factor is to be determined by its importance in comparison with that of other relevant factors. In determining the reasonable and equitable share, all the factors are to be considered.
- no use has intrinsic preference over others.

The implementation of the Helsinki Rules requires the close cooperation of the basin states. These rules have been followed in the integrated development of international basins in Asia, Africa and Latin America. Some examples are, the river basin agreements over the Senegal, Chad, Kagera, Gambia and lower Mekong rivers and the settlement of the Krishna River dispute in India. However, there is no international law that a basin state must get prior consent of the other basin state to use or to develop the waters of an international drainage basin within its own territory. But it is a legal duty to inform the other concerned states in case any development or activities are likely to affect seriously the rights or interest or others. The international law on cross boundary water sharing is still in its development stage which may be followed in the content and spirit of good neighbourly and peaceful coexistence. From the above discussions it is clear that close cooperation among all basin states should be firmly established and executed for the betterment of the humankind. This may be achieved through the exchange of all relevant data (technical, hydrological, meteorological etc), and the exchange of water resource plans and proposals in due time. Discussions about cooperation over water resource development should be held among the co-basin states and finally joint management established for the operation and overseeing the major hydraulic projects and structures affecting the basin water resources. In case any project may be beneficial or effective for more than one state then joint planning for the development of the whole basin as an economic and social unit may be more rewarding for all the concerned co-riparian states.

Article 1 of the UN Declaration on Social Progress and Development (1969) calls for 'all peoples and all human beings, without distinction as to race, colour, sex, language, religion, nationality, ethnic origin, family or social status, political or other conviction shall have the right to live in dignity and freedom and to enjoy the fruits of social progress and should, on their part, contribute to it'.

That activities concerning environmental protection do not end at natural boundaries is manifested in the UN Law of Sea Convention in 1982 (also 1979 convention on long range trans boundary air pollution). It is a state responsibility to abstain from causing damage to the environment and from physical harm to neighbours. The 1972 Convention on Dumping of Wastes in the Sea recognized that, states have to avoid causing damage to the environment of other states or areas beyond their national territory.

The recent move by the United Nations

The United Nations General Assembly (UNGA) has adopted a resolution on the Law of Non-Navigational Uses of International Water course on the basis of the report of the sixth committee (UNGA, 1997) by direct vote (103 for, 3 against and 27 abstained). It provides general principles and rules to guide states with common waterways with a framework for negotiating agreements on specific watercourses. It also includes measures to protect, preserve and manage such watercourses. The Convention (21 May 1997) is open for signature until 20 May 2000. It will be enforced and be a legally binding international treaty when 35 countries formally ratify the convention. The convention containing 37 articles with 14 annexes, address issues on flood control, water quality, erosion, sedimentation, salt water intrusion and living resources (The Daily Star, Dhaka, 29th May 1997). The salient points are as follows:

- It declares that every watercourse state is entitled to participate in the negotiation and become a party to any watercourse agreement (applies to the entire international watercourse)and participate in any consultation (Article 4).
- It calls for watercourse states to utilize international watercourses in an equitable and reasonable manner. An international watercourse shall be used and developed by states to attain optimal use, keeping in consideration the interests of other states and protecting the water course (Article 5).
- It calls for utilization of the water in an equitable and reasonable manner while considering following factors (Article 6):
  (a). geographic, hydrographic, hydrological, climatic, ecological and other factors of a natural character.
  (b). the social and economic needs of the states.
  (c). the population dependent on the watercourse.
  (d). the effects of the uses of the watercourse in one state to other watercourse states.
  (e). availability of alternatives to the existing use.
- It calls upon states to take appropriate measures to prevent significant harm to other watercourse states. If such harm is caused, in consultation with the states concerned, any state will eliminate or mitigate the cause and also consider giving compensation (Article 7).
- It calls upon states to cooperate with each other on the basis of sovereign equality territorial integrity, mutual benefit and good faith. This cooperation may be done through establishing joint mechanisms or commissions as required (Article 8).

- It calls for watercourse states to exchange available data and information on the condition of the watercourse e.g hydrological, meteorological, hydro-geological, ecological, on water quality as well as on related forecasts (Article 9).
- It calls upon, in the absence of any agreement no use of an international watercourse enjoys inherent priority over other uses (Article 10).
- It calls upon states to consult and negotiate with each other on the possible effects of planned measures on the condition of an international watercourse (Article 11).
- It calls upon watercourse states, while implementing any project to provide to concerned states timely notification with technical data and information including the results of any environmental impact assessment (Article 12).
- It calls upon the international watercourse state not to implement the project without the consent of the notified states (Article 14).
- It calls upon the watercourse states individually and jointly to protect and preserve the ecosystem of the international watercourse (Article 20).
- It calls upon the watercourse states individually and jointly to prevent, reduce and control the pollution of an international water course that may cause significant harm to other watercourse states or to their environment. This also includes any harm to human health or safety, to the use of the waters for any beneficial purpose or to the living resources of the watercourse (Article 21).
- It calls upon the watercourse states (on request) to enter into consultations concerning the management of an international watercourse, including the establishment of a joint management mechanism (Article 24).
- It calls upon the states to cooperate as required for regulating the flow of the international watercourse (unless otherwise agreed) on an equitable basis (Article 25).
- It calls upon the states individually or jointly to prevent or mitigate conditions to international watercourse resulting from natural or human conduct such as flood, diseases, siltation, erosion, salt-water intrusion, drought or desertification (Article 27).
- In the event of emergencies, such as floods, it calls upon a watercourse state within whose territory such an emergency originates to all necessary steps to prevent or mitigate any harmful effect. It should also notify the neighbouring watercourse states of the situation and work out joint contingency plans (Article 28).
- It calls upon the watercourse states for protection of the interests of persons, natural or juridical without any discrimination. Anyone, who has suffered trans-boundary harm as a result of activities of an international watercourse, should be granted access by the state to judicial or other procedures to claim compensation (Article 32).
- It calls upon the states concerned, the absence of an applicable agreement between them to seek a settlement of the dispute by peaceful means. If the parties cannot reach a settlement, they may request mediation by a third party or make use of joint watercourse institutions or agree to submit the dispute to arbitration or to the International Court of Justice. Even then if the dispute is not settled a fact-finding commission shall be established with one member nominated by each country involved. In addition a third member, not having the nationality of any of the parties concerned can be chosen by the nominated members to serve as chairman. The article includes a provision for the intervention of the Secretary General for the selection of a neutral chairperson. The parties will provide the commission all information as required, to permit access to their respective territory and to inspect facilities, plant, equipment, construction etc for the inquiry. The recommendations of the

Commission are to be submitted to the parties, giving reasons for the recommendations for an equitable solution, which the parties will consider in good faith (Article 33)(UNGA 1997).

It may be noted that China has voted against the convention. According to the Chinese ambassador in the UN, it did not reflect the principle of the territorial sovereignty over a watercourse. Pakistan abstained from voting on the grounds that it lacked obligatory and binding settlement procedures. India also abstained from voting and opposed the inclusion of the settlement provision (i.e. procedure for settlement of disputes should lie with the parties themselves). India has also opposed the inclusion of the mandatory third party dispute procedure (as explained by the Indian ambassador, *The Independent*, Dhaka, 22 May 1997, pp 1&16).

A global trend is emerging to defend against and control environmental degradation, which is important for humankind. The outlook and awareness that developed from the 1966 Helsinki rules to the 1972 Stockholm Conference, and from many subsequent conventions including the 1992 UNCED (Brazil) conference. Finally the 1997 UN resolution (UNGA 1997), would give better chance of harmony, peace and tranquility for cross-boundary water resource sharing.

CHAPTER 6

THE GANGA TREATY, DECEMBER 1996

The Governments of Bangladesh and India signed a treaty on 12th December 1996 and agreed to share the waters of the international rivers to promote friendship and good neighbourliness. Its full title is 'Treaty between the Government of the People's Republic of Bangladesh and the Government of the Republic of India on the Sharing of the Ganga/Ganges Waters at Farakka'. The two countries have committed themselves to make the optimum utilization of the water resources of the region in the fields of flood management, irrigation, river basin development and generation of hydro-power for mutual benefit. The salient features of the treaty regarding the Ganga waters at Farakka are as follows (The Daily Star, Dhaka, 13th December 1996):

- The quantum of waters agreed to be released by India to Bangladesh will be at Farakka (Article 1).
- The sharing of the Ganga waters at Farakka will be by ten day periods from the 1st January to the 31st May every year. The share of water will be as per the formula at Annexure I and an indicative schedule giving its implications is at Annexure II. Every effort will be made by the upper riparian to protect flows of water at Farakka as in the 40 year average availability.
- If the flow at Farakka falls **below** 1,416 cumec in any 10 day period, the two Governments will enter into **immediate** consultation to make adjustments on an emergency basis, in accordance with the principles of equity, fair play and no harm to either party (Article 2).
- The water released to Bangladesh at Farakka shall not be reduced below Farakka except for reasonable uses of water, not exceeding 5.66 cubic metres by India (Article 3).
- A Joint Committee (JC) consisting of representatives of the two Governments in equal numbers shall observe and record the daily flows below Farakka Barrage, in the feeder canal, navigation lock and at the Harding Bridge (Article 4).
- The JC shall submit to the two Governments all data collected by it and shall submit a yearly report to both the Governments.
- The JC shall implement the operation of Farakka Barrage. Any difference not resolved by the JC, shall be referred to the Indo-Bangladesh Joint Rivers Commission (JRC). If the difference or dispute remains unresolved, it shall be referred to the two Governments which shall meet urgently to resolve it by mutual discussion.
- To cooperate with each other in finding a solution to the long term problem of augmenting the flows of the Ganga during the dry season (Article 8).

ANNEXURE-I

Availability at Farakka in cusec	Share of India	Share of Bangladesh
70,000 or less	50 per cent	50 per cent
70,000-75,000	Balance of flow	35,000 cusecs
75,000 or more	40,000 cusecs	Balance of flow

Note. Subject to the condition that India and Bangladesh each shall receive guaranteed 35,000 cusecs of water in alternate three 10-day periods during the period March 11th to May 10th.

ANNEXURE-II

(Sharing of waters at Farakka between January 1st and May 31st every year). If actual availability corresponds to average flows of the period 1949 to 1988 the implication of the formula in Annex-I for the share of each side is:

Period	Average of total flow 1949-88 (Cusecs)	India's Share (Cusecs)	Bangladesh's Share (Cusecs)
Jan 1-10	107,516	40,000	67,516
Jan 11-20	97,673	40,000	57,673
Jan 21-31	90,154	40,000	50,154
Feb 1-10	86,323	40,000	46,323
Feb 11-20	82,859	40,000	42,859
Feb 21-28	79,106	40,000	39,106
Mar 1-10	74,419	39,419	35,000
Mar 11-20	68,931	33,931	35,000 *
Mar 21-31	64,688	35,000 *	29,688
Apr 1-10	63,180	28,180	35,000 *
Apr 11-20	62,633	35,000 *	27,633
Apr 21-30	60,992	25,992	35,000 *
May 1-10	67,351	35,000 *	32,351
May 11-20	73,590	38,590	35,000
May 21-31	81,854	40,000	41,854

* Three ten day periods during which 35,000 cusecs shall be provided.
1 cusec = 0.0283 cubic metre or 1 cubic metre = 35.315 cusec.

- Guided by the principles of equity, fairness and no harm to either party, both the Governments agree to conclude water sharing treaties/agreements with regard to other common rivers (Article 9).
- The sharing arrangement shall be reviewed after a five year interval or earlier and adjustments will be made based on principles of equity, fairness, and no harm to either party.
- The treaty is valid for a period of 30 years and it shall be renewable on the basis of mutual consent (Article 12).

The Implementation

The implementation of the Ganga Water Treaty started from 1st January 1997. The JC with three members from each country was formed. Bangladesh sent a team consisting of four members to Farakka. The flow of the Ganga at Farakka was jointly measured below the Barrage, in the feeder canal and at the navigation lock. A two member Indian team was stationed at the Hardinge Bridge to measure the flow. The measurements taken by the joint team at Farakka have been tabulated and compared with the water share of Bangladesh as in the 1977 (Table 6.1). On analysis the following is observed:

- The share of Bangladesh at Farakka are more or less consistent as per the agreement except in the 3rd 10 day period of March.
- Compared to the readings at the Hardinge Bridge it is found that from January to February 10th the readings are higher than the release at Farakka.
- From February 11th to April the readings at Hardinge Bridge are much lower than those released at Farakka. The release at Farakka and at the Hardinge Bridge differ significantly (Feb 21st-28th, 360 cumec, March 1st-10th, 289 cumec, March 11-20th, 428 cumec, March 21-31st, 114 cumec, April 1st-10th, 348 cumec, and April 21st-30th, 209 cumec).
- The discharge measurement has been taken at Hardinge Bridge for 6 hours from 0800 hours to 1400 hours daily excepting holidays which has been converted for the day i.e. 24 hours which is non adjustable.
- The similar reading at Farakka was taken and the discharge was calibrated according to the formula as stipulated in the treaty. The observed mean daily discharge for 24 hours which has been adjusted by the gate opening/closing of the barrage and the head regulator of the feeder canal.
- There might have been difference in rating/compatibility of the two measurements taken at Farakka and Hardinge Bridge.
- There has been no monitoring of water flow, water use and water losses in the 160 km of the Ganga downstream of Farakka in the section where 18 km of both banks lie in India, 105 km of the right bank are in India and left bank in Bangladesh, and 37 km both banks lie in Bangladesh.

- The readings in Table 6.1 have been drawn in Figures 6.1, 6.2 and 6.3 to compare the water flows.

