WATER RESOURCE DEVELOPMENT IN BANGLADESH

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CERTIFICATE

This is to certify that the Arpita Dutta Student of M.Phil in the South Asian Division of Centre for South, Central, South East Asia and South West Pacific Studies at School of International Studies, Jawaharlal Nehru University, New Delhi, has successfully completed her Dessertation entaitled **Water Resource Development in Bangladesh** under my supervision The work is original and has not been published else where.

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Dedicated to my Parents.

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I am also deeply grateful greateful to the library staff of the J.N.U. Library, C.P.R. Library, Indian Council of World Affairs (ICWA) Library, Nehru Memorial and Museum (Teen Murti) Library, and for their unreserved co-operation in collection of the material required for this study.

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Lastly I am greatful to my friend Vikash and offer my special gratitude to my parents whose inspiration enabled me to take up this study.

J.N.U., New Delhi

Date 7 July, 1997 **Arpita Dutta**

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CHAPTER I

Introduction

History of Bengal

In Bengal, dated history begins only from 326 B.C, when Alexander invaded India. There was probably some kind of organized social and political life in Bengal many centuries before that notable event, but we do not possess any detailed information about it. The little that we know of the earliest period is derived almost solely from a study of the Vedic literature. The historians of Alexander refer to a people whom they cal the Gangaridai. According to the evidence of Pliny. Ptolemy, and many other classical writers, the people in question occupied the country of the lower Ganges and its distributaries, Jaina and Buddhist legends connect the name of the great Maurayas and their contemporaries with Pundaravardhana. and Chinese pilgrims found Ashokan monuments, in various parts of the province. The existence of Pundranagara in the Maurya epoch, is in the opinion of some scholars, proved by an old Brahmi inscription,[1] unearthed at Mahasthangarh in the Bogra district.

Glimpses of Bengal in the early centuries after Christ are afforded by the Periplus of the Erythraean Sea, the Geography of ptolemy. the Milinda - panho, and the Nagarjunikonda inscriptions. The periplus describing the east coast of India, mentions the river Ganges and market town on its bank which has the same name as the river.

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[1] Mazumdar R.C., History of Bangal, Vol.I, Published by Dhaka Univ., Dhaka, 1933.

The city of Gange is also mentioned by Ptolemy who describes it as a metropolis and distrigushes if from Tamaliites i.e Tamralipti.

The Milinda-panho mentions Vanga in a list of maritime countries where ships congregated for purposes of trade.

From the fourth century A.D. onwards the epigraphic records available show distinct chronological periods (such as the Gupta. early post- Gupta. Pala and Sena ages) which enables us to trace the chief political or geographical divisions and administrative units of Bengal.

The ancient history of irrigation in Bengal is not also distinctly known. However, it is know from the treatise "Irrigation in Bengal' Sir William Wilcoks that about 3000 years ago the rulers of ancient Bengal introduced the system for irrigation called the "overflow irrigation". This system of irrigation had been practiced till 1213 A.D. when the Sultana's period commenced in Bengal. The period upto 1213 A.D. is therefore passed as the Ancient period.

The trend of irrigation practice changed on commencement of the Sultani period from overflow to tank irrigation. Besides, flood control through construction of embankments and improvement of drainage facilities began during the time. The communication facilities also developed through construction of roads and bridges network. This tank irrigation practice and development of flood control, drainage and communication network improved substantially and continued till the end of the Mughal empire in 1757 A.D. This period is called as the Medieval period in the history.

The development and maintenance of flood control, drainage and communication network suddenly stopped and attention was given to navigation than irrigation on the commencement of the British regime. The entire period from 1757 A.D. to 1947 A.D. of the British regime is called as the "Colonial period".

After independence of Pakistan the Eastern and Central part of the British Bengal named as East pakistan introduced due priority in the water sector As a consequence several projects on flood control, drainage irrigation were takenup and a Master Plan had been prepared. The period between 1947 A.D. to 1971 A.D. is called as the Pakistan period. After emergence of Bangladesh renewed efforts has been made on the agricultural and water resources sector. the period after 1971 is called Bangladesh period. The Pakistan period and Bangladesh period together are called Modern period. The enclosed chart indicates the different periods with the system of irrigation, drainage flood control (Exhibit 1).

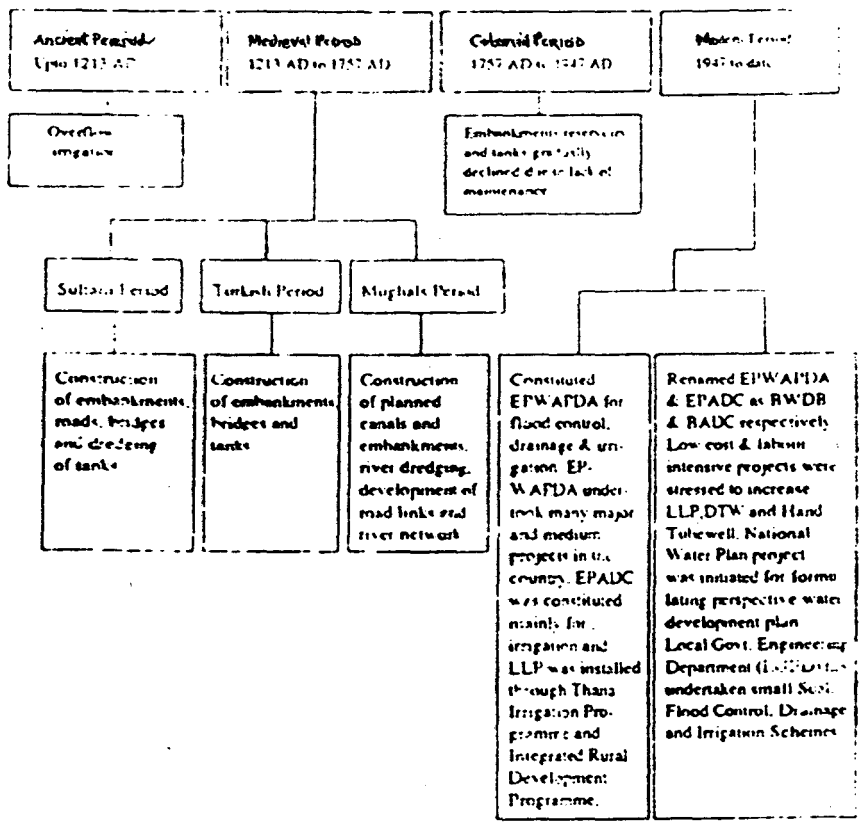
B. **Physical Features**

Bangladesh lies between 20° 38′ to 26° 38′ North latitudes and 88° 01′ to 92° 4′ East longitudes and is surrounded in the west, , north and north - east by India, on the south-east by Myanmar and on the south by the Bay of Bengal.

The most characteristic physical feature of Bangladesh is its river systems. The three mighly rivers, the Ganges, the Brahmaputra and the Meghna with their numerous branches and tributaries have played a large part in shaping its destiny. By the vast deposit of silt carried from upland, they have created the enormous area of deltaic lowlands and the process is still going on in full vigour. The same fluvial action is

Exhibit - 1

Flood Control, Drainage and Irrigation in Bangladesh: During Different Period



Note :
EPWAPDA - East Pakistan Water & Power Development Authority
EPADC - East Pakistan Agriculture Development Corporation
BWDB - Bangladesh Water Development Board
BADC - Bangladesh Agriculture Development Corporation
LLP - Low Lift Pump
DTW - Deep Tube Well

also responsible for the constant shifting of courses, the vast deposit of silt by the rivers in the deltaic region has been a potent instrument in changing its physical aspects to a considerable extent. The deposit of silt constantly raises the level of land in some areas and makes the other regions comparatively lower and water logged. The vast Sunderbaan area in the delta has once been populous tract but were depopulated by the ravages of nature and the depredation of marauding peoples like the Maghs and the Portuguese, Epigraphic evidence proved that the marshy area called Kotalipada in the district of Faridpur, was once a thriving seat of civilisation and possibly a centre of sea born trade and commerce. The change in the condition of the interior of the districts of Jessore and Khulna in recent times also well illustrates what might have taken place on much larger scale during the preceding centuries.[2]

The country has four divisions which fairly correspond to its major political divisions. North of the main branch of the Ganges and west of the Brahmaputra lies the extensive region which embrace the Rajashahi Division. South of the Ganges, Padma and the west of the estuary of the Meghna lies the central region of Bengal, the Khulna Division and the greater Faridpur district of Dhaka Division. The segment in the east of the Brahmputra, north of the Padma and west of the Medhna constitutes the greater Mymenshing and Dhakla districts of Dhaka Division. Beyond the Meghna in the east stretches the Chittagong Division. A Map of Bangladesh showing the political boundary and major river systems is presented in Plate - I.

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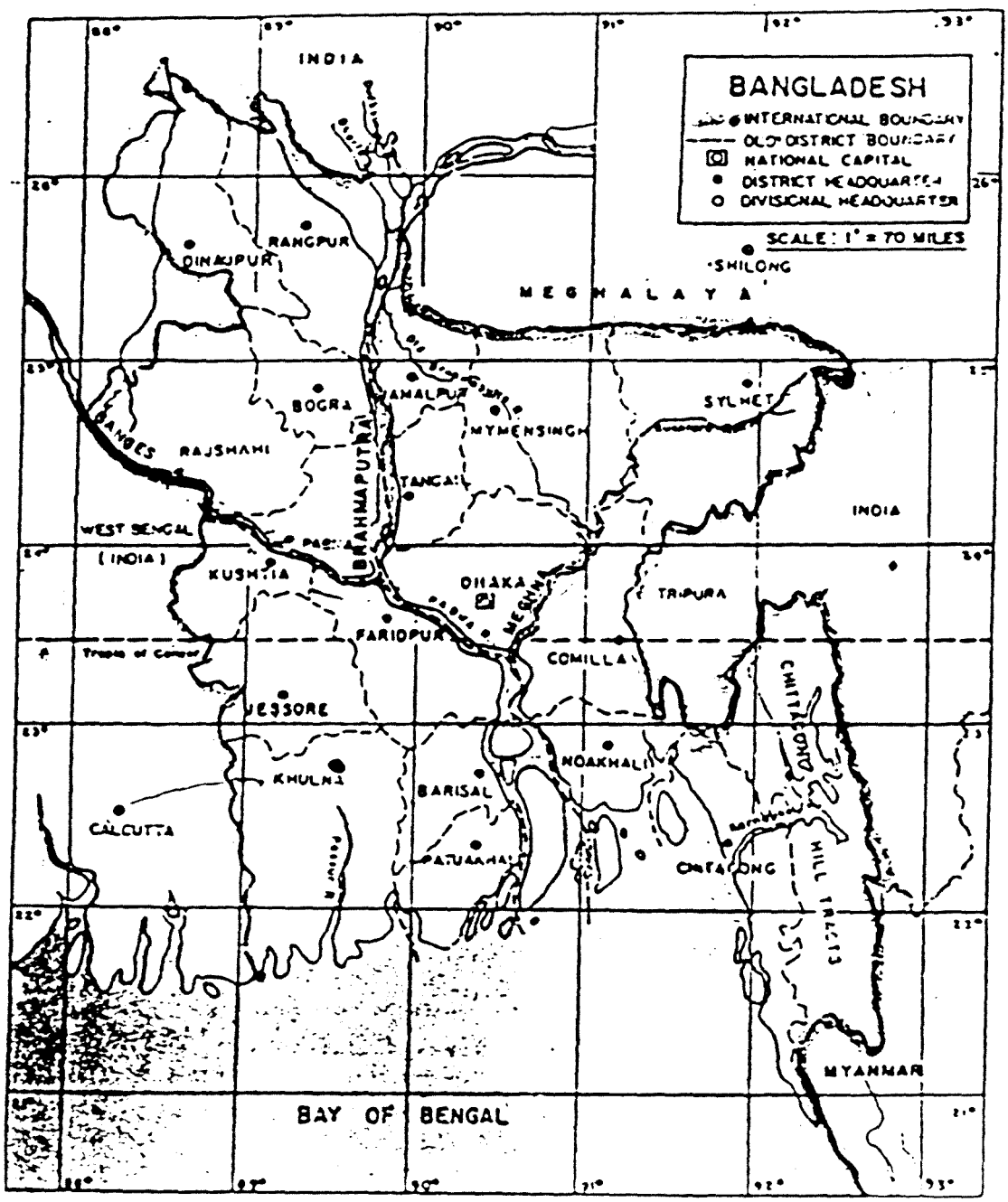
[2] D.R. R.C. Mazumdar, Physical Features of Ancient Bengal, Published by University of Calcutta, 1938.