Table 6.1 Water released at Farakka and received at the Hardinge Bridge for 1997 and Bangladesh share of 1977 agreement

Period	Bangladesh share as per 1996 agreement (cumec)	Actual released at Farakka (cumec) 1997	Received flow at Hardinge Bridge (cumec) 1997	Bangladesh share in 1977 agreement (cumec)
January 1-10	1761	1756	2006	1657
January 11-20	1405	1403	1580	1451
January 21-31	1378	1384	1417	1345
February 1-10	1291	1291	1371	1310
February 11-20	1161	1162	1085	1203
February 21-28	1059	1087	727	1111
March 1-10	937	948	660	1090
March 11-20	991	992	564	1076
March 21-31	382	468	391	1019
April 1-10	991	853	506	991
April 11-20	553	725	695	984
April 21-30	991	993	784	977
May 1-10	898	898	753	991
May 11-20	935	935	744	998
May 21-31	896	896	779	1097

Source: The Daily Star, Dhaka, 26th May 1997; The Daily Janakantha, Dhaka, 18th March and 16th July 1997.

Some criticisms of the treaty

The treaty is a relief from the unfavourable consequences of unilateral withdrawal of water at Farakka. If followed in its true spirit, it will allow the downstream riparian to plan optimum water utilization. In 1977 agreement, the share of each country was clearly stated, 75 per cent availability of water calculated from the recorded flows from 1948 to 1973 being taken as the amount to be

Figure 6.1 Comparison between 1977 and 1996 agreement (indicative flow)
Source: Table 6.2

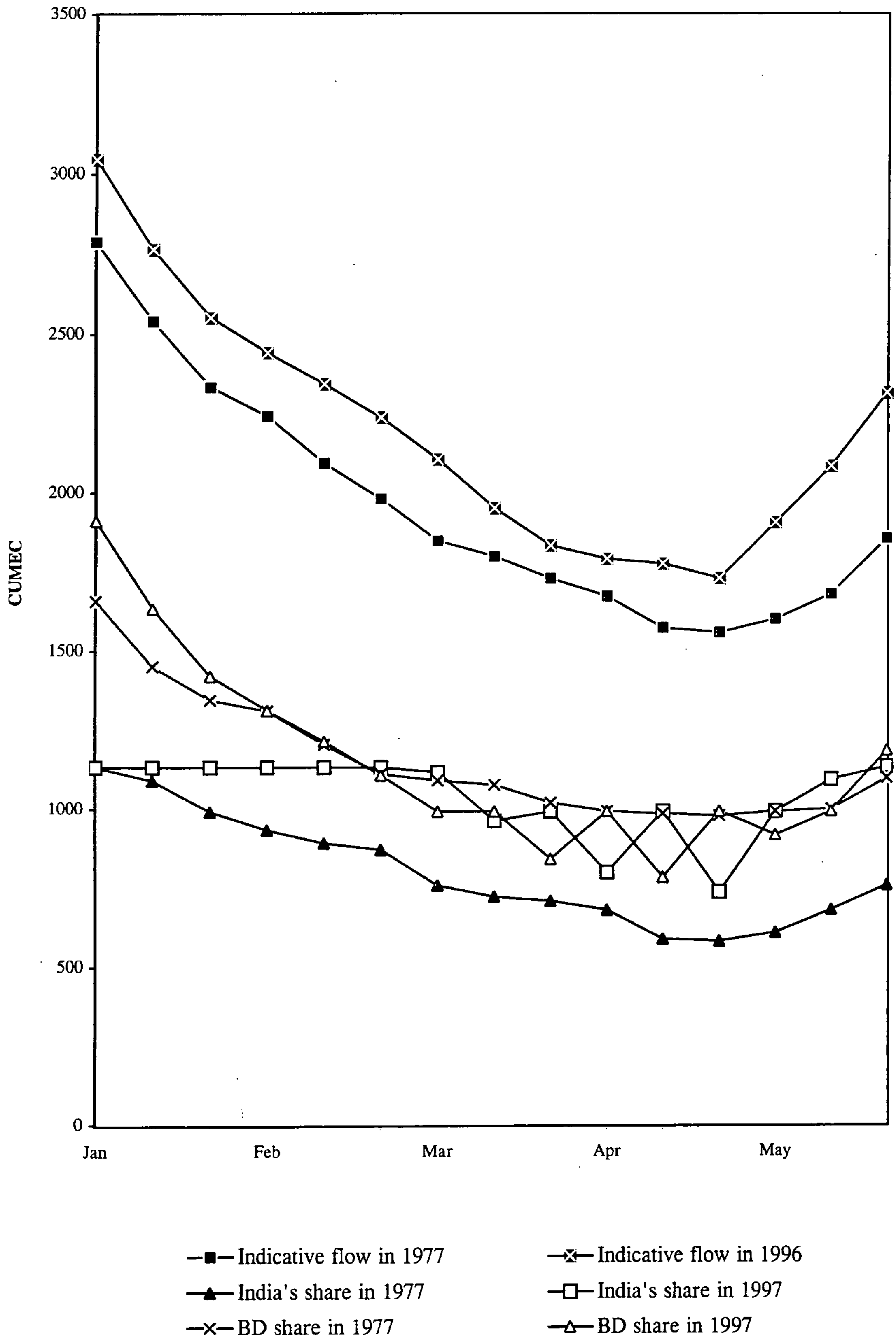


Figure 6.2 Comparison between 1977 and 1996 agreement: India's share (indicative)
Source: Table 6.2

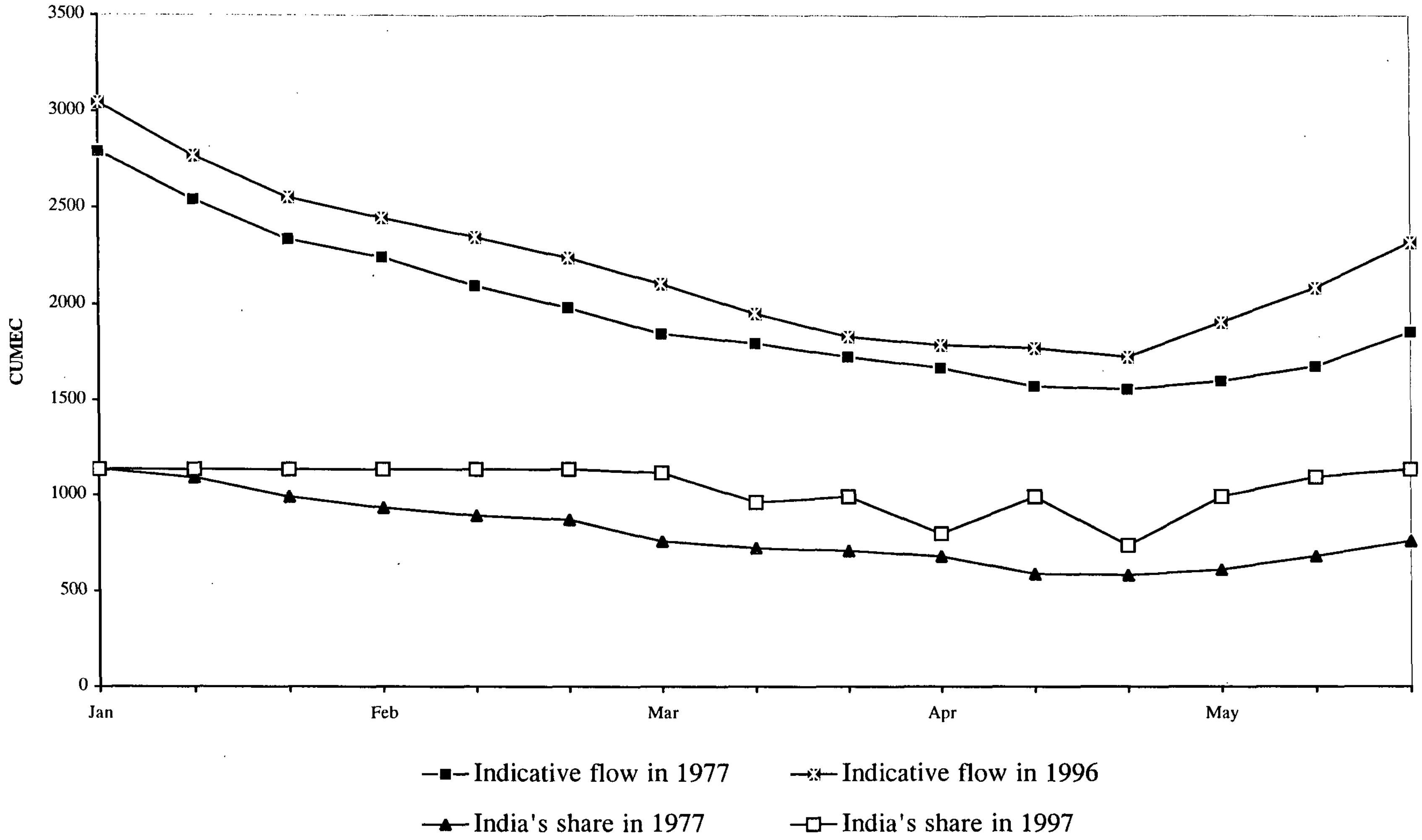
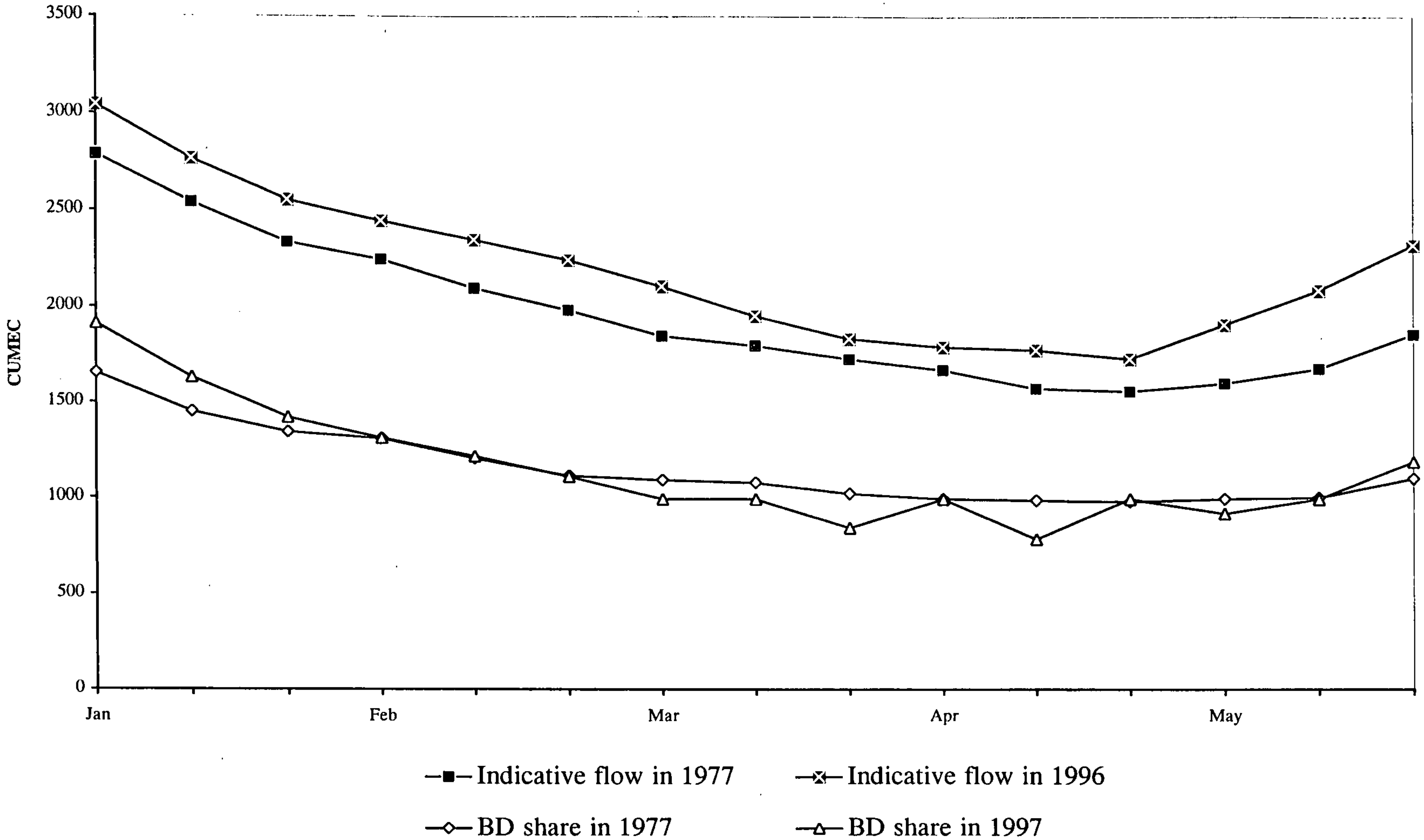


Figure 6.3 Comparison between 1977 and 1996 agreement: Bangladesh's share (indicative)
Source: Table 6.2



shared. This 75 per cent availability means Bangladesh could expect to get the quantity shown generally in three years out of four. The inclusion of a guarantee clause is important, i.e. 80 per cent of flows was guaranteed for that ten day period as indicated in the schedule. Comparisons between the two agreements are shown in Tables 6.2, 6.3 and 6.4, although in the 1996 treaty the sharing has to be worked out as per the formula given in Annexure I. It has provided guarantee of share of 991 cumec (35,000 cusec) of water for three 10 day periods each to both the countries during the period 11th March to 10th May.

The treaty indicates the available quantum of water only as an indicative figure and not as a definite amount that is based on average flow from 1949-1988. In case it was on the basis of a 50 per cent probability that it would occur once in two years. The stipulation in Article 2 of the treaty that every effort would be made by the upper riparian to protect flows of water at Farakka as in the 40 years average availability gives hope that everything will move in a positive direction. This statement, however, is not very assertive or convincing from past experience, given the mutual distrust and lack of confidence between the states. In addition, no one can guarantee the maintenance of an average flow over the years. For example, for the year 1997 India could **NOT** protect the flows of water at Farakka as per Article 2 of the agreement. Also there is no formula to share water if the flow at Farakka falls below 1416 cumec (50,000 cusec).

The water flows for the months of March and April 1997 came down to 1373 cumec (48,487 cusec) as reported by daily newspapers in Bangladesh and India and accepted by the two governments.