PLATE - I


BANGLADESH
INTERNATIONAL BOUNDARY
OLD DISTRICT BOUNDARY
NATIONAL CAPITAL
DISTRICT HEADQUARTERS
DIVISIONAL HEADQUARTER
SCALE : 1" = 70 MILES
INDIA
RANGPUR
DINAJPUR
SHILONG
MEGHALAYA
BOGRA
JAMALPUR
MYMENSINGH
SYLHET
RAJSHAHI
TANGAIL
INDIA
WEST BENGAL
(INDIA)
KUSHTIA
BRAHMAPUTRA
DHAKA
TRIPURA
FARIDPUR
COMILLA
JESSORE
NOAKHALI
KHULNA
BARISAL
CALCUTTA
PATUAKHALI
CHITTAGONG
HILL TRACTS
MYANMAR
BAY OF BENGAL

C. River System In Bangladesh

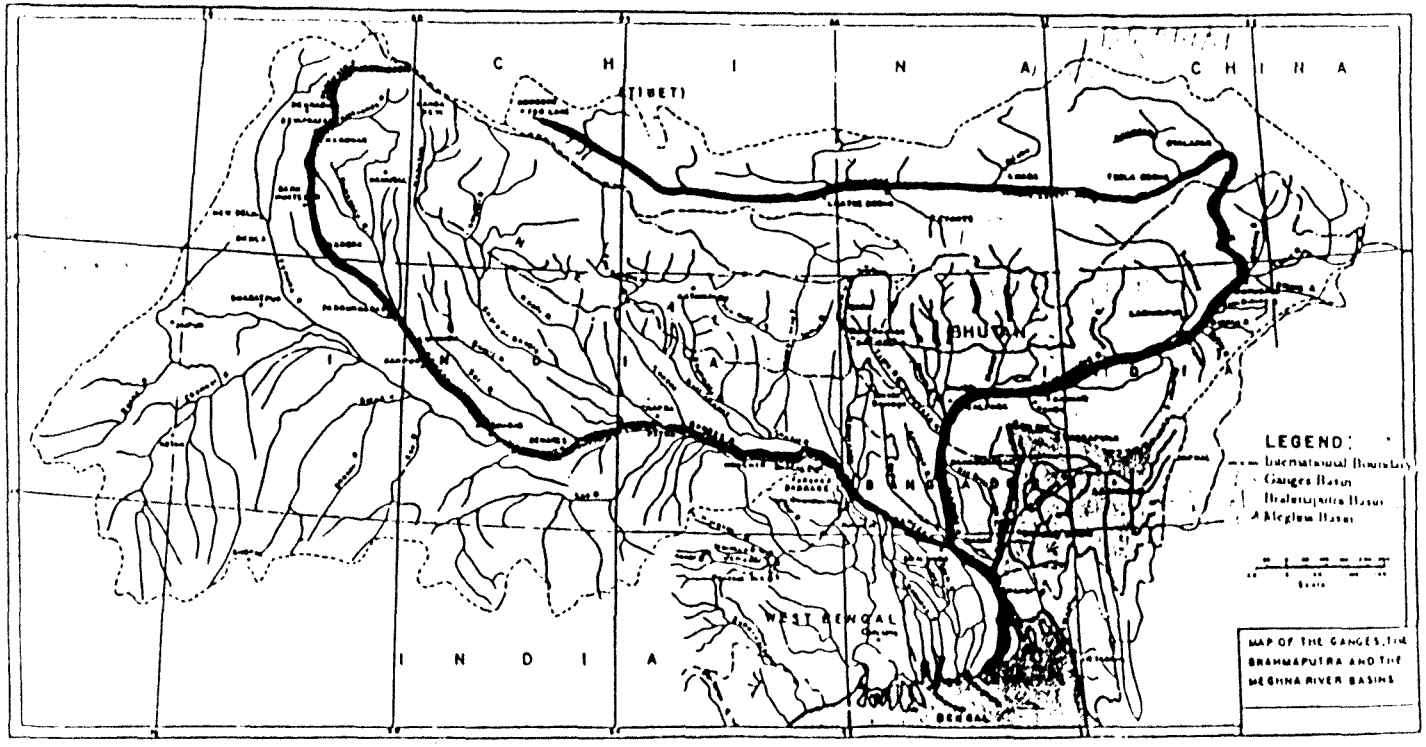
Present River Network

Bangladesh is a delta formed by the alluvial deposits of three mighty rivers of the world: the Ganges, the Brahmaputa and the Meghna. The geographical location of Bangladesh showing the Ganges, the Brahmaputra and the Meghna river basins is shown in Plate 1.1.

The Brahmputra river orginates in the Himalayan range and collects snowmelts and rainfalls from the huge catchment lying in China, Bhutan, India and Bangladesh. After rising from south of the lake Konguu Tsho in Tibet (China) very near to the Mansarover lake at an elevation of 5150 meters, the river under its Tibetan name of Yarlung Zangbo Jinag flow through southern Tibet (China) for about 1750 km eastward and parallel to the main range of the Himalayas. The might river then rolls down the Assam valley from east to west for distance of about 720 km and thereafter, the river swings round the spurs of the Garo hills and enters into Bangladesh. At the Indo-Banladesh border, the river again turns south and continues to its confluence the Ganges near Aricha. The length of the Brahmputra river in Bangladesh upto its confluence without the Ganges is 260 km.

The Ganges rises from the Gangotri glacier in the Himalayas at an elevation of about 701 om near the Indo - Chinese border. From Hardwar to Allahabad, the river flows generally in a south easterly direction and in the lower reaches it flows eastward and enters Bangladesh near Rajshahi. The river flows southwards for a length of about 260 km. and then meet the Brahmaputra near Aricha and flows under the name of Padma

PLATE 1.1


C H I N A
CHINA
BHUTAN
INDIA
WEST BENGAL
LEGEND:
MAP OF THE GANGES, THE BRAHMAPUTRA AND THE MEGHNA RIVER BASINS

The combined flows of the Brahmaputra and the Ganges then meet the Meghna at Chandpur. The lengths of the main river is about 2550 km. The Ganges basin practically covers the whole of the northern India, between the Himalyas an8d the Vindhyas except the state of Punjab and Jammu and Kashmir. Three major tributaries of the Ganges the Karnali, the Gandaki and the Kosi which rise in China and flow through Nepal to join the Ganges in India, provide a large contribution to its flow.[3]

The Meghna emerges from the hills of Manipur in India. At the head stream, the river is known as the Barak. After descending from the hills, the rivers flows in meandering course till it enters Bangladesh. Near the Indo-Bangladesh border, the Barak Bifurcates into two rivers : the Surma and the Kushiyara. The surma and Kushiyara again join together at Ajmiriganj in Bangladesh. The combined flow of Surma and the Kushiyara takes the name of Meghna. It then flows in southwesterly direction to meet the Padma 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 combined waters of the three rivers systems enter the Bay of Bengal through several estuaries collectively known as Lower Meghna estuaries.

The river network of Bangladesh is shown in Plate 1.2.

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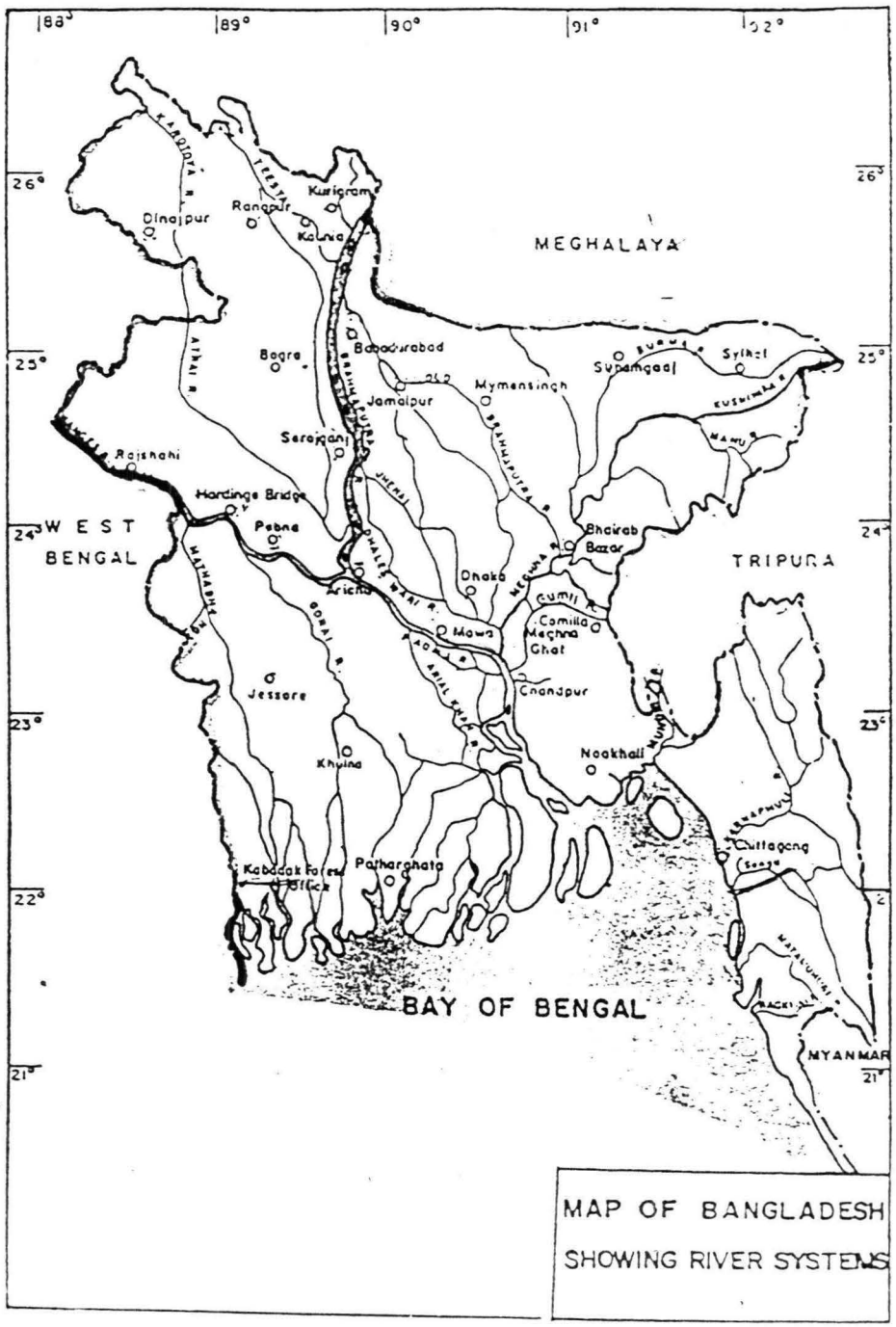
[3] Bhattashali N.K., Antiquity of the Lower, Ganges and its courses (Science and Culture), VII 233-39.