According to Article 2 clause III, `in the event of water flows falling below 1416 cumec (50,000 cusecs) in any 10 day period, the two governments will enter into immediate consultations to make adjustments on an emergency basis', but this was not done. The readings for the year 1997 for

Table 6.2 Comparison between the 1977 and 1996 Agreements (indicative flows)

	Average flow cumec		India's share cumec		Bangladesh's share, cumec	
	1977	**1997**	**1977**	**1997**	**1977**	**1997**
January 1-10	2789	3045	1133	1133	1657	1912
January 11-20	2541	2766	1090	1133	1451	1633
January 21-31	2336	2553	991	1133	1345	1420
February 1-10	2244	2444	934	1133	1310	1312
February 11-20	2095	2346	892	1133	1204	1214
February 21-28	1982	2240	871	1133	1111	1107
March 1-10	1848	2107	758	1116	1090	991
March 11-20	1798	1952	722	961	1076	991
March 21-31	1727	1832	708	991	1019	841
April 1-10	1671	1789	680	798	991	991
April 11-20	1572	1774	588	991	984	783
April 21-30	1557	1727	581	736	977	991
May 1-10	1600	1906	609	991	991	916
May 11-20	1678	2084	680	1093	998	991
May 21-31	1855	2318	758	1133	1097	1185

Source: Collected from both the agreements signed by the respective governments.

Table 6.3 Water recorded (in cumec) at the Hardinge Bridge (1977 Agreement)

Year	1978	1979	1980	1981	1982	Average
January 1-10	2543	2308	1537	1815	1623	1965
January 11-20	2308	1709	1411	1609	1430	1693
January 21-31	1912	1540	1165	1468	1300	1473
February 1-10	1794	1621	1111	1446	1303	1455
February 11-20	1639	1841	999	1352	1468	1460
February 21-28	1792	1706	947	1158	1388	1398
March 1-10	1800	1466	925	1086	1315	1318
March 11-20	1496	1540	927	978	1298	1248
March 21-30	1370	1313	927	963	1268	1168
April 1-10	1603	1170	942	926	1321	1192
April 11-20	1721	1305	909	1040	1603	1323
April 21-30	1825	1398	993	1353	1802	1474
May 1-10	2006	1452	1021	1436	1889	1561
May 11-20	2136	1406	1208	1512	1777	1608
May 21-31	2986	1785	1332	1744	1830	1935

Source: The Daily Star, Dhaka, 26th May 1997; The Daily Janakantha, Dhaka, 18th March and 16th July 1997.

Table 6.4(a) Water flow (cusec) after the 1977 agreement

		1978		1979		1980		1981		1982	
	Ave. flow at Farakka (1948-73, indicative)	Actual flow reaching Farakka	Release to Bangladesh	Actual flow reaching Farakka	Release to Bangladesh	Actual flow reaching Farakka	Release to Bangladesh	Actual flow reaching Farakka	Release to Bangladesh	Actual flow reaching Farakka	Release to Bangladesh
January 1-10	109828	112750	73649	108222	72363	88570	52774	95695	56857	86526	51434
January 11-20	101285	104506	65795	99417	61917	79565	45577	89344	51114	74579	43214
January 21-31	94094	91622	53008	93691	55634	60296	38408	80959	46600	66879	38800
February 1-10	90618	88458	51588	100207	61798	50995	37017	84588	49139	69606	41220
February 11-20	87409	84326	48588	111298	72878	48840	34032	77903	44747	76653	43995
February 21-28	83027	98922	60479	103904	65560	48608	31458	68953	38532	70934	39815
March 1-10	78415	83128	52221	99436	60901	47888	30886	60842	35814	66834	39402
March 11-20	73708	72797	43537	93613	56287	45345	30389	56691	34152	67370	40261
March 21-31	69259	75123	44189	77954	45898	40036	28870	56261	33129	68526	40369
April 1-10	66275	85752	51030	72492	42892	39580	28143	55900	33233	74356	44106
April 11-20	63192	87584	54779	81598	51127	43596	27956	66780	41858	84157	52601
April 21-30	61983	95443	59845	86965	54596	44085	27993	76880	48245	89070	55788
May 1-10	63730	100390	62219	88568	54822	55653	34284	82540	51096	90247	55890
May 11-20	69480	107677	68164	94453	56433	65073	38951	92179	54679	89372	53757
May 21-31	77373	139476	99187	109253	70310	73954	43857	105118	65861	95275	56477

Source: 1977 Agreement; The Daily Star, Dhaka, 26th May 1997; The Daily Janakantha, Dhaka, 18th March and 16th July 1997.

Table 6.4(b) Water flow (cumec) after the 1977 agreement

		1978		1979		1980		1981		1982		1978-82		
	Ave. flow at Farakka (1948-73, indicative)	**Actual flow reaching Farakka**	**Release to B'desh**	**Actual flow reaching Farakka**	**Release to B'desh**	**Actual flow reaching Farakka**	**Release to B'desh**	**Actual flow reaching Farakka**	**Release to B'desh**	**Actual flow reaching Farakka**	**Release to B'desh**	**Actual flow reaching Farakka**	**Release to B'desh**	**Average flow at Hardinge Bridge**
January 1-10	3110	3193	2086	3065	2049	2508	1494	2710	1610	2450	1456	2785	1739	1965
January 11-20	2868	2959	1863	2815	1753	2253	1291	2530	1447	2112	1224	2534	1516	1693
January 21-31	2664	2594	1501	2653	1575	1707	1088	2293	1320	1894	1099	2228	1317	1473
February 1-10	2566	2505	1461	2838	1750	1444	1048	2395	1392	1971	1167	2231	1364	1455
February 11-20	2475	2388	1376	3152	2064	1383	964	2206	1267	2171	1246	2260	1383	1460
February 21-28	2351	2801	1713	2942	1856	1376	891	1953	1091	2009	1127	2216	1336	1398
March 1-10	2220	2354	1479	2816	1725	1356	875	1723	1014	1893	1116	2028	1242	1318
March 11-20	2087	2061	1233	2651	1594	1284	861	1605	967	1908	1140	1902	1159	1248
March 21-31	1961	2127	1251	2207	1300	1134	817	1593	938	1940	1143	1800	1090	1168
April 1-10	1877	2428	1445	2053	1215	1121	797	1583	941	2106	1249	1858	1129	1192
April 11-20	1789	2480	1551	2311	1448	1235	792	1891	1185	2383	1489	2060	1293	1323
April 21-30	1755	2703	1695	2463	1546	1248	793	2177	1366	2522	1580	2223	1396	1474
May 1-10	1805	2843	1762	2508	1552	1576	971	2337	1447	2556	1583	2364	1463	1561
May 11-20	1967	3049	1930	2675	1598	1843	1103	2610	1548	2531	1522	2542	1540	1608
May 21-31	2191	3950	2809	3094	1991	2094	1242	2977	1865	2698	1599	2963	1901	1935

Source: 1977 Agreement; The Daily Star, Dhaka, 26th May 1997; The Daily Janakantha, Dhaka, 18th March and 16th July 1997.

Bangladesh's share at Farakka and the measurement at the Hardinge Bridge differed widely. It took six weeks for the JC to meet, discuss and conclude unsuccessfully (the JC met at New Delhi and Dhaka). That it took over three months to get the JRC to discuss the issue is an example of non compliance with the treaty. Again the case could not be referred to the two governments to meet urgently to resolve it by mutual discussion (Article 7) as the JRC could not meet immediately as construed in the treaty. Moreover it has to be agreed as to how to share the water when the flow falls below 1416 cumec.

Annexure I of the treaty states that when the water flow falls below 1982 cumec both countries will get 50 per cent each, but there have been exceptions to this already (Table 6.2). In the year 1997 the quantum of the flow was below expectations, possibly because of further withdrawals of water upstream. *India Today*, 30th April, 1997 writes that the downstream flow of the Ganga has been reduced since 1988 as a result of withdrawals by Uttar Pradesh and Bihar, which have been withdrawing around 710 to 1,275 cumec through 440 irrigation pumps. *India Today*, 10th April 1997, while analysing the water issue stated `it is not true that the two neighbours could not abide by the clauses of the treaty. It turns out that the treaty talked about water that just was not there'. On the experience of the year 1997 the two sides should take a joint scientific study to find the causes of failure and how much the treaty has been a success, including any harm caused to the lower riparian areas. Moreover, water sharing through the 10 day periods goes up and down abruptly, giving rise to environmental issues (e.g. siltation, soil erosion etc). This would be mitigated if the flow could be increased or decreased gradually.

Another weak point of the treaty is that the need for water on both sides will increase, but there is no provision of a means as to how this contingency will be met. Nor is there a clause for arbitration as a possible means of resolving a difference of opinion or any doubt regarding the treaty, nor indeed there is any compulsion to implement the spirit of the agreement. Comparative analysis between the 1977 and 1996 treaties is shown in Figures 6.4, 6.5, and 6.6. It is evident

Figure 6.4 Water flow after 1977 agreement
Source: Table 6.4b

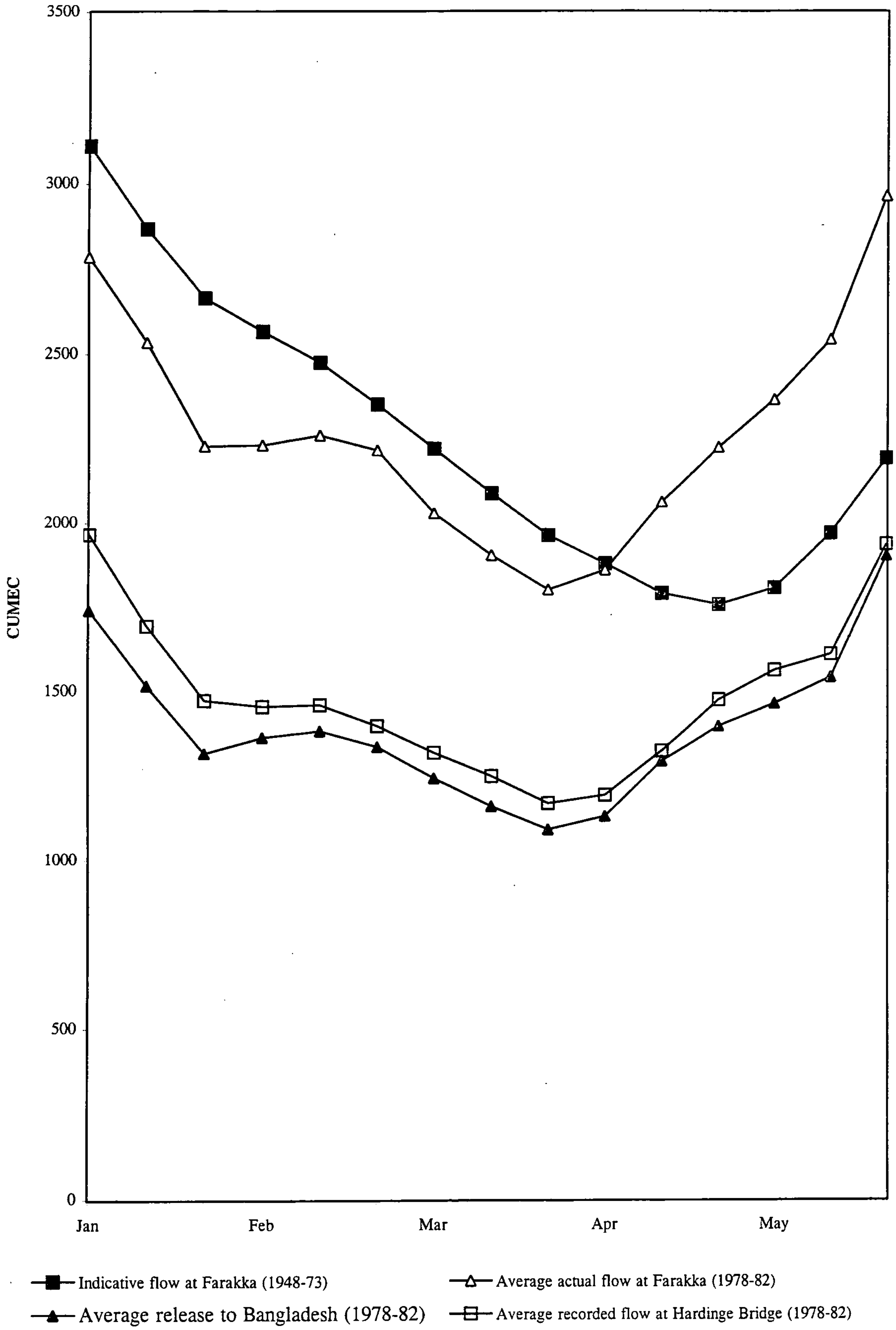


Figure 6.5 Water received at the Hardinge Bridge (indicative)
Source: Tables 6.1 and 6.4b