PLATE 1.2


88°
89°
90°
91°
92°
26°
25°
24°
23°
22°
21°
MEGHALAYA
Kurigram
Rangpur
Dinajpur
Kaliya
Bogra
Babadurabad
Jamalpur
Mymensingh
Sunamganj
Sylhet
Serajganj
Rajshahi
Hardinge Bridge
Pabna
WEST BENGAL
Aricha
Dhaka
Bhairab Bazar
TRIPURA
Comilla
Meghna Ghat
Chandpur
Jessore
Khulna
Noakhali
Kabadak Forest Office
Patharghata
Cuttagong
BAY OF BENGAL
MYANMAR
MAP OF BANGLADESH
SHOWING RIVER SYSTEMS

Past History : Migration of Course of the Major Rivers

Anaysis of history of formation of land in Bangladesh indicates that land formation of the country, over the ages, has taken place as logical consequences of the sediment deposit in the flood plains and estuaries of the major rivers and migration of the course.[4] Changes of the land formation and river course are shown in Plat 1.3

In the undated Past

* The Ganges had mainly southward course and was meeting the sea at a point north of the 23° N latitude.
* The Brahamputra was following by the west of the maadhupur highlands and was meeting the sea separate of the Ganges.
* The Kushiyara was meeting the sea separately.
* The coast line was to the north of the 230 latitude.

Prior to 1700 AD

* Course of the Ganges and the Brahmputra were separate.
* The Ganges had a south-easterly course.
* The Brahmaputra was flowing by the east of the Madhupur Highlands.
* The coast line and shifted southwards to sought of the 23°N laitude.

Rennel's Map, 1778

* The Ganges, flowing more easterly, joined the Brahmaputra near the present Chandpur and flowed jointly with the Brahmaputra to the sea.

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[4] Mazumdar S.C., River of Bengal Datta, Published by Caltuctta University, 1941.

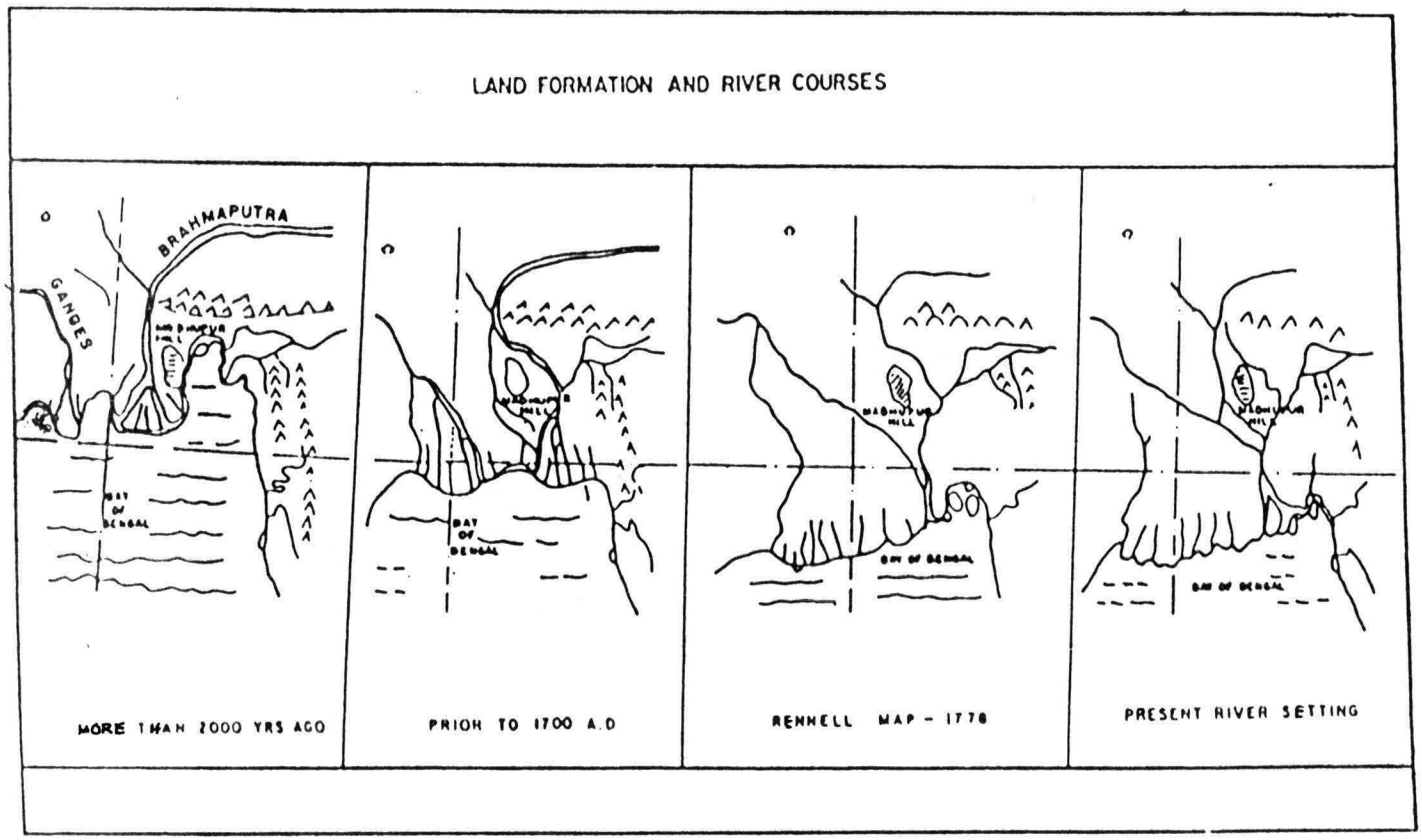
LAND FORMATION AND RIVER COURSES
BRAHMAPUTRA
GANGES
BAY OF BENGAL
MORE THAN 2000 YRS AGO
PRIOR TO 1700 A.D
RENNELL MAP - 1778
PRESENT RIVER SETTING

PLATE 1.3

* The Meghna has joined the Brahmaputra near the present Bhairab Bazar.

Present River Setting

The major rivers of the Bengal basin have been subjected to drastic change, occasionally moving onto the flood plains of other rivers. The course of the Brahmaputra shifted between 1787 - 1830. According to survey conducted by Captain Wilcocks in 1830 and subsequent studies between 1830-1963 indicated that the westerly movement of the course of the Brahmaputra was a consequence of tectonic forces active in the region in conjunction with the fluvial forces associated with the large moving water bodies. The present - day course of the Brahmputra is in equilibrium, since the Bay of Bengal has become a bay with slightly coastal erosion and aggradation of the Brahmputra river has gradually disappeared.[5]

Modern Period

(1947 A.D. to date)

Due to long negligence by the colonial administration the river system reached a "sorry state" by the time the country came out of the British rule. Water loging, drainage,sainity,setting up of the river beds and canal and at times sudden change of course of rivers became the characteristic of the water system in the province. As early as September 1947 the attention of the Government was drawn to the situations of the rivers and rivulets,canals and marshes, ditches and drains which needed re excavation. Innumerable canals and large number of rivers were silted up.

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[5] Willcoks Willian, Ancient System of Irrigation in Bengal, 1940. Published by Calcutta, University.

The situation deteriorated every year. The mouth of the Gorai in Kushtia district was silted up and causing serious inconvience to the people. The natural drainage of the area which existed 50 years ago was closed on account of silting up of the rivers. In Rajashahi, the Baral, the Nagar and the Old Atrai were almost dead. An additionl problem was salinity in the coastal Khulna rivers which needed embankments urgently. Gradual silting up of the Someswari, the Nitai, the Kangsa and the kangra in Mymensingh district resulted in the failure to contain the onrush of water from the Garo Hills as the depth of the river beds decreased over time. As a result, Durgapur, Kamla Kanda, Netrokona and Mohanganj towns were badly flood. Feni district was also affected by flood regularly, whereas the Sadar Thana of Noakhali had to face with the problem of water logging. Regular inundaation of paddy fields followed by rians caused serve damage every year in parts of Begumganj, Ramganj and Senbag of Noakhali.[6]

Large-scale water development in Bangladesh began in the early 1950's. At that time after several years of studies, a team of UN experts proposed the **Ganges - Kobadak Project** lying in the greater districts of Kushtia, Jessore and Khulna. After severe floods of 1954 and 1955 the Government of Pakistan sought the assistance of the United Nations to tackle the flood problems. A team of experts headed by Mr. J.A. Krug, former Secretary of Interior of the U.S.A., visited the then East Pakistan in late 1956. Their report known as the "Krug Mission Report" of 1957 recommended that water resources development was essential for higher agricultural production in the

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[6] Sarkar Jadunath, History of Bengal, Vol II, Published by Dhaka University.

then East Pakistan and that the control of floods the central issue. The Mission, a statutory body named "East pakistan Water and Power Development Authority (EPWAPD)" was created under the Ordinance No.1 of 1959,with the objective of integrated development of water resources of the country and proper implementation of Flood Control,Irrigation and Drainage Projects and Power Development of then East Pakistan.The authority was bifurcated into two separate bodies with promulagaion of P.O No. 59 of 1972, leading to creation of Bangladesh Water Development Board (BWDB) and Bangladesh Power Development Board (BPDB). This was done with a view to undertaking expanded water and power development programmes and speeding the pace of execution of projects. The BWDB has been entrusted with the responsibility of overall development and utiliztion of water resources in Bangladesh. The Board prepares schemes for the whole of Bangladesh or any part thereof providing for all or and of following matters namely:

a) construction of dams,barrages,reservoirs and other original works for irrigation, embankment and drainage channels for bulk water supply to communities and recreational use of water resources;

b) Flood Control including watershed management;

c) Prevention of salinity,water congestion and reclamation of land; and

d) Regulation of channels to concentrate river flow for more efficient movement of water,silt and sand excluding all such as in the opinion operation of the Government may be carried out by any other agency.

BWDB completed a Master Plan for water resources development in 1964,undertook feasibility studies of a large number of schemes for the 1964 Master Plan and initiated follow-up studies and investigations of others.Three types of projects were envisaged: (a) flood embankments with gravity drainage (b) flood embankments with tidal sluice drainage and (c) flood embankments with pump drainage. Irrigation within these flood protected areas was also envisaged but flood control was given a priority in the first stage. The principle that flood control and improved drainage creates opportunity for further development, including irrigation became a basic tenet for water resources planning. Extensive efforts were made to collect basic hydrologic data on the rivers of Bangladesh.

The BWDB achievement of the water development projects during pre-independence period (1959-71) is 87 nos. and during post independence period (1972-92), is 411 nos. Benefits accrued from these projects are :

a)	Area benefited by		
-	Food Control and Drainage facilities	:	3.84,601 ha.
-	Irrigation Facilities	:	771.874 ha.
-	Maximum Area Irrigated	:	4.27,000 ha.
b)	Area reclaimed from sea	:	1001 sq. km. (100,100 ha.)

In the context of increased need for agricultural development, in 1961 the then East Pakistan Agricultural Development Corporation (EPADC Presently BADC) was

created to supply seed, fertilizers, power pumps and other production inputs to farmers with conjuctive objectives the conductive of supporting the total programme.

Irrigation Practices

Small -scale irrigation in the form of primitive lifting devices has a long history in Bangladesh in view of the lack of rainfall during the winter months. As these devices are inefficient and can lift only small quantities of water, the area cultivated in winter through such means had, however, remained small.

Prior to 1960, irrigation in Bangladesh had been largely by traditional methods abstracting water from low lying water bodies and perennial rivers and streams. Agriculture of the country was then totally dependent on the monsoon and subservient to its vagaries. The common traditional methods were Dhoon, Swing Basket and Dug-well. The operation of these methods was done by manual means and these have low lifting capacity. These techniques are still low cost, labour intensive and they do not require imported parts or energy. The decade of the 1960's was open of rising pressure of accelerated water resources development. The distribution program for improved seed and fertilizer proved to be immediate success as did the rental of low lift pumps for irrigation.

Towards the late 60's irrigation became an important concern and minor irrigation started getting attention in the official policies. The other experience in the 60's in respect of minor irrigation was the model development by Akhter Hamid Khan of Comilla Cooperative firm. He introduced the "Thana Irrigation Programme" (TIP) with the aim to use to the fullest extent of the available resources by mobilizing the

local people where Bangladesh Agricultural Development Corporation (BADC) was to give supportive services by setting up workshop in each than to programme to form irrigation cooperatives and install irrigation equipment at suitable sites. It was based mostly on low-lift pump (LLP), but deep tube wells (DTW) were not excluded. A low cost sinking technique of DTWs was also developed. This programme brought about a green revolution in Comillia by the late 60's and the Government decided to replicate the experience in the whole country through an Integrated Rural Development Programme (IRDP) which later became Bangladesh Rural Development Board (BRDB).[7]

Modes of surface water irrigation under non-traditional systems in Bangladesh are mostly.

- Major irrigation-single lift.
- Major irrigation-double lift.

The modes of ground water irrigation under non-traditional systems are mostly.

- Hand tubewells.
- Deep tubewells.
- Shallow tubewells.

The pattern of modern irrigation development upto the present had proceeded in three main phases as follows.

(i) The first phase was Surface Water Development by means of rented low lift pumps during 1950's to mid 1970's. There has been very

[7] UNDP, Banladesh Flood Policy Study (1989).

limited growth in this mode since 1975 because the best sites with access to adequate water supplies have already been developed. Surface water development by major schemes, some of which are double lift schemes using LLPs, has been a significant factor in the contest of growth of irrigation regionally. Experience with the low-lift pump programme indicated that Bangladesh farmers respond quickly when irrigation water was in the dry season. The area irrigated (mostly boro rice) during the winter months growth from nil in 1962 to about 810,000 ha 1996/67 and to 283400 ha 1969/70. The areas irrigated were located along perennial streams where conditions have been relatively favourable. The second phase was of Tubewell irrigation with DTWs in Northern Bangladesh in the mid 1960's under BWDB and became an important factor dur to its rapid expansion after 1975.

(ii) The third phase in the expansion of modern irrigation was brought about by the development shallow tubewells (STW). Between 1978 and 1985 the number of shall tubewells grew from the low base of about 14,000 to 154,000 units. The area irrigated increased from about 50,000 ha to 528.000 ha in 1984/85.

The area irrigated has reached to about 1.90 million hectares by 1989/90. About 87 per cent of that area is irrigated by modern methods including low lift pumps (LLP), shallow tubeless (STW) deep tube wells (PTW) and major canal irrigation schemes of BWDB e.g. Ganges-Kabadak (G.K.) project, Chandpur Irrigation Project (CIP),

Karnafuli Irrigation Project (KIP) and Barisal Irrigation Project (BIP). Irrigation by traditional means declined very slowly until about 1980 when this trend began to accelerate.

The area irrigated by different modes of irrigation during the year 1980-90 are summarized in the **Table 1**. below :

Table - 1

Mode - wise irrigation upto 1989-90

Sl.No. Mode of irrigation	Area in ha.
1. Low Lift Pumps	527,360
2. Shall Tube [illegible]	206,548
3. Deept Tube [illegible]	502,084
4. Major projects	427,000
5. Traditional	238,270
[illegible]Total :	1,901,262

Flood and Flood Management

The floods that occurred over the years between 1947 and 1991 are well recorded. During the period Bangladesh experienced severe flood in 1954, 1955, 1962, 1966, 1968, 1969, 1970, 1971, 1974, 1987 and 1988. In 1987 about 39 per cent and in 1988 over 60 per cent of the total and area suffered flooding.

Bangladesh, has concentrated its efforts towards flood mitigation measures by constructing flood embankment, channel improvement and development of flood forecasting and warning system. Both structural and non-strucutal measures are carried out to reduce the flood problem.[8]

i) Structural Measures

As structural measures for flood mitigation, series of medium and small sized Flood Control and Drainage (FCD) projects have been constructed all over the country. Scuh projects cover about 40 per cent of flood vulnerable ara. Table - 2 shows the statistics of flood protection so far achieved through these projects.

ii) Non-structural Measures

The non-structural measures consists of Flood Forecasting and Warning, Flood preparedness, Flood proofing, Research, Training and Exchange of Technical Expertise.

iii) Flood Management Plans

The catastrophic floods of 1987 and 1988 has demonstrated the inadequacy of the present FCD projects in respect of planning approach. A comprehensive plan of flood management comprising both structural and non-structural measures within the territorial limit of Bangladesh gets priority to meet the requirements.[9] This type of

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[8] Bangladesh - Nepal Joint Study Team Report on Flood Mitigation Measures and Multipurapose use of Water Resource 1989.

[9] R. Rangachari, 'Flood Management', in B.G. Vergese and R.R. Iyer (eds.) Harvesing the Eastern Himalayan Rivers - Regional Co-operation in South Asia, Konark Published, Delhi. (1993).

comprehensive plan comprises experience that has been gained in the planning, implementation and operation of the past projects. Impact on agriculture, socio-economic and environment may provide input in order to guide the design of future projects or in the rehabilitation of existing projects. Involvements of beneficiary from planning stages is now an essential fact.

The catastrophic floods of 1987 and 1988 have caused a change in the attitude of planners and decision makers and the Government of Bangladesh has emphasised that a comprehensive national flood protection programme needs large project aimed at controlling the high deshcarges that come from the upstream catchment. The strategy is, therefore:

a) to accord the highest priority to flood protection;

b) to implement effective flood protection works with emphasis on the need to confine major river flood water within channels:

c) to further riparian cooperation leading to a long lasting solution.[10]

[10] China - Bangladesh Joint Expert Year Report on Flood Control and River Iraining Project on the Brahmputra river in Bagladesh Vol. 3 (1993)

Table - 2

Achievement of Flood Protection

Basin Name	Basin Area (Sq. Km)	Flood Vulnerable Sq. Km)	Area Brought under Protection (Sq. Km)	Area under ongoing projects (Sq. Km)	Residual after completion of ongoing projects (Sq.Km)
Brahmaputra	39.100	26.540	12.733	12.733	9.840
Ganges	46.300	23.165	2.294	2.647	13.224
Meghna	35.000	17.690	6.757	3.004	7.928
South-Eastern Hill Basin	22.378.	6.565	8.13	624	5.128
Coastal Region	--	9.762	9.578	189	0
Total :	--	83.722	28.410	19.192	3.120
Per cent	142.778	100%	34%	23%	43%

Areas bay islands to included.

iv) Flood Action Plan

In the wake of the devastating successive floods of 1987 and 1988 the Government of Bangladesh undertook a comprehensive flood control policy.

The Flood Action plan was prepared by the Government of Bangladesh in close co-operation with the World Bank in 1989.

The Action Plan aim at identification, planning design and construction of high priority projects, which are technically, environmentally and socially feasible. The plan follows a staged approach which will focus on:

- measures to control flooding and impose irrigation and drainage in areas bordering the main rivers, their tributaries and distributaries;

- regional studies of flood control irrigation and drainage together with supporting activities, to provide inputs into the planning and design of the main components of this and subsequent Action Plans.

The Action Plan has been undertaken in parallel with agricultural and other rural development programmes and a programme of non-structural measures including flood warning ad flood preparedness. The plan envisages to develop a pragmatic methodology of involving the beneficiaries of water management schemes in their planning, implementation operation, maintenance and evaluation.

CHAPTER - 2

CHAPTER -2

WATER RESOURCE SITUATION

Introduction

Readily available water for the population used to be regarded as an inexhaustible gift of nature by many people in Bangladesh. But such complacency is no longer warranted by the experiences over the last one and a half decade. The rapid population growth and the consequential increase in demand for water in every sphere of the national life and economy are seriously straining the water resources available in Bangladesh, at the same time leading to deteriorations in the quality of water. As against this, the gradually decreasing supply of surface water in lean season of the year is making the situation ever more difficult.

The annual cycle of water -- from over abundance to scarcity is a dominant factor of life in Bangladesh. During the monsoon (June through Sept.), one third of the entire country is gripped with the calamities of flood every year. But the situation changes entirely during winter months (Nov thought May) when the flows in the major rivers diminish drastically; most of the small rivers dry up, leading to, scarcity of fresh water for use in agriculture, fishery, navigation and industries as well as for drinking and domestic uses. The water availability situation in Bangladesh is unique in its characteristics and nature.

Bangladesh which a total population of over 90 million occupies an area of 143,998 sq km between latitudes latide 20^0 3' N and 26^0 7' S N and longitutides 88^0 0' and 92^0 7 E the country is bounded on the west, north, and East by India and in

extreme south east by Burma. Bay of Bengal lies to the South. About 6% is covered by streams and estuaries.

Bangladesh is one of the biggest delta region with major rivers's passing through its plains, about 90% of their catchment. areas remaining out sides the country.

The deltaic plain of Bangladesh [redacted], with a concentrated rainfall of the over 80%, spread within a period of 4 months creates a seasonal fluctuation from nearly 100% humid climate to dry spell during winter months.

The 4 regions of the country are geographically separated by 3 major rivers -- Ganges, Bramhaputra and Meghna, each having distinct hydrological features. The north west region slopes from north to south with an elavation ranging from about 12 m above sea level at Pabna to about 90 m in Panchagar areas. The atrai basin is a drainage congested area due to the back water effect the of Bramhaputra.

The north east region is dominated by Meghna depression, more commonly refferred to as the Sylhet basin with elvation of 3-6 m above sea level. The region is influenced to a large extent by the backwater effects of the Padma river. The south west region is complicated by poor relief, low gradients and Saline intrusion along its Southern Areas. The South East region commonly known as South East hill basin, is different from the rest of the country having generally elavated relief [redacted] and being independent in terms of hydrological [redacted] response from the major rivers.

Climate and Hydrology

Climate : Typical of the Monsoon climates of Asia. Characterized by high temp, heavy rainfall and exxcessive humidity.

Temp : Mean annual temp throughout the country is 20^{0} c but extreme range from less than 5^{0} to more then 43^{0} c.

Rainfall : It is the major component of water resources planning in Bangladesh. It provides a major share of crop water requirement imposes the need for land drainage and recharges ground water storages. Its magnitude and variability in time and location and in relation to concurrent conditions of flooding, cropping and water table, are very important for water resources planning in Bangladesh. Rainfall in Bangladesh, Originate from 3 sources (1) The Western depressions of winter which account for, less than 5 % of the total; (2) the early summer thunderstorms which accts for about 15% of the total (3) the sources monsoons which account for about 80% and above.

River Systems : The major streams of Bangladesh are the Ganges - Padma the Brhmaputra - Jamuna, and the Meghna rivers. Throughout the areas transversed by these streams scars of old channels are numerous and maps made approx 200 years ago, show that the pattern of stream channel has changed substantially ·Swamps and Marshes in lower Bangal were smaller, and the coast was more irregular than it is today. Such migration and reallignment of channels and the building up and smoothing out of coast lines are characteristics of the delta reaches of large streams.

The Brahma - Jamuna flowing from the North joins the Ganges - Padma flowing from west near Goal undo. The combined flow, known as Padma, flows south easterly to its confluence with the Meghna near Chandpur. South of this junction the combined rivers are known as the Meghna. The waters enter the Bay of Bangal through many estuaries, collectively known as "Mouth of the Ganges".