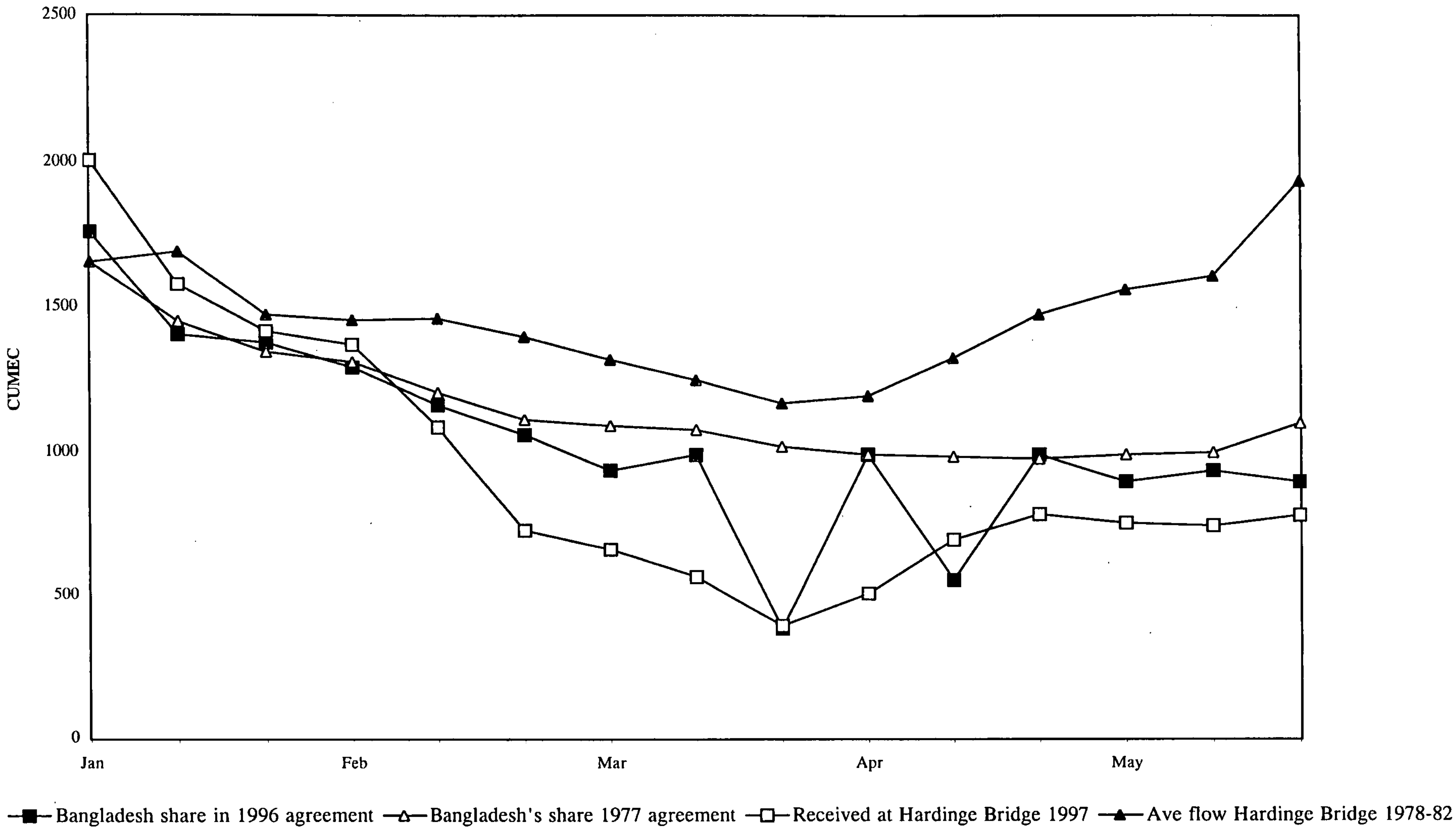
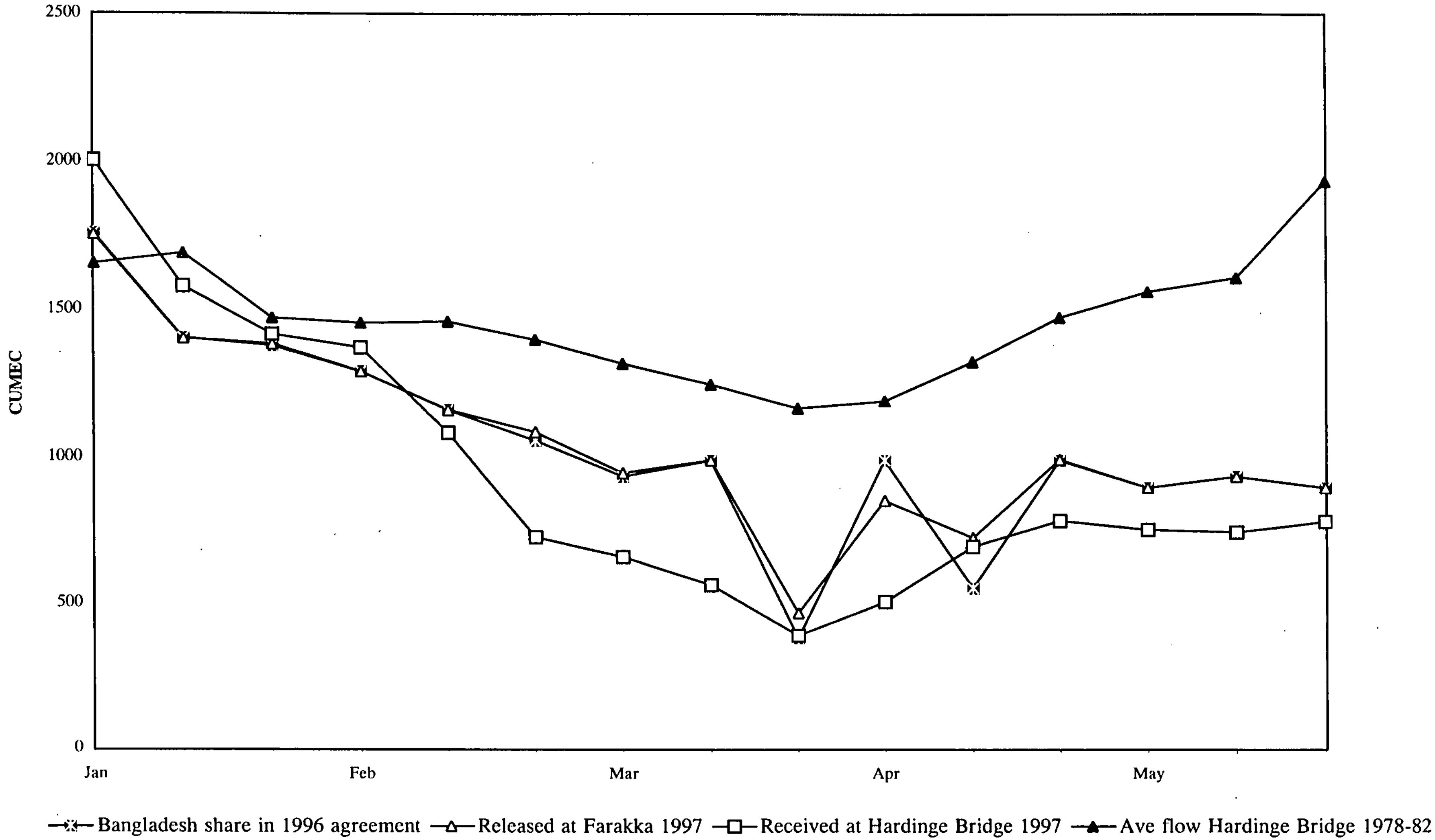


Figure 6.6 Water received at the Hardinge Bridge (actual)
Source: Tables 6.1 and 6.4b



from these figures that the overall indicative water supply at Farakka has increased and accordingly the share of India has also increased. On the contrary the share of Bangladesh has not increased proportionately. Rather it has decreased substantially. Since Nepal contributes significantly to the flow of river Ganga, the inclusion of Nepal in the Ganga treaty would have given an extra dimension and strengthened it. The overall agreement has been signed to share the river Ganga, the international river, but Articles 1 and 2 stipulate that the sharing of water is based on water **available** at Farakka (i.e. after withdrawal in the upstream and left as a residue at Farakka), which contradicts the whole concept of apportionment of equitable water sharing.

The flow of the Ganga according to the present sharing arrangements is not enough to revive the Gorai, a distributary of the Ganga, and so save the south west region in Bangladesh from environmental imbalance. The manual excavation of the silted up offtake of the Gorai and dredging may not provide a long term solution. Thus, the construction of a barrage is essential for the augmentation of the Padda-dependent areas. Feasibility studies of the project should be undertaken immediately to save time and further environmental deterioration of the area. On the other hand Bangladesh must be sure that the Ganga waters as agreed will be coming in the future. However, the 30 year water treaty has opened avenues of cooperation both bilaterally and regionally. No effort should therefore be spared to ensure the successful implementation of the treaty.

The water issue and its impact on the region

During the last few decades, environmental degradation has become one of the prime concerns of people worldwide. Attention over various environmental issues, especially different types of pollution, began in the west and developing countries are now concerned, but at a much later stage because of their complex problems associated with low levels of education, urbanization, industrialization and poverty. By the 1960's environmental awareness had accelerated in South Asia due to over-population, deforestation, land degradation, soil erosion, siltation floods, water scarcity, construction of dams and barrages, changes in sea levels, pollution, and so on. In many cases environmental issues raised security concerns.

Security normally involves military threats but in the present day context it may also involve non-military threats like environmental hazards, economic sanctions and embargoes. etc.. In this context Ullman's (1983, 133) definition of security stated that:

> `A threat to national security is an action or sequence of events that (1) threatens drastically and over a relatively brief span of time to degrade the quality of life for inhabitants of a state, or, (2) threatens significantly to narrow the range of policy choices available to the government of a state or to private, non-government entities (persons, groups, corporations) within the state.'

Similarly `conflict' with regard to water sharing may be defined as one `where more than one country or party strives at the same time to acquire the same scarce resource'. In recent decades conflicts over fresh water have grown as demands have increased. The exploitation of common water by an upper riparian country beyond its share affects the interests of the lower riparian in many ways. Fresh water shortage is becoming a factor for conflict both internally and internationally. In future, the growing world population, intensity of irrigated agriculture and industrialization will put more pressure on water resources and even might be a source of international conflict (Ohlesson, 1996). With the increasing demand, the water management may face a challenge in the 21st century and hence it has to be more efficiently managed to keep the internal and external hydro-political balance and to prevent conflicts.

Environmental security is closely related to social, economic and political factors especially in the South Asian region. Security concerns have been raised in South Asia with respect to environmental degradation. Some of the issues within this area of concern relate to changes in the livelihood patterns of different ethnic groups in terms of water sharing and management, hydro-power generation, dam construction and transit facilities. Economic opportunities may decline due to environmental degradation and may promote political instability. For example, the construction of Kaptai dam in the hill district of Bangladesh displaced many tribal people and gave rise to internal tension. Later on some of the displaced tribal people crossed the international border and took shelter, which promoted mistrust between the two neighbours.

In future, environmental security protection will play a vital role in developing countries like Bangladesh, which is largely dependent on foreign aid, including food supply, and would also like to secure her agricultural sector. National security will also include national, regional and global environmental issues within its scope. However, although there cannot be any military solution to environmental insecurity, the degradation of the environment may lead to a deterioration of the life system and so promote civil disorder, tension and hostilities within the nation and with other neighbouring states. Environmental insecurity could be a national issue within the geographical boundary or across boundaries due to a neighbour's activities like artificial, natural and geophysical human-made changes.

The case studies mentioned in earlier chapters demonstrate that conflicts develop in terms of the sharing of water resources, aquifers, rivers and lakes. There was conflict and annexation of territories in the 1967 war when Israel occupied the West Bank; the Golan Heights and the Gaza Strip, and water was one of the issues in this conflict. In 1975 Iraq, Syria and Turkey were almost on the verge of a war over the waters of the Euphrates. Even today, water harvesting by Turkey threatens the common security of Iraq and Syria. During the celebrated Camp David peace agreement, Egyptian leaders made war threats over the waters of the Nile.

The decade-long war between Iran and Iraq is also another good example, this time originating with a dispute over the Shat-el-Arab water course. Shimon Peres, the then Deputy Defence Minister of Israel recalled that in 1962 that water issue could have sparked an Arab-Israeli war if Israel had seized waters which is not hers. Israel's Prime Minister at the time Levy Esnkol said that water is like the blood in our veins (Kally 1991/92). During 1950s and 1960s Syrian-Israeli relations were marred by armed confrontations and war, with water as one of the factors. Israel bombed the Syrian water diversion installations two months before the 1967 war. Thus, from early in Israeli political history water was closely connected to the issue of state security. The increasing water shortage in the region and salinization of fresh water may create an ecological threat to regional security in the coming days as well.

South Asian Perspective. South Asia has long been an area with considerable instability and unrest. Since the partition of the Indian-Sub continent in 1947, countries of this region have fought five major wars, involving China, Pakistan, India and Bangladesh and have narrowly averted another two between India and Pakistan. The prevailing insurgencies in Kashmir, Punjab and Assam in India; the Chittagong Hill Tracts in Bangladesh; Sind and Baluchistan in Pakistan and the Tamils in Sri Lanka, have given rise to political instability in the region. Moreover, the trade war between Nepal and India; the race for possession of nuclear weapon between India and Pakistan; India's growing progress to become a regional super power; and other differences e.g. ethnic, religious, cultural, etc. among and within nations; all together have created an environment which has raised more security concerns than hope and optimism. The following illustrations may highlight such concerns.

After the partition in 1947, India was faced with severe food scarcity. About 160 large surface water development projects were executed to increase agricultural productivity. Two years later 29 per cent of the First Five Year plan (1951-55) budget was allocated to this sector (Hansen 1966). The growth rate of annual food grain production rose to 3.1 per cent against 1 per cent in earlier periods (Blyn 1966). For achieving self reliance, India gave priority in building large scale water development projects. The expansion of irrigation projects made India self sufficient in food by mid 1970s despite rapid population growth. Hydro-energy has boosted heavy industries which in turn degraded the environment within and beyond its territories. The diversion of water at various upstream locations has caused ecological problems in downstream areas and neighbouring countries. This has added a dimension to the security environment of South Asian States.

Activities related to water sharing have given rise to national and international insecurity, including political disorder or regional instability. For example, social and political tensions in India about the Koel Karo hydro-electric project in tribal Bihar where the Jharkhand groups agitated because of their displacement (*The Statesman*, Indian daily dated 14th December 1991, same issue, `Koel Karo Project stalled due to public protest'). The Cauvery water issue between Karnataka and Tamil Nadu ended in civil unrest. In the case of the River Cauvary, Tamil Nadu, the lower riparian depended largely on its water for rice cultivation. The state of Karnataka, the upper riparian, increased its water needs for expansion of agriculture. This resulted in regular clashes. The most striking part of dispute was in 1991; clashes between Tamils and Kannadiga around the border between the two states. In fact there is a constant movement of people between the states, i.e. many Kannadiga farmers live in Tamil Nadu and the Tamils also provide cheap and dependable labour in southern Karnataka. This is attributed partly to the existing water sharing issue. The ethnic groups have developed hostility because each feels that the other is depriving them of their share of water usage. It can, therefore, be said that conflict has existed over the sharing of water for a long time.