Of a large number of rivers flowing through Bangladesh, 56 originate out side Bangladesh, including 3 major rivers (the Ganges, Brahmaputra and the Meghna) The remaining rivers are mainly distributaries of the major and Medium rivers. The major rives are briefly described in the following paragraphs --

The Ganges river rises in the Himalaya mountain near the Indo - Chinese border flows, south easterly across India, and enters Bangladesh near Rajshahi. The drainage area of the Ganges - Padma above the Hardinge Bridge is about 976, 200 square Km (UNECAFE, 1966). The 3 trans Himalayan tributaries -- the karnali, Sapt Gandaki, and Sept Kosh from Nepal contribute about 71% of the natural dry season flow and 41% of the total annual flow of the Ganges.[1]

The Brahmaputra rivers rises in Tibet in China on the northern slopes of the Himalayas flow east ward, then turns south and west through India to the border of Bangladesh. At the border, the river again turns south and continues to its confluence with the Ganges - Padma. The Brahmputra has a total catchment area of 60 7, 464

[1] Ministry of Power, Water Resources and Flood central, Govt of Bangladesh - 1978.

sq km lying in China (293, 348 sq kms), Bhutan (54,516 sq kms.), India (186,912 sq mare kms.) and Bangladesh (72,688 sq kms).[2]

The Meghna river is formed by the confluence of the Surya and Kusiyara rivers, aprox 140 kms north east of Dacca. It drains the hills of Assam and Tripura states in India and the north eastern part of Bangladesh. In comparison with the Ganges - Padma and Brahmaputa - Jamuna the meghna river system is small. Its drainage areas above Bhairab Bazar is about 64,500 sq. km's.

FLOOD

Each year, floods in Bangla cover almost a third of the land area and in years of severe flood almost half of country may be under water. The geographical setting, topography, concentration of heavy rainfall in four months of the year with most of the rivers characterized by limited depth, fine sandy bottoms; flat slopes, and meandering and erodible banks make Bangladesh vulnerable to annual flooding of a modest to high degree of severity. The drainage form large catchment areas, if not only three major rivers but also a number of other medium and minor rivers during the monsoon from June to Oct, Leads to concentration of large volume of water in all the major rivers of Bangladesh. On an annual basis, the surface water inflow into Bangladesh is in 999, 124 mcm. and about 90% of this flow comes during the monsoon. Above this, more than 80% of the total annual rain fall (250,398 mcn) occurs during the first four monsoon months (June to Sept). And the only outlet of this enormous volume of water is through this highly over populated flat, deltaic

[2] UNECATE, 1966.

country. Although the smaller severe along the eastern border, lying in the meghna basin and south eastern hill basin, frequently fly carry destructive localized flood, the extensive flooding in Bandladesh each year is principally related to the 3 main river system. The flow in these rivers vary widely between the dry and wet(monsoon) seasons. While the dry season flow in the ganges at hardinge bridge is a 1100 to 1500 M3/SEC, the flood discharge peaks at about 70, 792 M3/SEC in the Brahmputra, at Bahadurabad, the dray season flow averages about 5100 M3/sec while the flood peak sometimes exceeds 84,950m3/sec.

The meghna is a rain fed river while the Brahmaputra and the ganges are both snow fed and rain fed. The Brahmaputara starts rinsing in Mar/April due to snow melt in the himalayas and usually reaches apeak in June/July and reaches its annual peak in late August or early sept when this peak coincides with second peaking of Bramputra,severe flooding usually occur at their confluence and downstream. The Surma and Kusiyara reach their maximum between June and Aug but the Meghma at Bhairab bazar may not reach its peak until Aug/Sept due upsteam storage and back water effect from ganges, Padma which also carries Brahmputra flood. Floods in smaller rivers are much less predicable as to timing since these streams drain the areas of greater rainfall intensity, flood peaks can be proportionately larger, of shorter duration, and more destructive than of the main river.

Flooding in Bangladesh is now viewed as a problem to be solved rather than something which must be tolerated as in the past until international cooperation in controlling floods can by head water storage can be achieved with Bangladesh

neighbour, flood control within the country can only provide a degree of protection against damage[3].

Water resources

From the view of water availability in the country a year generally can be divided into 2 seasons. The dry season (Nov to May) and the heat season (June to Oct). In Bangladesh water resources available situation is unique in its characteristics and complexities.

Surface water

Most of the flow in the river of Bangladesh originate from outside the country. The water availability [redacted] in the river of Bangladesh during the dry season is critically important for its agriculture, fisheries, navigation, forestry, water supply, industries and for checking salinity intrusion in the southern areas[4].

After cessation of the monsoon rains, the rivers of Bangladesh undergo a rapid decrease in flow volume. This usually takes place in late Oct or early Nov, and there after there is continual and gradual recession of flow until the rain recommences. The time of recovery is variable across the country. In the eastern parts, where catchment occupy the hills of Assam, the flow recovery commence in March, thus making February on average the driest month. In the western parts, the flow do not begin to increase until May with April being the month with least mean flow.

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[3] Verghese B.G., R.R. Iyer (eds.), Harnessing the Eastern Himalayan Rivers - Regional Cooperation in South Asia, CPR, Konark Pub Pvt. Ltd., New Delhi, 1993.

[4] Khan, T.A., Water use delta in Bangladesh, ACT, Bangkok, Thailand, 1980

During the 7 months of the day season from Nov To May, the month of Feb to April are the driest in terms of total surface water availability. Of the total average Feb to April inflow in the country, the Brahmaputra contributes 65% and the Ganges 15%. The Meghna and smaller rivers contribute the remaining 20%.

Dry season flow conditions in some of the major and Medium rivers are discussed briefly.

Brahmputra: The lowest flow occurs in Feb, and the discharge increases from March onward to a primary peak in June and July.

Run off during the period is due to snow melt in the Himalayan and the Tibetian plate all plus local run off from rainfall in Assam Basin and Himalaya.

A secondary peak occurs in August - Sept due to run off of the monsoon rainfall. From Sept to Feb the flow steadily decreases.

The increase in discharge early in the dry season gives the river its great potential for supplying irrigation water when flows in the internal rivers of Bandladesh are at the lowest.

Ganges : The annual hydrographs plotted shows a peak in Aug or Sept with flows then reducing steadily through the following April. May Sometimes show only a slight in crease on the April flow but by June they increase significantly.

The natural flows of the Gangesinto Bangladesh, have been considerably modified by abstraction across the border in India, in particular at the FARAKKA Barrage which is located in the Ganges only 18 km upstream of the border of Bangladesh.

Subsequent to the construction of the Farakka barrage, the govt of India, has been in a position to divert a substantial part of the low flows of the Ganges and associated link canal and ([redacted]) to the Hoogly which is designed to divert upto 1130 m^3/sec. The flows of the Ganges available in Bangladesh during the dry season has since then been reduced considerably[5].

In 1977 an Agreement valid for five years was reached between India and Bangladesh for sharing the Ganges flow during the period between Jan 1 and May 31. A Moll in Oct 1982 extended the sharing arrangement for another 2 years up to May 31, 1984, with the exception that Bangladesh was not automatically entitled to a guaranteed minimum share in case of exceptionally low availabilities of the Ganges at Farakka in India there was no sharing arrangement between the 2 countries during 1985[6].

The Meghna: Average annual discharge of the Meghana at Bhairab Bazar was about 4.465 m^3/sec during the period 1965 to 1975. Considering the mean monthly flow, the highest flow in Meghna at Bhairav Bazar occurs in June (10,400 m^3/sec). While the minimal flow in the month of Feb is about 95 m^3/sec.

The Teesta : The mean monthly flows of Teesta measured at Dalia, from Nov to April form 1975 to 1983 are asfollows, in m^3/sec.

Nov	Dec	Jan	Feb	Mar	Apr
386	245	182	159	181	281

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[5] National Water Plan Project, second Interim Report, Vol. 11, Surface water Available Dacca, Bang June 1984.

[6] Review of the '1977 Ganges water Agreement, Ministry of water dev and Flood Control, Govt of Bangladesh, Chanc, Bangladesh, Dec 1982.

Under an adhoc agreement between Bangladesh and India, reached in 1983, Bangladesh is now entitled to only 36% of the Dry season Teesta flows. India would use 39% which the remaining 25% will be apportioned further under a future final sharing agree.

Smaller rivers : Of the smaller waters which orginate out side the country, it is reported that the flows of the Mohananda, Bhairab, Kedala and Selonia have undergone considerable reduction as a result of upsteam ream diversions or blockages across the border. The Dahuk, Tagon, Krotoya a and Gumti and also facing imminent reduction of flows during dry season, due to human interference in the upstream region, outside the country, according to water use Data in Bangladesh 1980.

Ground Water

Besides surface water, ground water is the other major supplier of water in Bangladesh for agricultural, drinking, municipal, and industrial use, Ground water plays a vital role during the dry season and drought periods.

Bangladesh is mainly underlain by unconsolidated sediments ranging in age from tertiary to recent. The sediments are generally thick over most of the country. In general, there are two aquifers in the country: the upper aquifer and the main aquifer. In most areas, these two aquifers are probably hydraulically interconnected. The main aquifer in most parts occurs at depths ranging from less than five meters in the northwest to more than 75 meters in the south.

Ground water levels are highest from August through October and lowest in April and May. A sharp rise in water level generally begins in May and continues

until July. The range of fluactuation is from three to six meters in most areas. After July, the rate of rise decrease, and in may areas ground water levels remain almost stationary from August to October, indicating rejection of recharge because the aquifer is filled to capacity. The rejected recharge varies form place to place and depends upon several factors, including permeability of surface materials, rainfall amount and intensity, and the time factor.

Recharge to ground water occurs primarily through direct infiltration of rainfall. Actual recharge is considerably less than potential recharges, Highest potential recharge occurs in Dinajur, Mymensing, Sylhet, Noakhali, and Chttagong, the lowest potential recharge occurs in Western Bangladesh in Rajshahi, Kushtia, and Pabna.

The ground water reservoir is hydraulically connected to the major stream of Bangladesh. At high stream stage during monsoon, there may be direct recharge into the upper aquifer if there is room for any after the rainfall recharge at low stram stage, there is discharge flor the quifer into the stream into the stream. Upstream diversion of surface water from the major rivers effects ground water levels in Bangladesh ad increases salinity in shall aquifers in the coastal areas due to decreased outflow.

Ground water qualify in most areas of Bangladesh s suitable for agricultural, domestic, municipal, and industrial purposes. Iron and hardness are locally excessive. Water quality generally deteriorates southward.

Estimates of Ground Water Resources

Since independence, there have been number of investigations and studies in Bangladesh on the resources and potentials of ground water in the country. Perhaps due to lack of adequate data. there are wide variations between different estimates, However, a picture would emerge if the three latest estimates made by three different agencies/groups in the country are looked into.

a. According to estimates made in report of May, 1984, on Upzila wise recharge conditions of Bangladesh (prepared from the ground water investigation circle of BWDB), the total available recharge on the basis of an average recharge being 159mm/unit area, is 14,802 mcm over 92,960km^2. Of this amount, lithologic and water quality data indicates that about five percent of the total available recharge water may not be used for poor aquifer conditions and water quality hazards. About 10 per cent should be allotted for future, increase demands for domestic, municipal, and industrial water supplies during dry months. As such, there remains only 12,458 mcm of ground water for use in irrigation, Minus the present utilization, the potential for further developments is limited to only about 3,800 mcm.

b. According to the Third Interim Report of the Master Plan Organization (MPO) of December 1984, the ground water resource potential is 32,727 mcm, of which potential for future development was estimated

as 21,728 mcm. This estimate is however, a major departure from all previous estimates made in the past.

c. An estimate by a group of local experts (unpublished report, 1984) indicated the total GW resources, in an 80 per cent dry year at about 20,726 mcm, with a potential for future development of 9,727 mcm.

The above three estimates show how poor and widely variable are the estimates of potential recharge of ground water in Bangladesh. Without further extensive investigations and studies it is not possible to correctly quantify the ground water potentials of the country.

WATER USE

Domestic and Municipal:-

About 90% of the total population of Bangladesh is rural. In the village, the domestic and live stock water requirement is met from the rivers, khals, beels, ponds, and open wells. Hand tubwells and dug wells are used in some places for supplying drinking water.

Municipal water requirements in the large cities and urban areas are met by pumping ground water. The Dhaka water supply system is showing serious problems to a abnormal lowering of the ground water table and inadequate recharge during monsoon season.

Agriculture : It is the major user of water in the country. There are about 9.12 million hectare of land under cultivation out of total available 9.92 million hectares of cultivable land. Under present condition. only 20% of the cultivable land has been

brought under irrigation. During the dry seasons, large areas remain often fallow or under low yielding crops due to lack of water. Water for irrigation has mainly been supplied by surface and ground water. Of the existing major surface water irrigation projects, notable ones include G- K Project, Chandpur Irrigation project, and Karnaphuli Irrigation project. But none of the 2projects could yet be fully commissioned as they were originally envisaged. 3 more phases of the G-K Project still remain to be implemented for want of adequate dry season supply of water in the Ganges. Of the projects which came up later were Teesta Barrage project, Manu River Project, khowai Project Pabna Project Meghna - Dhonagoda Project.

Also several low lift pumps are being used for supplying water for Irrigation. Moreover there are many smaller surface water projects under planning and implementation[7].

There has been a very rapid expansion of Ground Water exploitation for Irrigation since 72, through hand tube wells, shallow tubewells deep tube wells (varying in capacity). Estimates indicate that tubewell irrigation can serve a maximum of 15 to 20 acres per cusec. Use of Ground Water for irrigation is about 82% of the total Ground Water extractions in the country 73% of this around is derieved from deep tube wells and remainder from shallow tube wells.

According to Bangladesh Bureau of statistics (jan 1985) areas under irrigation by different means during 82-83 are as follows.

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[7] USAID / Dhaka, An Assessment of Agricultural Sector in Bangladesh, Dhaka, Bagla Aug. 1983.

Power pump	--	746,802
Tube well	--	411,984
Doon	--	293,644
Swing basket	--	85,020
Canal	--	180,607
Other (in hectares)	--	150,729
Total (in hectares)	--	1,868,785

Industries :- The major uses of water in industries and manufacturing are for cooling, processing, boiler water and general purposes. Cooling is the principal purpose of withdrawl and commonly accounts to as much as 60 to 80% of total industrial with drawls. No firm estimate is available on Industrial water uses, but rough estimates indicates industrial use of water in the country in the amount of 30 m/cm. Very often, since 76, the industrial belt in the Khulna region has faced difficulties with the supply of water because of deterioration in quality due to increased salinity in river waters.

Navigation : There are nearly 8,000 km of navigable water ways of different categories. In land Navigation contributes a major share in the handling of goods passengers in Bangladesh. During dry seasons, the navigable waters goes down by more than 50%

Checking Salinity Intrusion

The salinity limit in the Southern REGION OF Bangladesh is checked and maintained by the combined flowers of the Ganges, Brahmaputra and Meghna. Any reduction in the flows of these rivers allows salinity to escalate and penetrate deep in

land. The salinity of the Khulna region is heavily dependent on the flows of Gorai a major distributary of the Ganges. During Dry Season the Khulna has salinity of 14,000 to 18,000 micromhos in place of 500 to 1,000 micromhos. This occurred when the discharge of gorai was cut down, as result of abnormal reduction of Ganges flows at Hardinge Bridge.

Studies and Estimates indicate that a combined flow of 2,582 m^3/Sec is required to meet the demands of lower Meghna Channel for salinity control.

IMPACT OF REDUCED FLOWS ON WATER USE

The reduction of dry seasons Ganges flow since 1976 caused lowering of the ground water table by 0.5 to 2 m from the normal limits along both the bank of Ganges, Mahananda and Gorai Madhubati. The salinity limit in S-W region penetrated 100 miles further inland and reached as for as Kamarkhali at one time. The navigability of major water routes in the Ganges and Gorai Madhumati was reduced significantly. In the Sundarbans the largest mangrove forest of Bangladesh, the reduction of upland fresh water discharges has created a critical situation and is threatening the delicate ecosystem of the region. The production of fish has also fallen sharply. The reduction of flows of other smaller rivers is causing adverse effects on agricultural practise and water supply situation of varying magnitudes in the areas dependent on the waters of the rivers during dry season.

APPROACHING WATER RESOURCE DEVELOPMENT

The development of water resources is multi-dimensional challenge. Water is a fugitive resource. It tries to elude everybody. Appropriate technology is necessary

but not a sufficient condition for the optimum utilization of water. Water encompasses the entire gamut of a nations life. There can, therefore, be no piecemeal solutions for the problems of this sector. These problems are not, always confined to national boundaries. The hydro logical link that bind nations in abiding ties very often transcends political frontiers.The harnessing of water resource is not merely a technical problem the political dimensions are equally important.

Water is becoming increasingly scarce. The diffusions of high varieties of crops is contingent on timely availability of water. The development of water resources has therefore assumed special urgency in Bangladesh where absolute poverty blights the life of 2/3rd of her population. The ever increasingly with drawal of water from transnational rivers has not only disrupted her traditional ways of life but also impeded the development of agriculture. There is therefore the need for

1) Long range planning in water sector.
2) Integration of technical and non technical aspects.
3) Need for systematic, accurate and comprehensive data base.
4) Need for equitable share of transnational water.
5) Need for formulation of effective and acceptable water laws and codes.
6) Need for development of national water policies in the light of aspirations of the people.
7) Need for ensuring the quality of water.

The withdrawal of water from transnational rivers and aquifers should not bea zero sum game where one party's loss is the gain of the other party. Water resource should be developed in a manner which is beneficial to all co-basin states.

REGIONAL WATER RESOURCES SITUATION

The management of water resources has influenced the history and culture of the Asian region in many ways. All of the ancient civilizations and major settlement flourished along the river banks or in the vicinity of water bodies. Albeit, the availability of water resources has been a necessary condition for survival and, growth, many civilizations have perished due to improper use of water resources.

In contemporary world development, water resources continues to occupy an area of prominent concern, this despite the fact that only a very small fraction of the total volume of water constitutes fresh water readily available for use. Globally out of the total vol of water amounting to 1.4 billion cubic km more than 97.3% is ocean water and only 2.7% is fresh water that can be productively withdrawn for agriculture, water supplies and other uses.

Ground water is an important component of fresh water resources. Except for Europe, part of North America, and small parts of Asia, the availability of ground water, resources is not w ell established.

Globally only 0.1% of the total reserve of ground water have conditions favourable to their exploitation and role in hydrological cycle.[8] Water quality is not

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[8] Khan, Tauhidul Anwar, Water Resource Situation in Bangladesh, Problems and Prospects, Regional Symposium on Water Resource Policy Agro-Socio Eco Dev Dhaka Aug 1985.

uniformly good even for this small quantity of ground water. IN several cities and rural areas, its exploitation far exceeds, recharge and results in ground subsidence. Additionally in case of excess ground water with drawl, there may be seawater intrusion if the ground water aquifer is connected to sea water. Such an intrusion makes the fresh ground water saline and water becomes unfit for several uses. Such developments have taken place in Bangladesh.

In same cases also surface irrigation increases the leaching of salts resulting in salinization of ground water, making it unfit for dinking and ground water irrigation.

WATER QUALITY

Sources of Aquatic Pollution Degradation of the aquatic ecosystem is a serious environmental problems. There are several cases for such degradation. The stretches of rivers located immediately downsteam of major towns and cities are polluted mainly due to domestic and industrial sources, Coastal area near centres of population. industries or heavy seatraffic are, contaminated by domestic and industrial pollution agriculture run offs and oily mixtures. In the case of offshore marine areas. the effects of pollution are still minimal with the advancing technology and in creasing population in addition to the rising use of the resources of the sea, degradation of aquatic environment is bound to increase in the future unless remedial measures are taken on a large scale.[9]

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[9] Nishat, Ainun, and Chaudhury, and Chaudhury Kabir, Water Quality Problems and Need for Integrated Control in Bangladesh regional Symposium an Water Resources Policy, Dhaka 1985.

Domestic sewage is an important source of aquatic pollution. It has been severely exacerbated due to the increase in the regions population. In most of the countries more than 80% of BOD. In the inland water near Urban centers, is on account of domestic sewage.

Industrial pollution is also becoming increasingly serious because there has been an increase of 130% in Agro industrial 450% in manufacturing and 20% increase in mining of gross domestic products. Oil pollution is mainly due to tanker washings and accidents Physical pollution from silts, sedimentation and erosion is probably the highest. The minning and dredging of beaches, sea bed and river bed, thermal and nuclear bar pollution and pollution generated by pesticide and other inorganic chemicals are also causing a serious detriment to the aquatic environment.

Because of the diversity of human influences on the one hand and the quantity of quality of fresh and marine water resources in the region, water quantity varies considerably even within the boundaries of the individual nations.

Several positive measures have been undertaken by these countries in containing aquatic pollution. Almost all the countries implemented programs promoting the IDWSSD, 1981-90., according to which sewage and sewage treatment facilities were being augumented.

With the implementation of this program, the organic pollution entering the water courses were reduced to a great extent. Though there are a number of success in containing the water pollution, a more concentrated effort is required to free rivers and lakes in Bangladesh from the scourage of pollution.

TOWARDS RATIONAL WATER RESOURCES MANAGEMENT

With increased economic and social development effort an one hand ad demographic pressures on the other, not only is the demand for water rising but its quality is also deteriorating. There are serval development option relating to water in the contemporary world. It has inevitably resulted in conflicting demands for the same body of water, and resolution of these conflicts assumes an important dimension in water management policies and strategies. There is apparantly need for a comprehensive approach to the whole question of water conservation, control and use. All these efforts should essentially lead to more efficient use of water resources and result in optimum benefits in the overall socio-economic context. The integration of this complex system can be secured through a systems approach which can take into consideration the inter relationship among all variables. The objectives of this system approach.

a) Conseveration of water resources.

b) Their wise, efficient and balanced use.

c) Control of the behaviour of water such as flood control, erosion and sediment control for reducing social distress and for achieving socio-economic development.

Water Resource Planning

Water resources planning provides a co-ordinated approach to the investigation development and management of water resources viewed in this perspective, its aim

is to cover a number of purposes or functions involved in conservation use and control of water. Some of these functions are listed in the table below:

Some of these are complementary to each other, while others are competitive exhibiting some degree of conflicts. Table below can show some potential conflicts. These conflict can be taken care of to some extent by adopting and implementing a national water policy. the main objectives of which are to undertake comprehensive water resource planning and to rank order the different kind of water uses.

NATIONAL WATER POLICY

Development and Management of water resources need to be planed and implemented in the context of a national water policy. This policy would be an integral part of and in line with the national socio-economic development plan.

Within each country, the type of development and priorities ascribed to different water uses might vary from region to region, but there are certain common features and general principles which should be applicable in most cases and which taken together would provide useful framework for water use and management.[10]

[10] Vohra, B.B., Issues in Water Management, New Delhi. INTACH. Jan 1987.

Table : Water : Uses and Controls

Use

Supply	1. Community water supply. 2. Industrial water supply 3. Agriculture etc.
Flow	1. Waste water reception 2. Hydro power
Institution 1) Navigation 2) Fish and wild life 3) Recreation	
Control	1. Flood control. 2. Erosion and Sediment control 3. Pollution abatement. 4. Aquifer recharge 5. Impoundment. 6. Watershed Management 7. Induced Precipitation.

CHAPTER - 3

CHAPTER 3

WATER RESOURCE DEVELOPMENT IN BANGLADESH

Bangladesh has an area of 14.29 Million hectares, lying in the delta of the worlds 3 great rivers -- the Ganges, the Brahmaputra and the Meghna of which 8.6 million hectares (60%) are cultivated.[1]

Food grain self sufficiency has emerged as one of the major policy objectives in Bangladesh. The populations growth rate had generally surpassed that of food production in recent years. Necessitating the annual imports of more than 1.6 million tons of the grains -- a serious difficulty in a country which depends primarily on agriculture. Consequently the overall development program particularly agro investment had been geared to a food grain self sufficiency objective. In this context the govt of Bangladesh has perceived that activities should focus more on irrigation investments with immediate impact on food grain production.