The India-Nepal relationship has also faced several constraints. Although India has contributed significantly to Nepal's economic development in the fields of agriculture, industry, irrigation, hydro-electricity, transport and communications, education, etc., particularly in the initial and later stages, Nepal's contribution to India, especially in the field of irrigation, is no less important. The Sharada canal, the Koshi project and the Gandak project of Nepal irrigate a considerable portion of land in India as compared to that in Nepal. In industrial development, Indian private investment individually and in collaboration with the Nepalese is as significant as that by Nepalese in India. It is important to note that India and Nepal signed a `peace and friendship' treaty (INPFT) in 1950 which was kept secret until 1959 (Kansakar 1987). The treaty contained a number of restrictions imposed on Nepal by India in the matter of defence and foreign assistance beyond India. There had been frequent strains in the relationships between the two countries at government level due to political, geographical, economical and cultural reasons.

Nepal's trade has been under constant pressure since the days of British India. Treaties between India and Nepal for trade and transit were crucial for a small and developing land-locked country like Nepal. India has not favoured Nepal's trade and transit facilities through Bangladesh, not at least until August 1997, and hence there has been a strain on the limited natural resources of Nepal with the adverse impacts on the ecosystem of the Himalayas and effects upon the common interest of all the countries in the foothills of the mountain range. There have been effects on agriculture, hydro-power and ultimately on the overall economy and environment of the region.

In 1988 Nepal was blockaded by India for several months due to Nepal's arms deal with China. During this time all the exits and entrances through India were closed excepting one or two. In October 1989 the Nepalese foreign minister told the United Nations General Assembly that `India's trade embargo against Nepal and the closure of most of the border exits prevented kerosene, cooking gas etc from entering the country which triggered a fresh round of deforestation'. The same was reported by the press (*Far Eastern Economic Review*, 1990, p. 186). A stage came when petroleum, sugar etc. had to be air lifted with special permission from India from Bangladesh to meet requirements on humanitarian grounds. It is interesting to note that Nepal has to depend on India for incoming and exit arrangements at the same time she has the control of the major international water sources upstream on which India is so much dependent.

With a change of government in India since September 1997, India has allowed Nepal transit through its territory. It may be noted that between Nepal and Bangladesh already three agreements were signed since 1976 for the use of the transit facilities for trade which are valid until the present. For over 100 years Nepal has been using Calcutta port which is about 1200 km from Kathmundu. Use of the Bangladesh port of Mongla would mean crossing 56 km of India and 500 km of Bangladesh, half the distance and perhaps an economically more viable proposition.

Nepal's deputy Prime Minister and Foreign Minister told the Indian Vice President while visiting New Delhi that `the new government of Nepal is committed to maintain excellent relations based on cordiality, mutual respect and understanding with India ...Nepal would like certain provisions of the 1950 Treaty of Friendship with India, which is now obsolete, reviewed to reflect the changed world situation...'. (*The Asian Age*, daily newspaper, 9th February 1995, London). The people of Nepal were unhappy with their Indian neighbour for the agreements signed between India and Nepal over the diversion of water in the rivers of Koshi and Gandak and the building of the Tanakpur barrage on river Mahakali. Nepal's highest court of law has given judgement against the agreement between India and Nepal for the construction of Tanakpur barrage. However, later Nepal's parliament finally ratified the treaty with India (*The Asian Age*, daily newspaper, 22 September, 1996, New Delhi).

In Nepal ever since the 1950s exploitation of the country's water resources has been not only an economic issue but a political one. Although a number of India-aided hydro-electric projects have contributed substantially to Nepal's economic development, the delay in implementation of others, and the perception that some of them gave an unfair deal to Nepal, has led a section of the Nepalese ruling elite to view India's role with suspicion (*The Daily Star*, Dhaka, 9th June 1997, p. 5). While India stressed bilateralism in terms of providing funds, technicians, construction expertise, power purchase, etc., Nepal continued with its multilateral approach to avoid delays and cost over run. As a result a number of river-harnessing projects suffered delays of years, even decades.

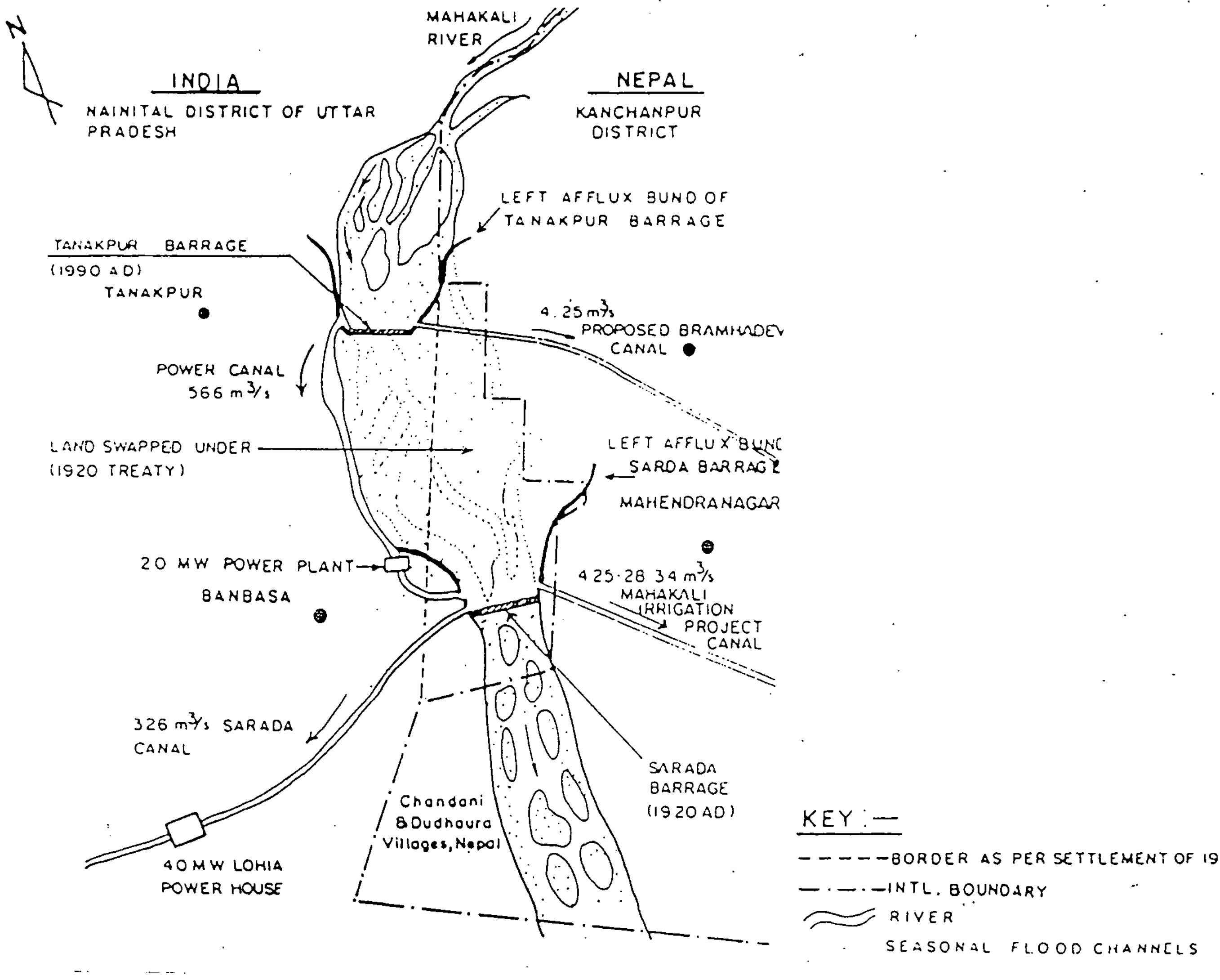


Figure 6.7 Schematic layout of Nepal-India border river development

The governments of India and Nepal signed a treaty on 29th January 1996 at Kathmandu to promote friendship and close neighbourliness for the co-operation in the development of water resources of the international river Mahakali on the basis of equal partnership. This is outlined below (and see Figure 6.7).

The development of the River Mahakali, Sarada Barrage, Tanakpur Barrage and Pancheshwar project

- Nepal will supply 28 cubic metres per second of water from the Sarada Barrage in the wet season (15th May-15th October) and 4 cubic metres of per second in the dry season (16th October-14th May). India shall maintain not less than 10 cubic metres per second flow downstream of the Sarada barrage in the river Mahakali (Article I). Nepal will allow India to use of 577 metres long area (2.9 hectares) at Jimuwa village in Mahendranagar and a certain portion of no-man's land on either side of the border for the construction of the eastern afflux of the Tanakpur Barrage. India shall construct the head regulator near the Tanakpur Barrage including a 132 kv transmission line up to the Nepal-India border from the Tanakpur power station, which will be operated jointly in return for Nepal's water supply. Nepal will receive 70 million kw hours of energy on a continuous basis annually, free of cost.
- The Tanakpur Barrage, Pancheshwar Multipurpose Project head regulator and waterways up to Nepal India border, shall be constructed to supply additional water to Nepal and operated jointly. Nepal shall receive half of the incremental energy from the Tanakpur power station in exchange for payment of half of the additional cost (Article 2).
- The Pancheshwar Multipurpose Project when implemented will have a power station of equal capacity on each side of the River Mahakali. The power generated will be shared jointly. Costs are to be shared in proportion to the benefits. A portion of Nepal's share will be sold to India (Article 3).
- India shall supply 10 cubic metres per second of water for the irrigation of the Dodhara-Chandani area of Nepal. To maintain the flow and level of the waters of the river Mahakali both the countries will not use/obstruct or divert the waters to affect the natural flow. However, local communities living along both sides of the river shall use up to 5 per cent of the average annual flow at Pancheshwar (Article 7).
- There shall be a Mahakali River Commission (MRC) formed by equal number of members from both countries to coordinate all activities and to be guided by principles of equality, mutual benefit and no harm to either party (Article 9).
- In case of any dispute, **arbitration** shall be conducted by a tribunal of three members, one arbitrator each shall be nominated by both countries and the third arbitrator shall be nominated jointly who will preside the tribunal. In case of failure to nominate an arbitrator within 90 days, then the arbitrator will be appointed (not a citizen of either country) with the help of Secretary General of the Permanent Court of Arbitration at the Hague. The majority decision of the tribunal will be final, definitive and binding (Article 11).
- This treaty will remain valid for a period of 75 years and be reviewed at 10 years intervals or as required and amendments made if necessary.

Source: The Treaty between His Majesty's Government of Nepal and the Government of India Concerning the Integrated Development of the Mahakhali River Including the Sarada Barrage, Tanakpur Barrage and the Pancheshwar Project, Signed by the Foreign Minister of Nepal and Minister of External Affairs of India on 29th January 1996 at Kathmandu.

It is important to note that there is a clause of arbitration (Article 11) to settle any dispute in this treaty. The inclusion of this clause may be an indication that it may serve the purpose of the stronger lower-riparian, India, in case of any disputes arising and also to safeguard its interest. It has already been mentioned earlier that India did not include such a clause while signing a similar bilateral treaty with Bangladesh regarding sharing of waters of the River Ganga.

Bangladesh-India relations have also passed through several upheavals. The resolution of the water sharing issue is constrained by domestic factors in both India and Bangladesh. India's technical capability to harness water for irrigation purposes together with the need to boost food production will increase the pressure to arrange for more water. India faces domestic political considerations arising from the economic and security point of view in the context of Union-State tensions, including West Bengal.

Bangladesh has internal and external challenges for survival and to solve its numerous problems. Due to geo-political and economic factors the external dimension of Bangladesh's security is of great concern and is dominated by India. Bangladesh's geo-political position surrounded by India on three sides, coupled with its domestic problems compounds the security and vulnerability of the country. Immediately after independence, Bangladesh-India relations were much more cordial. Good relations were at a peak and a 25 year friendship treaty was made at this stage. The relationship, however, calmed down as a result of the changing political scenario, especially with respect to the water issue. The long and arduous process of negotiation between the two countries for about 25 years, has made a beginning to producing results towards a long term agreement to share the river Ganga. However, Bangladesh's hopes were raised when the Indian Prime Minister in 1992 pledged to his Bangladesh counterpart during their meeting in New Delhi that `every possible effort would be made to avoid hardship to Bangladesh by sharing the waters of the Ganga on equitable basis'.

Unfortunately this commitment was not implemented until the end of 1996. Interestingly it was done at a time when there was change of government in both the countries.

Until now several studies have focused on agro-ecological and socio-economic aspects of the devastating implications of India's `turning the tap on and off' at its own will at Farakka. The internal political implications due to international river water diversion without consultation have given rise to anti-Indian sentiments in Bangladesh. Unilateral withdrawal of Ganga's water immediately after the independence of Bangladesh meant that the expectation of everlasting friendship was lost sight of even after the great contribution by India in the independence struggle of Bangladesh. In other words it can be said that the Ganga water sharing issue has contributed extensively to the erosion of a promising friendship between the two countries. In the meantime, the friendship treaty ended and was not renewed because of people's sentiments and existing circumstances in both the countries.

There are several other problems with India besides the sharing of the Ganga's water. The two countries share 54 rivers where India is constructing barrages and other works in their rivers to divert the natural flow (Hassan 1991). Thus the prime concern of the lower riparian Bangladesh is that in due course there may be many more Farakkas affecting Bangladesh-India relations if water sharing is not settled amicably. The basic difference of opinion is over India's notion of bilateralism in dealing with regional issues of water sharing. India's resistance to a regional approach in the absence of any better acceptable or workable solution is viewed as a worry in Bangladesh which remains vulnerable politically, economically, socially and environmentally.

The concept of regional peace and stability can therefore be interpreted not as merely the security of territory from external aggression or as the protection of individual natural interests in foreign policy. We cannot overlook the legitimate concern of people who need security of stability in their daily lives. For countries like Bangladesh regional peace and stability means protection from the threat of disease, hunger, unemployment, crime, social conflict, environmental hazards and natural degradation. For Bangladesh the major threat of cross boundary water sharing may lead to disparity for sustaining life even beyond the existing disproportion of human land resources to other resources.

Population growth, along with meager resources, including improper management, would make life more insecure and unstable than even internal aggression.