Agriculture is the most sector of important Economy. According to BBS[2], the agriculture sector, which includes fisheries, live stock and forestry accounts for about 4.6% of GDP, employs 70% of the population and provides the base for more than 90% of the country's exports.

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[1] Verghese B.G., Iyer R.R. (ed.) (1993). Harnessing the Eastern Himalayan Rivers, Konark Pub., New Delhi.

[2] BBS, Monthly Statistical Bulletin, July 1983.

Bangladesh is predominantly an extremely flat delta built up by 3 major rivers of the area. Many swamps have been formed in the delta building process and peat has accumulated in marsh tracts.

The nearly flat topography which is ideal for agriculture is prone to drainage and flood control problem under the prevailing rainfall pattern and river regimes. Most of the countries lies less than 20 meters above mean sea level. The highest part of the flood plain, on the north western border is about 90 meters above mean sea level. The coastal tidal land and as well as the lowest part of sylhet depression lies only a meter above seal level.

The complex differences in elevation are important in planning drainage and irrigation, especially because they are usually associated with important differences in social permeability and associated crop suitability.

A number of constraints are inherent in the monsoon rainfall and climate patterns. The 5 to 6 months dry seasons restrict the cultivation of perennial and annual dry land crops to soils with superior moisture - holding capacity, found only in the limited areas, or to irrigated land. Uncertainty of pre monsoon showers causes variations in Jute acreage and yields while cloudiness imposes limitations in Monsoon seasons production, thus encouraging various crop diseases which make it difficult to harvest, dry, store and transport crops. Finally monsoon season cloudiness reduces the yield potential of most rice varieties below what can be achieved in the sunny dry season.

Irrigation Development

Various Irrigation Methods

For generation the people of Bangladesh have practised irrigation using various traditional devices such as dons, swing baskets, dugwells and even earthen jugs. An estimated 0.49 million Ha are now irrigated by these traditional devices. The first form of mechanized irrigation was initiated about 30 years ago with the introduction of a low lift centrifugal pump (LLP). At present about 66,500 ha are irrigated by LLP. Due to the limited availability of surface water[3], both shallow and deep tubewells are used to tap the ground water for Irrigation. Approx 656,000 ha presently are irrigated by tube wells the deep tube wells (DTW) and shallow tube wells (STW).

In addition about, 150,000 ha are irrigated by large scale irrigation projects In such projects water is lifted from rivers because of the very low water levels during dry seasons. These comprise the most expensive irrigation projects in Bangladesh.

The Bangladesh water Development (BWD) and the Bangladesh Agricultural Development Corporation (BADC) are the two major agencies that plan ad implement water development projects.

Small scale irrigation projects are being implemented through the (RWP) Rural works Programme and Bangladesh Crash Bank (BKB) BWDB mainly implements large scale irrigation projects while BADC is concerned with LLP and Tube wells. These organizations are responsible for creating irrigation facilities.

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[3] Excluding major rivers like Brahmaputra, the Ganges and the Meghna. Development of these , major rivers will require high costs.

Irrigation based on Ground water

Ground water is the principal dry seasons source of water available in many areas of Bangladesh. It is generally utilised where irrigation from surface sources is, difficult or impossible and water demand is high. The area irrigated by ground water was planned to increase 5 fold between 1980 and 1985. and to account for about one half of the total are one half of the total area irrigated in order to achieve " balanced development, if not if not otherwise barred by physical constraints"[4].

Ground water planning and management in Bangladesh is at a critical stage the period of rapid exploitation started in 1972; since then the number of irrigation wells has in creased from 1,800 to over 309,000. The annual increase in irrigation well number has not be constant but growing at a compound rate in excess of 40% doubling. The consequences of such rapid growth rates -- donating of irrigation well numbers between 80-81 and 82-83 are now apparent. In the RAJSHAHI district irrigation table equipped with (STWs) in 1982 were reported to be incapable of pumping due to increased seasonal decline of ground water levels. In 1983, suction lift pumps in both irrigation wells and HTW's were running dry in some area in both the Northwest and North East.

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[4] Planning commission SFYP, May 1983, p.164.

[5] MPO, "Second Interim Report" June 1984, p.9-3.

The situation became so serious in the Rajshahi District that Agricultural credit I project was stopped for 8 upazillas and was regarded by world Bank as being dangerously over exploited in Nov. 1983 [6].

The Bangladesh Bank recognized a similar problems in Bogra Distt and stopped STW credit in additional 6 upazillas in Dec 1983. The 1983-84 national sales target of 40,000 STW's has not been achieved only 12,000 units were sold by May 1984, in what was formerly a demand led market[7]. Taken together, these facts have been interpreted as indicating that the limits of ground water resources in same areas has been reached and that its development prospects in future are poor[8].

Irrigation Based on Surface water

On an annual basis large amounts of water enter Bangladesh. The average annual surface water inflow into the country is 107 Mha [9] and the average annual rainfall in 25 Mha-m, a total of 132 Mha-M. Linth a gross area of 14.29 Mha, the country received about 9.23 ha-m (about 30 feet) of water per year. The average annual evaporation is about 1140 mu (45') over the gross area. Thus, 65% of the rain - only a little more that 12% of the total valume of water entering Bangladesh cannot be used for agriculture and virtually all the rest flows the sea.

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[6] MPO, "Second Interim Report" June 1984.

[7] Gill, G., "The Demand, for Table Equipment in relation to Ground water availability in Bangladesh", BARC, Nov., 1983.

[8] UNDP, GROUNDWATER SURVEY, The Hydrogeologic conditions of Bangladesh, "New York, 1982, p.7.

[9] IBRD, The Land and Water Resources Sector Study -- Bangladesh, Vol. II, p.6, 1972.

This annual picture conceal the important fluctuations during the course of a year. The average rainfalls over most of Bangladesh amounts to only 7-11 mm during November through March (the minimum rainfall is zero, during the period) which is in sufficient to sustain crops. In addition, the flows in the rivers are significantly reduced during this period of low rainfall. Water supplies are needed during Nov and May for agriculture as well as domestic and industrial purposes, and to maintain river debts which allow adequate navigation, thus avoiding damage to fisheries and limiting the inland penetration of sea water. These are conflicting demands and the division of scarce winter water among them is the crux of the planning task associated with the "low flow" problems. Upstream uses have an important effect on water availability and ecology of the coastal areas.

Large volumes of water are required for irrigating crops in the Non monsoon season and for the control of seawater intrusion. Navigation requires the maintenance of minimum water depths and widths in streams used for that purpose. The requirement for fisheries and municipal domestic and industrial supplies, while significant are smaller and less conc by area than those of irrigation or control of sea water intrusion. The aggregate demand for these various purposes, however must be met over space from rainfall surface water or ground water.

The time distribution of rainfall and surface water posses problems because of the huge excess of water during the monsoon and the lack of rainfall and surface water during winter and spring months. Surface storage potentials are virtually nonexistent within Bangladesh.

The stream flows in the Brahmaputra and Ganges are about four times the total stream flows in other rivers in the country. The primary surface water development potential in Bangladesh, in therefore in the development of stream flows in the Brahmaputra and Ganges rivers.

Food Control

Although the annual flood affected area varies between about 2.4 million to 3.8 million ha the area subjected to flood over a period of years is much larger[10]. This occurs because the localities affected from year to year are not the same, and different areas are inundated depending on the distribution of rainfall coincidence and magnitude of river peaks and tides in some areas. The flood vulnerable area comes to nearly 6.8 million hectares, out of which 5.6 million hectares are cultivated.

It means that at one time or another, close to half of the area of Bangladesh is flooded. Although the floods supply water for AMAN and boro rice crops in some areas, with the people adapting their living and farming habits accordingly, still the floods in other areas damage crops and property, curtail crop productions and sometimes causes loss of life.The impact of flooding results not only from the actual flooding event but also from its uncertainty whether in terms of area dept, duration on time of recurrence. Because of its overbidding impact, a better knowledge of floods

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[10] IBRD, Bangladesh land and water Resource Sector Study, Vol III, The Flood Problems, 1972, p.5.

and associated drainage problems and of means to manage them, is essential to the long run development of Bangladesh.[11]

The villages are used to the normal flood' and the crops grown are adapted to it. However it does restrict the cropping in some areas and in some years there are abnormal floods which do a great deal of damage either because of their timing duration or extent. It there is an early flood, it can ruin young rice and jute plants in the field or destroy seed beds. Moreover floods of unusual height drown short stemmed rice plants on inter mediate and retalively high lands. Apart from crop damage floods also knock down houses erode road embankments, accelerate river bank erosion and result in loss of life.

The production of Aman Crop did not increase during the last decade. This crop is cultivated during flood season. Almost a stagnant production level for aman means that the return from the extensive flood control embankments are not adequate.

Earthen embankments are normally used to provide protection against floods and tidal inundations. Flood embankments are constructed either along one or both banks of rivers.

In the absence of embankments floods cause maximum damage to crops in low lands,where as the higher and medium lands benefit from it.

Silt deposition in the low lands improves the infertility of the soil. If the timing is not improper, farmers welcome shallow floods. In the embankment areas the

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[11] Rogers P.P. Lydon and D. Seckler (1989), Eastern Waters Study, Strategies to Manage Flood and Drought in the Ganges - Brahmaputra Basin, USAID/ISPAN Virgnia, U.S.

medium and highland suffer due to shortage of water. That is why farmers have cut flood embankments to achieve inundation of their agricultural lands by silt laden river water. Moreover Monsoon run off accumulates in low lands causing floods. Assume the river stage is high, it is not possible to drain the low pockets by gravity.

Pumping is the only method of drainage of low lands during monsoon season unless improved controls of water levels are maintained for agricultural lands of various elevations (high, medium and low).

In a typical upland polder, the higher land will need greater amount of supplemental irrigation where as the lower lands require drainage, which may not be possible without pumping.

As long as we are unable to provide necessary level of controls for high, medium and low lands, fewer flood control programmes need to be undertaken.

Water Resources Planning

Water resources development activities in this sub continent started more than a century ago. Some of the earliest modern irrigation systems are located in India and Pakistan. In both these countries gravity systems get preference over lift system.

A gravity system operates around a barrage a gaited structure used for pumping water. Where as lift system utilize large pumps for punpray water from rivers at low stages. Initial expenditure are higher for barrages but the maintenance and operation is cheaper and easier. It is difficult to operate large pumps, spare parts have to be

specially ordered. BWDB had difficulties in operating the large pumps of the G.K.Project at rated capacity.[12]

Instead of choosing a technology, which is performing adequately in neighbouring areas. Bangladesh decided to choose a technology which needs higher levels of technological capabilities.

BWB, is empoldering the whole country the coastal areas will prove useful if the embankments are aligned properly and an adequate number of drainage and flushing sluices are provided.

There is serious siltation problems in the South west region due to improper planning of polers. Large areas in Shathira and Khulna are suffering from water logging due to siltation of drainage canals. Source of these problems can be rectified by relocating embankments along major channels and developing improved internal drainage systems.

Similar concepts of confining rivers by embankment may not be appropriate for upland and central areas. Confinement of rivers will cause siltation of river beds and higher flood stage, Gumti in Comilla and Khowar in Sylhet are two good examples We should allow floods to deposit silt and clay on land, raising their levels.

In the planning of very few projects, were surveys and or studies undertaken to find out the requirement of farmer. Mainly engineers decisions and designs were

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[12] Verghese B.G., Waters of Hope, Oxford and IBH Publishing to Pvt. Ltd., New Delhi, 1990.

imposed on them. Farmers should not be under estimated. Through manual lifting, farmers are irrigating about 0.4 Mha without any government investments For small scale projects farmers are the best source for hydrological ad agriculture information. They are also managing a large number of hill streams and smaller rivers by constructing temporary earthen dams.[13]

Farmers are ultimate users of the facilities and so their requirements should be fulfilled.