All of these issues necessitate a need for the study of environment and security in the South Asian context. Thus a nation's economic, social and political structure may destabilize with environmental degradation and the consequences may include demographic imbalance, with population displacement within and across boundaries promoting inter-state tension. The inability of the South Asian states to remove the threats perceived within the region has reinforced traditional assumptions of fear and mistrust among nations about each other. Moreover, owing to the lower riparian countries' heavy dependence on the Himalayan rivers, any unilateral measure to control the availability of water by one country will be perceived as a threat to other nations' survival and security. Thus cross-boundary water sharing not only adds to instability but also becomes a major foreign policy issue in determining inter-state relations. In recent times, water sharing has become an important issue between Bangladesh and India in determining their bilateral relations, as environmental degradation is threatening the economic emancipation of the Bangladeshi people. Food insecurity resulting from environmental causes continues to be a cause of external dependence and affects the political stability of ruling governments. Bangladesh as the lower riparian state has limited choices on the availability of water, which greatly influences agricultural output.

The water problem is a current and future threat to the fragile security of the South Asian countries such as Bangladesh. In an interdependent and inter-connected world the conflicts in the developing world might spill over to endanger the peace and stability of the region. There is a close link between the environment and security in South Asia because of the following:

- As a nation's environmental foundations erode, its economy will progressively decline, its social cohesion will tend to collapse and its political structure will move towards de-stabilization.
- Environmental degradation will reduce economic opportunities, lead to population displacement, within a state and across international boundaries giving rise to political tension between neighbouring states.
- Environmental stress may give rise to political disorder, civil strife and even insurgency.
- Environmental calamities may trigger policy choices which can catalyse a potential conflict or aggravate an existing one.

- Environmental devastation due to natural calamities as a result of human intervention, especially those originating from beyond its borders can embitter bilateral relations and lead to regional insecurity.

Therefore it is evident the water issue has been used as a tool by politicians to achieve their political gains or even in diverting their internal power struggle for leadership. Water is a natural and important resource of this planet which is renewable but demands of the growing population, rapid industrialisation, and urbanization and expanding agriculture result in water scarcity, especially with strong seasonal variations. This affects the poorer countries more because of their weak state structure and lack of resources to deal with the problem.

Assessment of the bilateral Treaties in the context of the Region

It is expected that after the lessons learned from the first year of the treaty by India, both countries would take sufficient measures to ensure proper implementation in the coming years especially in protecting the flows. With signing of the India-Nepal Mohakali treaty there is a positive environment for regional cooperation among the riparian countries. The Sapti Kosi high dam project is nearer to Bangladesh. Bilateral discussion between India and Nepal is in its final stage. Similarly the inclusion of Bangladesh in this project would be beneficial for the other two countries (in terms of the sharing of water and hydro-power export).

Environmental Issues, Peace and Security and the UN role

As per Article 1 of the United Nations' Charter, the primary purpose of the UN is to maintain global `peace and security'. As such the security issue for any state in the coming years whether it be environmental, political, military, sovereignty or even sharing of cross boundary resources, needs to be considered. Broadly speaking, in future the UN will have to protect peace and stability between nations within a region or for that matter, globally, for sustainable development and the survival of humankind. For example, human rights is very closely linked to environmental stability, which is directly linked with many factors including cross boundary water sharing. The conflict in the Horn of Africa is connected with environmental degradation and non availability of resources in the region (Zartman, 1989). Iraq was always tense about her share of water especially due to a significant drop of water flow in the river after the construction of a number of dams. These reduced the flow of the Euphrates to approximately 25 per cent of the normal flow. Over three million farmers in Iraq were affected and there was a threat to bomb the Al Tabqa dam. In 1975 after two years of drought, Syria and Iraq nearly came to a full scale war when Syria and Turkey locked the water of the Euphrates by lowering the flow. Both Syria and Iraq placed troops along their frontiers and the war risk was avoided only by mediation of Saudi Arabia. Even conflict over water has been a security issue to promote an armed conflict between Syria and Turkey. In the case of the river Nile, Egypt, the lower riparian is concerned about Ethiopia, the upper riparian's future plans with respect to the use of Nile waters. This potential threat of conflict from water shortage is the basis that dictates much of Egypt's security policy. Thus in 1979 after signing the peace treaty with Israel, President Sadat stated: `The only matter that could take Egypt to war again is water' (Starr 1991). A decade later in 1990, Egypt's ex foreign minister and former UN Secretary General, Mr Boutros Boutros Ghali stated that the national security of Egypt, which is based on the waters of the Nile, is in the Lands of other African countries. He also stated that `the next war in our region will be over the water of the Nile' (Pearce 1991).

A central Intelligence Agency risk assessment paper for the US government has estimated that in at least ten places war could erupt over the sharing of dwindling water resources. The majority of these potential crisis are in Middle East. In 1992 the Pentagon undertook a review of conflicts that might call for US intervention. One case was a war between Syria and Turkey (Bulloch 1993).

Thus it can be argued that in the new post Cold War world order, security perception is engulfing new areas of conflict like cross boundary water sharing, pollution and many issues. Like all other species, human beings are also governed by laws of nature that regulate growth and development. These again depend on ecological interdependence leading to extensive demand of ever increasing population which may unbalance available global resources. The destabilization of regional ecosystems is becoming a source of human suffering in many places of the world leading to insecurity and a fight for existence. Thus, in the near future the peace and stability perception will be changing in terms of human misery due to overpopulation. Therefore, security and political stability in future will have to include environmental consequences and disorders caused by neighbours and any other states for their activities. The environmental destability may cause tension and hostilities within and among nations.

Military solutions are becoming less viable in the present day context. Security is now a broader concept encompassing economic, social and environmental factors. Military threat in boundary disputes may be reducing but there will be increased flow of migrants and refugees across borders mainly for economic reasons for survival. In distant future resolutions/dispute/sharing of control of cross boundary pollution may be necessary either by the UN or any other body agreed by the neighbouring states.

CHAPTER 7

CONCLUSION AND RECOMMENDATIONS

With the signing of the Ganga water treaty, which will run for 30 years, Bangladesh is now in a position to undertake water resources development plans for maximizing the use of its water. However, the water that will be available under the Ganga water treaty, and in future by any other river treaty for sharing all other common rivers, may not be enough to meet the entire needs for irrigation and other uses to maintain the ecology of the country. In Bangladesh, the excess of water during the monsoon and the shortage in the dry season are the two factors which need attention for proper water resource planning. The overall water management goal of the government is to recognise that the land and water resources should be simultaneously and properly developed to promote continued growth of agriculture as a source of food, employment and poverty alleviation. Similarly fisheries, forestry and navigation should be given emphasis and equally developed to meet the people's needs for their survival.

A Master Plan Organisation study (MPO 1986) in Bangladesh indicated that by the year 2000 current surface water projects will exhaust the available surface flow. For future developments, there will be no other alternative but to go for barrage projects on the Brahmaputra and the Padda. To meet its future need, Bangladesh has to prepare a projected water resource management plan by parallel use of surface and ground water. A thorough review of all water resource development projects needs to be done to monitor the on-going and proposed/future ones.

Therefore this study proposes that a National Water Council may be formed for better and proper utilization of water resources of the country. The structure of the Water Council is presented in Figure 7.1. It could be given responsibility to monitor the effects of water use and advise the government appropriately. This Water Council should look into the policy and prepare a profile of priority projects to establish the water rights of the nation. The Council might meet three times a

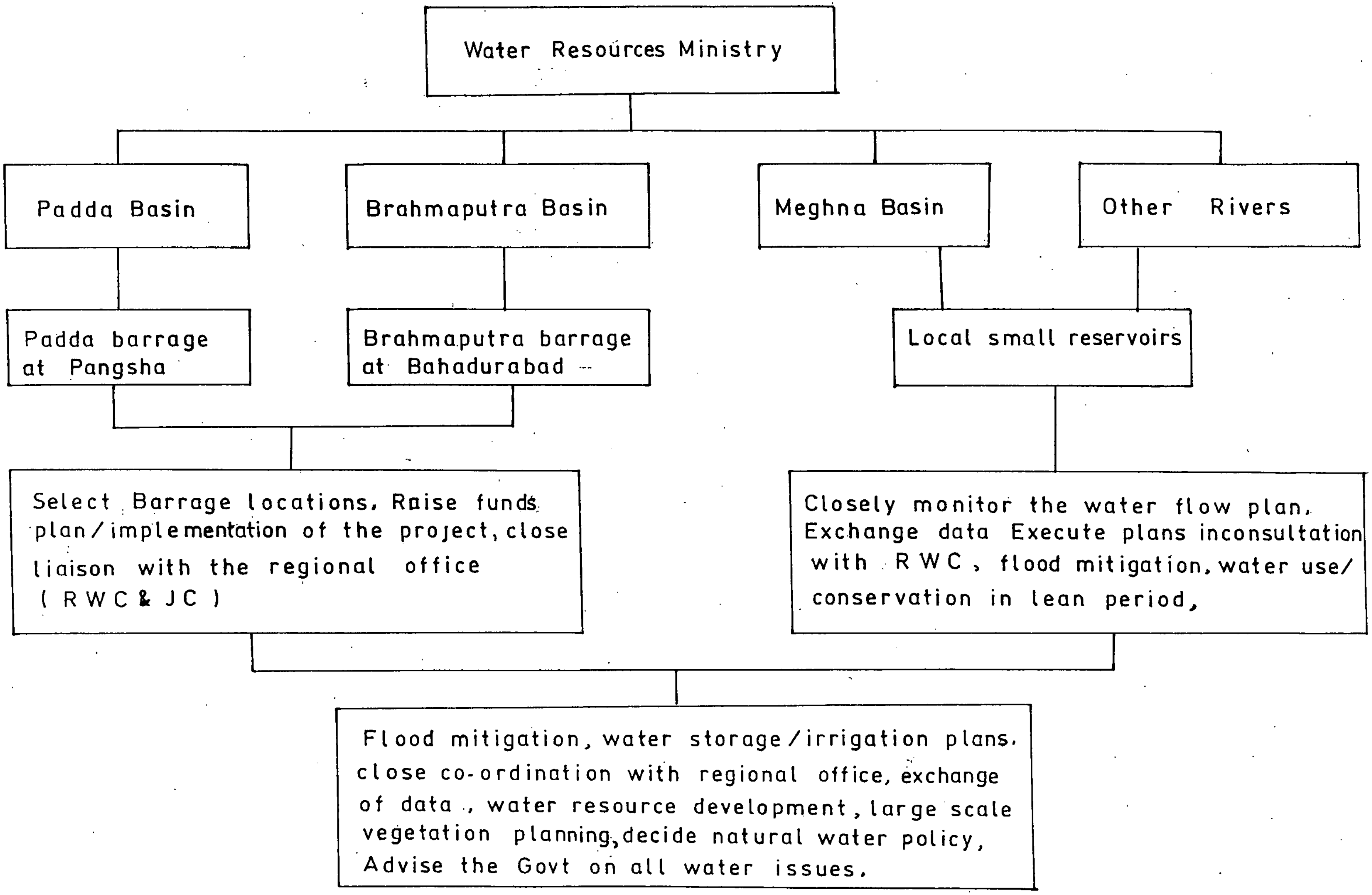


Figure 7.1 National Water Council Management Plan for Bangladesh

year, or more as necessary. The Water Resources Minister could be the chairman of the proposed Council. The Ministry of Water Resources may act as the secretariat of the Council. It could have further subdivisions organised as per the river basins. Its scope should include the following:

- To decide national water policy for water resources development.
- To review the works of various national water resources development plans.
- To decide national policy for various water users of different agencies and their uses.
- To decide the management plans for maximizing water uses.
- To undertake any works related to water resources.
- To minimise wastage or excess use of water.
- To select the exact locations of the Padda, Brahmaputra or any other barrages and plan for their implementations to augment the dry season flow.

Efforts are to be made for making optimum utilization of water resources of this region for flood management, river basin development and augmentation of dry season flows of the Padda. The augmentation of the dry season flow at Farakka by storage of the vast monsoon run off through the construction of storage reservoirs in the upper reaches of the Ganga in Nepal would bring the best result. (Studies for high dams in the Himalaya have been made over a period of 40 years beginning with the investigations for a 240 metre high dam at Saptkosi when there were doubts about the tectonic history of the site. Since then great advances have been made in the technology of dam design and construction and in the understanding of the associated physical processes, particularly seismicity).

Proposed Dams. This study proposes construction of several dams in appropriate locations for the greater benefit of the people of the basin. The Dam sites at Pancheswar and Chisapani have catchment area of 11,600 and 42,890 square km respectively. The two main rivers, the Trisali and the Gandaki, have their confluence in the low foot hills where a large dam can be made. So these dams could regulate 98 per cent of the water resources of the basin (Pancheswar, Chisapani, Kaligandaki 1 and 2, Trisulganga and Seti). The Kosi basin is the largest of the Nepalese catchments available (59,400 sq km) for the augmentation of the river Ganga where a dam could be constructed (Sapt Kosi)(Map 7.1).

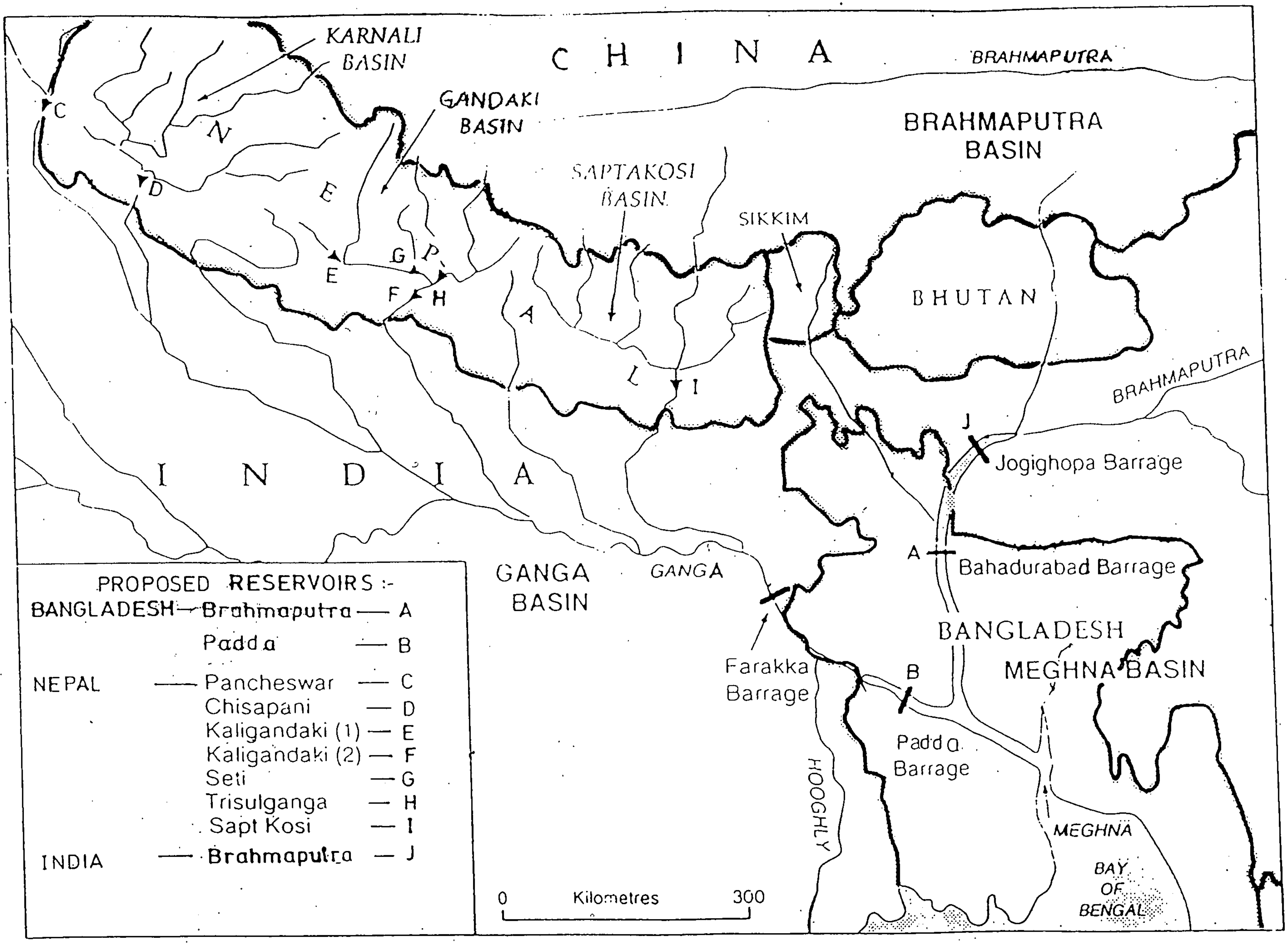
The water released from these dams in Nepal if built as proposed, would augment the short supply of the dry season flow in the Ganga basin in the following ways:

- Increase supply for irrigation.
- Flood mitigation.
- Generate a huge quantity of power in Nepal.
- Improve navigational routes.
- Control saline intrusion in the Padda (lower Ganga) basin.
- Quantitative and qualitative improvement of Ganga's water for domestic and other purposes.
- Probable International river route.

Steps must be taken by each country of the region to maintain and protect the environmental balance at national, community and village levels. These can be initiated by education programmes by the regulatory bodies as well as through massive publicity campaigns. Public and private activities, having environmental effects, need to be co-ordinated as water is getting scarce. The impact of vegetation growth to hold water in the surface to filtrate in the sub-soil and increase ground water recharge capacity should be realized by the countries of the basin. Vegetation will also reduce erosion, so it is important to have a large scale vegetation planning in the region for this and to hold/utilise excess water in the summer.

Most of water resource development would help to improve agricultural output by crop diversification. Effort has to be made to expand smaller irrigation projects to achieve food self sufficiency. In addition the industrial sector should be developed efficiently by addressing water quality first. The fisheries sector needs equal importance to generate employment, including expansion of capture fisheries, fish culture firms and shrimp production. All the projects may be successful with prudent planning based on local people's participation and co-operation.

So far no agreement has been reached on the sharing of the river Brahmaputra. Further studies and exchange of data on the river are needed by both India and Bangladesh so that an amicable



Map 7.1 Proposed reservoirs / barrages

settlement can be reached to share the water. As far as this research is concerned this river basin also needs augmentation both at upper and lower parts of the river especially for the dry season. To solve the problem, sharing of the water resource is suggested as 20 per cent for the river, 60 per cent for Bangladesh and 20 per cent for India (due to the lesser number of people in India being dependent on this river). To plan, monitor and execute the agreement and the dams a cell has been suggested in both the local water management plan for Bangladesh and also for regional water sharing under the Regional Water Council. This research **proposes** reservoirs at Subansiri and Dihang on the tributaries of river Brahmaputra in India to be built to mitigate floods, augment the dry season flow and power development for the benefits of the region. Similarly dams could be built at Manas and Sunkos in Bhutan and at Bahadurabad in Bangladesh to moderate the floods and augment the dry season flows.

Similarly separate cells have been suggested to plan and develop the river Meghna basin and other rivers. It is recommended that any factor influencing the normal river flow has to be discussed through the Regional Water Council (RWC) before projects are implemented. The Tista irrigation projects developed by India and Bangladesh could be integrated and the two barrages and canal systems operated in tandem under joint management, water supplies being augmented at a later date from storage in Sikkim (Tista High Dam) or Bhutan (Indo-Bhutanese, Chukha II or Sunkosh projects). Until the finalisation of a water sharing agreement for the waters of the river Tista, a sharing method has to be agreed for the running of the Tista barrage in Bangladesh. The recommended solution (to be finalised at a later date after further study) could be 20 per cent for the river and 40 per cent each for India and Bangladesh. The river Tista flows could be further augmented by the construction of the Geilkola Dam in India.

The Tipaimukh Dam and Fulertal Barrage in Manipur, India could be taken up jointly to be developed by India and Bangladesh to moderate floods, improve irrigation, navigation and generate hydro-electric power for both countries under joint management. The project planning, execution and development could be done by a joint committee consisting of members from Bangladesh and

India. The cost should be shared by the two countries proportional to the benefits received by each (i.e the total cost of hydro-power generation, construction of irrigation projects etc.).

Both India and Bangladesh should discuss the 53 other common rivers to settle amicably on the basis of equitable sharing in the interest of regional cooperation and future environmental stabilisation. A probable solution could be 40 per cent of the water flow to be taken by each country, leaving the residual 20 percent to maintain a river flow. However, further study on each river has to be undertaken and data for each river has to be exchanged to finalise the equatable and agreeable sharing.

The objective of water projects in this region is to build to improve health, boost production, stabilize income, maintain balanced ecology and environment and finally sustainable existence of all the riparians. As water is a finite and limited resource which directly influences society, environment and future civilization, the major issues of water management should include:

- Water marketing plans for the future e.g. ground water marketing in parts of India and Bangladesh (well developed water markets also operate in Chile and Colorado in the USA).
- All riparians to share responsibility in water management, helping, contributing and managing the issue regionally. If needed, help of other international experts may be sought. (for example the French river basin management approach which started in 1960's. Six river basin agencies manage the technical and long term planning, monitoring financial calculations, operation and maintenance. The other six committees e.g. farmers, industrial representatives, municipalities and others meet and negotiate their contribution, goals of organisation, fees, investments and so on. The French water management covers the entire country and could be followed as a model in this region). The South Asian region is impoverished and cannot afford further loss of time to share the waters of Ganga, Brahmaputra, Barak/Meghna and others constituting an abundance of wealth and energy. This has to be judiciously, creatively and cooperatively used to move forward together for a better future.
- To move forward in a co-operative spirit in harnessing the eastern Himalayan rivers for sharing benefits of all riparians, it could be planned and shown that a win-win, positive-sum solution is possible for all countries of the region. It is important to address the short term critical needs on an urgent basis while long term planning must be done for regional water management development for mutual benefit. The greatest need is for a mass movement for the awareness of the users all along the river banks and to educate them about the implications of damage to the river water and the environment. Serious punishment should be meted out and religiously executed on industries if they fail to execute/install pollution treatment plants. In 1986 the Government of India enacted a law in the form of their Environment Protection Act 1986 which should be judiciously implemented and perhaps replicated by other countries in the region.

The present problems are not the product of technical differences regarding the implementation of agreements or how costs and benefits are to be shared. The real problem is the legacy of political mistrust based on a variety of considerations and experience. Over the years self created myths have obscured reality in the changing socio-economic conditions. Each country has become a victim of its own myths from which political leadership finds it difficult to break loose for fear of being accused of betrayal or appeasement.

On the basis of above discussion, **this study makes following specific recommendations**:

- As practised in Israel, that water management and saving technologies should be applied in the South Asian region so as not to waste water. For example in irrigation by using underground storage and converting sprinkler to drip irrigation as introduced by Israel, as well as enhancing public awareness of the need for water saving through publicity media. Israel's water savings in the form of waste water recycling for irrigation is another best practice for the region.
- Regional cooperation for cross boundary water resource sharing may be set up by establishing a Regional Water Council. A full-time secretariat of the Regional Water Council to be made functional: to plan, undertake water resource management and monitor all inter state water projects for regional benefit.
- A national water code may be framed for future use to ensure proper distribution of responsibilities to different agencies, proper maintenance of irrigation, drainage and embankments.
- Cost of prevention/damage on environment has to be borne by the polluter.
- To ensure that activities in one state should not cause any degradation of the environment of another state. Protection of environment to be done by the individual, by the community, by the state and finally by the region.
- All water resource projects should be regionally monitored to assess environmental impact and maintain ecological balance.
- Appropriate legal institutions should be developed to protect local people's rights including other riparian rights, so that no excess is allowed without consultation and regional co-ordination.

Recommendations for Ganga water sharing (Figure 7.2)

- To continue proper monitoring of equitable sharing of the Ganga.
- Padda barrage to be built at Pangsha to augment the Ganga flow.
- Development of surface water irrigation projects (privately financed for local areas).
- Construction of drainage schemes.
- Maintenance of river and irrigation canals.
- Further study be carried out to implement project and generate local financial support in terms of use/benefit from the users (e.g. water tax or low rate of recovery costs etc).

Recommendations for regional co-operation (Figure 7.3)

Flood moderation annually inflicts damage to life and property which causes a huge economic burden for the region. The main causes of such floods are the very large mountainous catchments discharging into the Ganga, Brahmaputra and Barak valleys, extensive jhumming (shifting agriculture) and torrential rainfall. All of these combine in generating huge quantities of sediments which flow down to the Bay of Bengal. The jacketing of rivers with embankments has uplifted bed levels and increased bank erosion. The great Assam earthquake of 1950 twisted the landscape and brought down a lot of debris, choking the rivers and reducing the navigational draughts (Verghese 1996). The Brahmaputra Board was established in India in 1981 to look for a long term solution which recognised the International Boundary and Water Commission (IBWC) for dispute resolution regarding water resources, and also for regional co-operation in trade, commerce and industry. There is great prospect for co-operation in transit by river, rail and road in the region. Transit navigational routes for Nepal from the Kosi to the Ganga to the Meghna may be explored. The navigational route from north eastern India through the Brahmaputra to the Meghna and rail transit from Chittagong to Nepal through Tetulia and Shiliguri may also be considered.

The Bangladesh railway system has been run down over the years. Its deficit grew from US$ 7.1 million in 1981 to US$ 27.5 Million in 1992 with both passenger and freight traffic declining, the former by 50 per cent and the latter from 3.2 million to 2.5 million tonnes over the past decade. Before 1965 about 20-25 per cent of the Bangladesh railway revenue was earned through cross

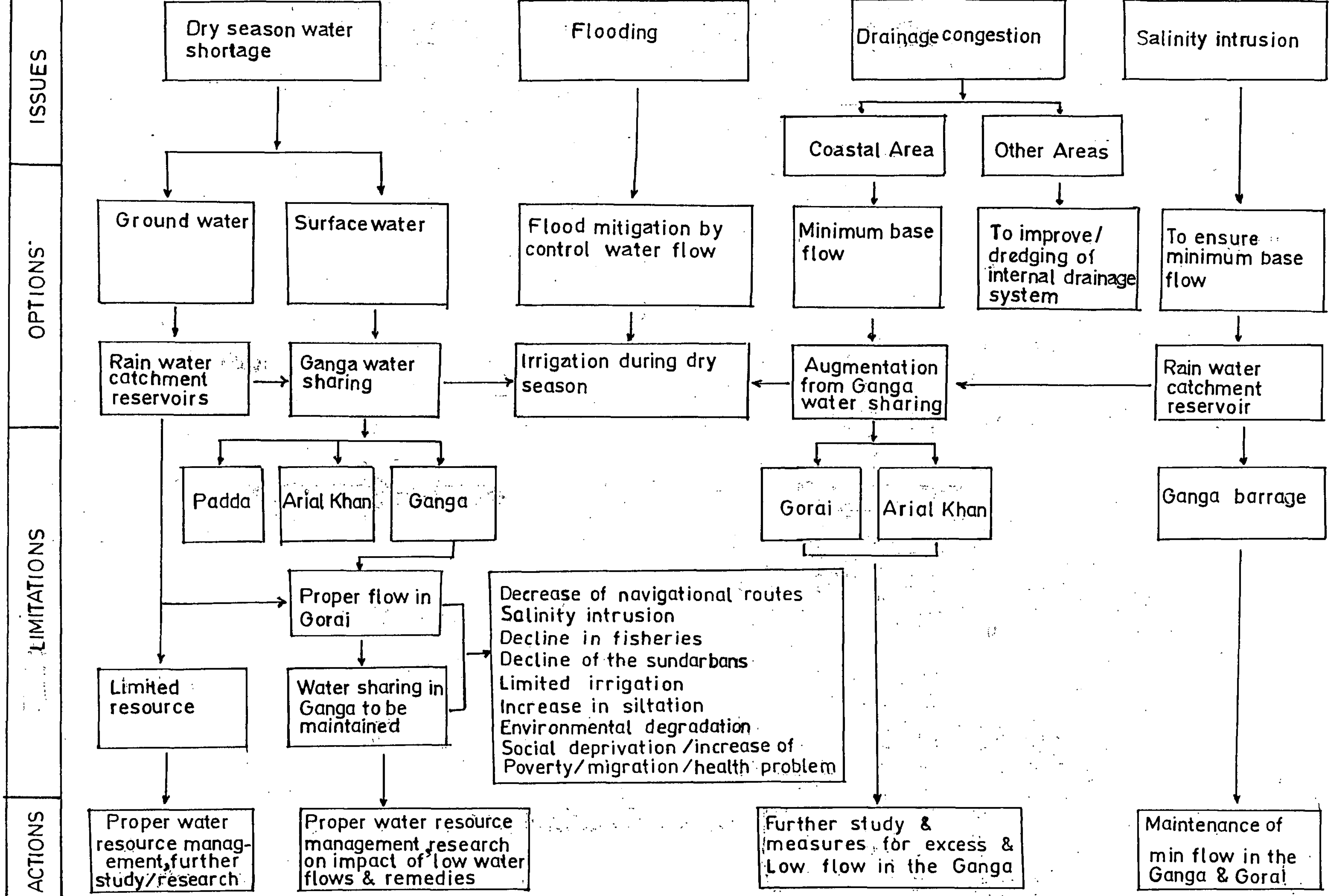


Figure 7.2 Problems with recommendations for Ganga Basin

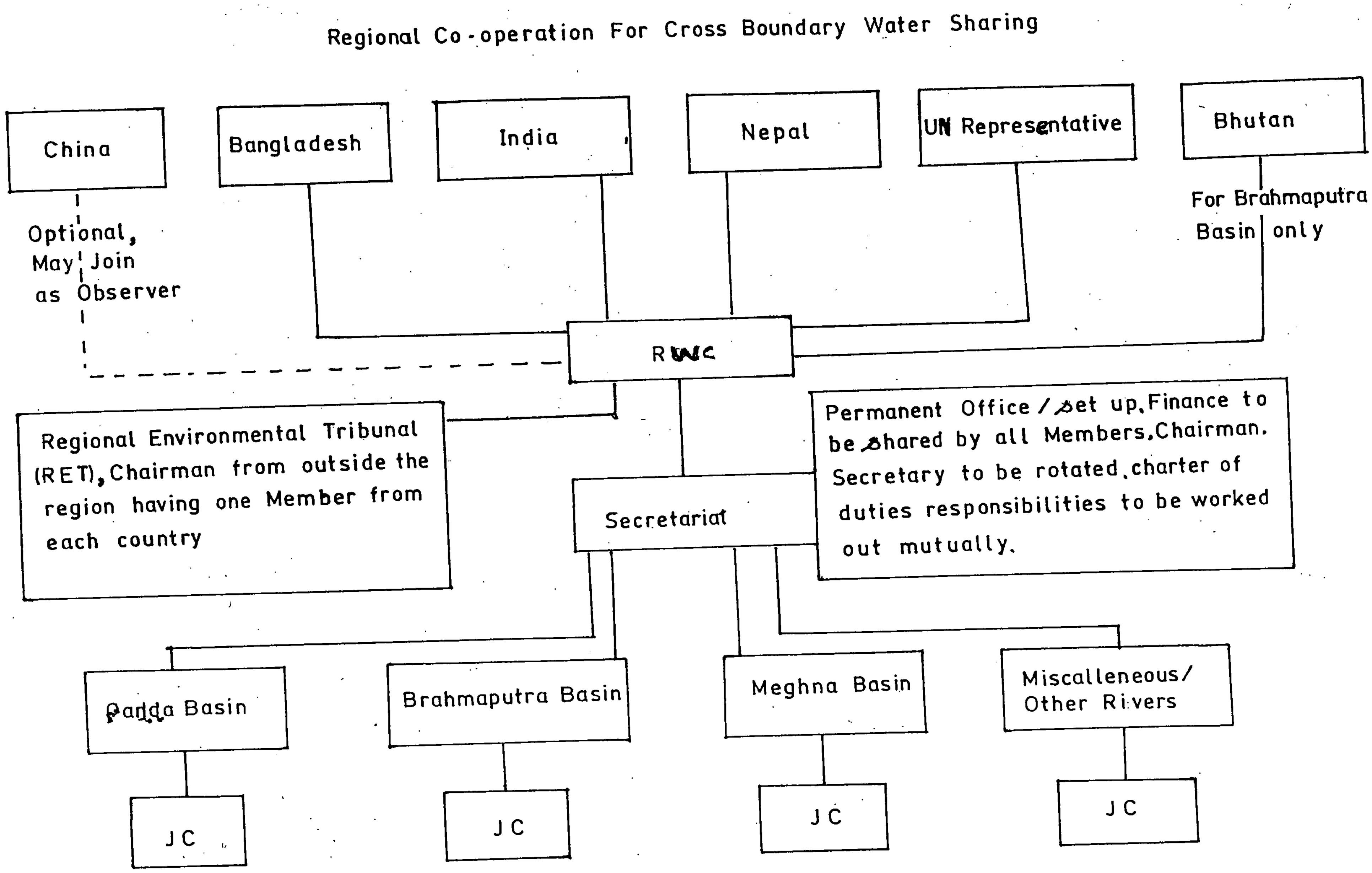


Figure 7.3 Regional Cross Boundary Water Management Plan

border traffic from India. This income would increase (due to the Jamuna bridge which will be ready for use by June 1998) by 18 per cent if Indian traffic is permitted (Centre for Policies Dialogue, Dhaka, August 1994).

Thus, community/regional participation is the key concept and would give good dividends for co-existence. If the current population increase and pollution goes on unchecked, the future living conditions looks gloomy. A famous statement by Parakrama Bahu I (1153-86 AD) said 'not even a little water that comes from the rain must flow into the ocean without being made useful to man'. Further co-operation could be as follows:

- Chittagong and Mongla ports to be further developed and may be used by India, Nepal and Bhutan under regional co-operation.
- Transit facilities may be provided by road, rail and water to Nepal, India and Bhutan.
- Trade among the countries of the region could be developed on the basis of mutual interest and benefit.
- Non-Governmental co-operative ventures may be encouraged (for example cement factories can be developed in the Sylhet border between India and Bangladesh where India sells limestone and Bangladesh produces a better quality of cement at a cheaper price than imported cement). Such agreement and co-operation will be successful once there is a better understanding between the governments and trust among general population which has to be further developed.
- The exchange of water resources data has to be done for internal and external planning, leading to greater agricultural growth and hence improvements in the general economy. Thus, agricultural development through proper irrigation and equitable cross boundary water sharing would help develop agricultural sectors for more timely production and improve the livelihood of farmers.

India and Nepal are planning to build the Kosi high dam with Japanese help. This dam is close to Bangladesh and will be producing electricity and storing water. If this plan matures then Bangladesh could be included on the basis of regional co-operation and would benefit by sharing the electricity and water. The potential areas of cooperation among the countries are listed in Table 7.1

Table 7.1 Potential cooperation between countries

Countries	Subject
Nepal-India	Export of hydro-electric power Supply of water in dry season
India-Nepal	Navigation and transit Finance for construction of dam
India-Bangladesh	Supply of water during dry season Ensuring minimum flow in all rivers
Bangladesh-India	Transit (transboundary by rail, road and water) communications
Bangladesh-Nepal	Transit (communication facilities for trade and movement)
Nepal-Bangladesh	Export of hydro-electric power Supply of water during dry season
Bhutan-India	Export of hydro-electric power Supply of water as planned, financial and other help to construct a dam
India-Bhutan	Navigation and transit facilities
International community	Finance and engineering expertise To ensure equity in the distribution of benefits amongst countries, maintenance of environmental balance, harmony, peace and stability in the region.

At the end it can be said that by sincere and dedicated regional co-operation there should not be any obstacle to harness huge surplus water resource with local and international help for mitigation of floods, increase agricultural output by proper irrigation, and other uses. The Ganga water treaty should allow better understanding for rest of the bilateral issues. For example, some of the Brahmaputra's vast monsoon surplus can be diverted to the water-short heartland, by an understanding between the two countries. On the other hand, transit by rail, road and waterway through Bangladesh would allow the north east of India to be in close touch due to its the geographical position. India, Nepal, Bhutan and Bangladesh all would benefit in finding valuable markets, encouraging more investment, infrastructure developments, trade, joint ventures and above all more employment that would provide a better antidote to migration than border fences (Verghese 1996).

Topics for further study/research

In the process of this research it has been found that annual rainfall has little impact on the ground water table in the region. This has been further confirmed in discussion with the officials of the Ministry of Water Resources (Personal Communication, Dhaka, July, 1996). So it is recommended that further study/research can be undertaken to find out how best rain water can be utilised or be used to its maximum in recharging the ground water level/table.

Finally, in the coming decades, due to population increase and concurrent increasing demands for more and safe water for multifarious purposes, the countries of the South Asian region will enter into a serious water scarcity. But natural resources have definite limitations. In future we may face a serious water crisis unless some positive measures are taken by all the countries of the region both individually and collectively. The UN should also be committed to help in fulfilling the regional goal of socio-economic and environmental conservation and protection objectives while developing a regional water sharing solution.

It is predicted that in future the effects of micro area water crises may be felt regionally in their political and security related implications, especially areas of high population growth population. This will aggravate health problems, affect food requirements and promote conflicting demands for increasingly scarce water resources. In turn, the effects may lead to local/regional conflicts as well as social changes. Until such inequalities are addressed and the larger issue of the permanent allocation of water rights is solved, tensions will persist in this part of the world. Strategies should be developed for land-to-water linkages, and pollution-free land use. Possible impacts of land-use changes have to be recognised. Water management plans should include local water allocation in a framework of regional water resources conservation using water judiciously, selecting priorities between conflicting water functions and upstream-downstream claims. Food self-reliance and urban-industrial development have to be carefully planned, and food shortages/dependance of other regions may be considered along with external food financing. The conventional instruction to **`think globally and act locally'** will make sense when cross boundary water sharing is done in consultation with all riparians in a river basin for the better future of the people. It is time that a new global water use is made to avoid future conflicts and misunderstandings in days to come.

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APPENDIX

Notes on River names

The rivers in the South Asia region bear different names in different segments of their length. The main Himalayan tributaries of the Ganga (Ganges in English) have different names in Nepal. The Maha Kali becomes Sharda in India and the Karnali the Ghaghara. The Narayani in Nepal becomes Gandak in India. The Kosi has seven streams in Nepal. The main ones are the Sun Kosi, the Arun (which rises in Tibet) and the Tamur.

The Bhagirathi and Alaknanda rise in the Garhwal Himalaya and meet at Devprayag to form the Ganga. The Ganga then divides into number of streams below Farakka in West Bengal. The Western-most tributary turns south is known as the Bhagirathi which becomes the Hoogly. The main river Ganga flows south-east enters Bangladesh, meets the Jamuna (Brahmaputra) at Goalando Ghat, the combined stream is called the Padda which meets the Meghna at Chandpur.

The Brahmaputra rises in Tibet, just east of Kailas-Mansarover, is known as the Tsangpo or Yalu-Tsangpo untill it enters India. Then it takes the name of Dihang or Siang in Arunachal. The Dibang or Sikang and the Lolit meet the Siang near Saidya below which the combined river takes the name of Brahmaputra in Assam in India. The river flows up to Bahadurabad in Bangladesh where it bifurcates into the Jamuna to join the Padda and the other continues as the Brahmaputra, also called the old Brahmaputra, and flows into the Meghna at Bhairab Bazar. There are many streams rising in Manipur from the Barak which flows through Cachar in Assam to enter Bangladesh as the Kushiyara which on meeting the Surma from Meghalaya, takes the name of Meghna which meets the Padda at Chandpur.

Transliteration of South Asian languages also sometimes causes confusion. Thus the river Teesta or Tista is the same.

GLOSSARY

Bandh : An earthen dam or embankment.

Beel : Ox-bow lake.

Boro : Winter rice/crop in Bengal.

Command area: irrigable area within an irrigation system.

Jhum : Shifting cultivation.

Kharif : Monsoon crop.

Rabi : Winter crop.

ABBREVIATIONS

BADC : Bangladesh Agricultural Development Corporation

BIWTA : Bangladesh Inland Water Transport Corporation

BWDB : Bangladesh Water Development Board

cm : Centimetre

cu m : Cubic metre

cu mecs: Cubic metres per second

cusecs: Cubic feet per second

CWPB : Central Water Pollution Board, India

ha : Hectare

ha m : Hectare metre

ICJ : International Court of Justice

ILC : International Law Commission, United Nations, New York

ITTC : Irregular Tripartite Technical Commission

IWT : Indus Water Treaty

JCE : Joint Committee of Experts, Indo-Bangladesh

JRC : Joint River Commission, Indo-Bangladesh

KOE : Kilo Oil Equivalent

MAF : Mean average flow

MW : Mega Watt

PIC : Permanent Indus Commission

PJTC : Permanent Joint Technical Commission

PPM : Parts Per Million

TDS : Total Dissolved Solids

CONVERSION FACTORS

Length:

1 metre (m) = 3.28 feet (ft)

1 foot (ft) = 30.48 centimetres (cm)

1 mile = 1.609 Kilometres (km)

Area:

1 acre = 0.405 hectare (ha)

1 ha (Hectare) = 2.47 acres

1 sq km (square kilometre) = 100 ha

1 sq mile = 259 ha = 640 acres

Volume:

1 a f (acre feet) = 1233.48 cubic metres

1 cu ft (cubic foot) = 6.23 ga (gallons) = 0.0283 cu metre

1 cu m (cubic metre) = 219.97 ga = 35.315 cu ft

1 cu mec (cubic metre per second) = 35,315 cusec (cubic ft per second)

1 b cu m (billion cubic metre) = 1,000 m cu m = 0.81 maf

1 ha m (hectare metre) = 10,000 cu m = 8,107 a ft

1 m ga (million gallons) = 160.544 cu ft = 4546.09 cu m

1 litre = 0.22 gallons

1 Mega Watt (MW) = 8.759 Gwh