Agricultural land use in Bangladesh depends on, among other factors, on land elevation, soil type, locations relative to water source and flooding possibilities. Elevations of lands many vary by several feet over a medium sized area. That is why there are considerable variations in the planting dates and cropping pattern over a small area and also why the crop calendar is so complicated, making farmers, participation in the planning stage a necessity for successful functioning of water development projects.

Land is a very scarce resource for Bangladesh while there has been an increase in cultivates and total cropped area over the past decades, in no way, has it kept pace with population growth. Thus serious attention should be given to land conservation. Projects should be planned and designed to put minimum amount of land out of cultivation.

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[13] Md Ali, Radosevich, ed. Water Resources Policy for Asia Dhaka, 1994.

Table 13.3 EFFECTS OF FLOOD EMBANKMENTS.

Land Elevation	Without Flood Embankments	Flood Embankment
1. Low	1) Monsoon crop suffer badly or not possible due to flooding. Flood deposit thick layers of silt. Ground water recharge is good. Boro'is good to excellent. Irrigation for BORO is local. Fishing is good Excellent transportation by boat.	Monsoon crop good and needs supplementary irrigation and drainage : - No silt deposition ground water recharge is fair Boro needs more irrigation an fertilizer Fishing is poor No boat transportation
2. Medium (Low)	2) Monsoon crop is average due to medium flooding, aman grows but yield is lo Siding is fair ground water recharge is good.	2) Monsoon crop is good but Boro needs full irrigation.
3. Medium (high)	3) Monsoon crop is good only with supplementary irrigation Bodo fully depends on irrigation.	3) Monsoon crop needs supplementary irrigation Boro is fully dependent on irrigation.
4) High	4) Monsoon crop is average to poor supplementary irrigation would improve it. Support irrigation by LLP would be possible.	4) Monsoon crops not possible without simple irrigation by Tubewells.

1. H.R. Khan, "Environmental Consequences of water Development Projects' Rutgers University June 1985.

Towards a National water Plan in Bangladesh.

Water assumes a unique dimension as a resource in the riverine delta of Bangladesh, where national life for more than 80% of the population hinges on this resource. The economy of the country is essentially agrarian, with the contribution of agriculture to GDP. Inland Navigation through the numerous water courses is still the major means of transportation for men and cargo over a large part of the country.The water of the rivers, channels and the flood plain produce the. required tons of fish an important source of protein in the peoples diet. Over and above this a large quality of fresh water is needed by the estuary during the dry period to prevent the penetration of a salinity front from the bay and to maintain ecology and environment.

Traditionally, water used to be considered free goods endowed in abundance by nature but developments outside the country have led both to conflicts and consequent shortage of water among different water use sub-sectors and to the realization that water is a scarce resource. Development which is likely to intensify even more in the future, would further aggravate this situation. In addition un co-ordinate development efforts have resulted in undesirable overlap, encroachments and unnecessary duplication by various water use agencies.[14]

Because of variation in the temporal and spatial patterns of the occurrence of water, the development characteristics of traditional agriculture are its adaptation to climatic and environmental hazards and minimization of risks.[15] This is primarily why agriculture would not be modernized to the extent desirable to meet the food grain demand of an in-creasing population Nearly, every government effort, aimed at the well being of the people includes, as a major dimension investments and

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[14] Chaudhury, M., and Siddiqui M.H., Towards a National Water Plan in Bangladesh. Regional Symposium in Water Resources Policy, Ddhaka August 1985.

[15] Verghese, B.G., Iyer R.R., Ahmed Q.K., Pradhan B.B., Malla, S.K., Converting Water into Wealth, Konark Pub., New Delhi, (1994).

programs to manage water resources. Imports due to chronic food storage and relief and rehabilitation works after the recurrent flood damages usurp a considerable amount of financial resources, thus impeding development in other sectors. Abundance in one season and scarcity in another result in conflicts which call for comprehensive and coordinated planning.

NEED AND PURPOSE OF A NATIONAL WATER PLAN

The annual cycle of weather from over abundance to scarcity is a dominant factor of life in Bangladesh Patterns of activity in crop production , fisheries and transportation bellow this annual cycle. Public health problems intensity or diminish with the cycle. Overlying this cycle are the trends of economic and population growth that place constant pressure to increase production from the fixed land base.[16]

In response to these demands, the government of Bangladesh , in co-operation with numerous donors continues its long standing policy of directing a major share of each annual development budget to agriculture and water sector The 1964 Water Master Plan, which dealt primarily with the agricultural sector and emphasized large flood control and drain age works has long been inadequate as a complete framework for water sector planning .The IB&D review of the 1964 plan and the 1972 IB&D Land and water resources sector study provided guidance to water development strategics in the 1970's .But a great deal of new data has been gathered Since these documents near prepared, and these documents no longer have sufficient long range perspective to guide decision making in the mid 1980's.

The opportunities for low cost, quick yielding investment programs advocated called in these documents are gradually diminishing. The gradually ministering. The decade of the 1990's is seen as one when major efforts have to be concentrated on production of more water by identifying new sources. This simply implies massive flood control, drainage and irrigation (FCDI) projects along the major rivers as the

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[16] M.P.O., National Water Plan, 1985 - 2005 Minority of Irrigation, Water Development and Flood Control Incorporation with UNDP and World Bank, Dhaka Dec. 1986.

scope of easy draw water and simple technology in shallow, flooded areas is exhausted over time. The objective of flood grain production has bene seen in recent years as so imperative that the water sector investment program is completely dominated by agricultural investments. Not only have investment funds been channelised away from other sub sectors, but project design has largely ignored negative impacts and conflict with other water users. For example, the rapid development of ground water in some areas by agricultural and the public health sector has began to create problems for suction pumps which can only tap the shallow aquifer. Number of hand pumps and suction pumps cease to function during a part of the dry season.

A range of remedies based on technological innovations, regulations and policies may be adopted to overcome this problems, but coordinated across development programs and sectors is desirable.

Limitations on the water resources of Bangladesh during the dry season are becoming more completely quantified as they become more evident withdrawals of surface and ground water for irrigation in Bangladesh and diversion of river flows for irrigation and other uses in India, have had sufficient effects, particularly the diversion of Ganges flows to show that the untaxed for water resource planning and development has shifted form that of earlier plans, and it can be expected to continue to shift. Development pressures on water resources will continue in Bangladesh and in the nations upstream.

The number of agencies responsible for water development in Bangladesh is large and the types of agencies are varied.

In planning their programs, these agencies receive some guidance from GOB, but the coordination among program is frequently in adequate No agency, or program until recently has been established, nor has any comprehensive plan been prepared, to coordinate these efforts.

The need for a new, more comprehensive and multi sectoral National water plan has been widely recognized by GOB.

OBJECTIVES AND PRINCIPLES

The objective of the NWP is the development of water resources to.

a) Maximize the net value added in agriculture and fisheries and thus make the greatest possible contribution Economic growth.

b) Provide adequate water supplies in time and quantity for domestic and industrial users, navigation, salinity control and environmental management.

GENESIS : - The decade of the 1960's was one of raising pressure to accelerate water resource development.

The East Pak Agricultural Development Corporation (EPADC) Programs to distribute imported seed and fertilizer had met with immediate success, as had the use of low lift pumps for Irrigation.

THE EAST PAK WATER AND POWER DEVELOPMENT AUTHORITY (EPWAPDA) had completed a master pan in 1964 water development and under taken large number of schemes and follow up feasibility studies and investigations based on follow the recommendation of the master plan. These included .

1) 0.95 Mha coastal Embankment project.

2) 0.24 Mha Brahmaputra Right Flood Embarkment, the Ganges - Kobadak and Dakha - Narayanganj Demra irrigation and a number of regional drainage improvement schemes (Old Dakatia, Little Feni river, Faridpur and Noakhali). A multi purpose storage project on the Karnafuli River located in the Chittagong Hills was completed with an initial installed capacity of 80 mw with a project undertaken to increase that to 120 mw with a third unit.

The 1964 EPWAPDA Master Plan envisaged flood protection for 5.8 Mhw of land mainly by means of polders

Two types of projects were envisaged-

a) Flood embankments with pumps drainage.

c) Flood embankments with tidal drainage sluice.

Irrigation within these flood protected areas was also envisaged, but flood control was given a priority in the first stage partly because of a lack of knowledge of ground water and surface water resources at that time.

The struggle for liberation in 1971 was a tremendous disruption to the normal functioning of govt institutions and all national life, and of course the water management program suffered accordingly. During this period, the World Bank completed a nine volume sector study to provide a basis for post lib development programs in water and agriculture. However the bank study was never accepted by the Govt despite the fact that the water development program of the Govt since 1973 has gradually evolved into one consistent with the proposed strategy of the study. The study emphasized the need for quick results from water development effort in order to achieve food grain self sufficiency in the face of rapidly increasing population and declining financial resources. it attached high priority to small and medium sized, low cost, labour intensive projects in shallow flooded areas. Such schemes world involve low embankment and gravity drainage requiring simple and less sophisticated technology. Benefits would accrue from higher intensity and yields. It was to be the monsoon counterpart to minor irrigation. The main task of the development program was the spread of HYV fertilizer technology by means of water control in the monsoon season and water supply to expand irrigation in the dry season.

The management strategy essentially moved investments physically away from deeply flooded areas and main river to the shallow in flooded areas.

NWP : The initiative to prepare a new National water plan for Bangladesh had its genesis in discussion held during a National symposium on River Basin Dev held in Dhaka in Dec'1981. The ministry of Irrigation, Water Development and Flood Control prepared a project proposal with the assistance of BWDB and UNDP. In Jan'1983, the MPO was created to carry out the NWP project with technical assistance and support of UNDP and World Bank as the executing agency.

The MPO started functioning since July 1983. The 1st Interim Report was completed in 1983 Nov, which included a review of available data and a work plan. A national workshop on National water planning program was inaugurated by the President of Bangladesh in Dec'1982. The second Interim Report was completed in July'84. This report consisted of a main report supported by 10 technical volumes summarizing progress and findings from studies within Various section of MPO. The

main report dealt extensively with a review of water sector issues in the 3rd Five year plan period (85-90).

The IIIrd interim Report was completed in Jan 1985. This report was intended to provided an early opportunity to discuss the long term framework of the NWP, particularly long term issues in the supply and demand for water resources and their relation to food grain production.

A IIIrd National workshop was held in March 1985 to discuss the preliminary findings of MPO.

The Draft NWP already Prepared has been circulated A series of informal workshops has been scheduled for finalization of the Draft National Water Plan.

CHAPTER - 4

Chapter 4

DEVELOPMENT THREATS AND FUTURE ACTIONS

Developmental activities in the wetland areas are mainly arrived at reduction of flood level and size of wetlands to facilitate agriculture. The flood protection embankments have considerably altered the hydraulic regime to the detriment of sustainable management of wetlands. Increased with drawl of water for irrigation and drainage and flood control have a dramatic impact on open water fisheries reducing the size of fish habitats and diversity of species. The continual loss of wetlands threatens the very ability of the land to maintain life resulting in the reduction of wildlife habitat and displacing the wetlands based socio-economic activities.

In the Ganges-Brahmaputra flood plain alone approx 2.1 million ha of wetland has been lost to flood control, drainage and irrigation development (Nishat A 1993). Chalan Beel which was once the largest in Bangladesh encompassing parts of 3 Northern districts, was subjected to rapid natural saltation in the early 20th century. About a century ago, the beel stood at 421 m2. In 1987, it dried up completely leaving only small man-made ponds (Khan H.R. 1993)[1]

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[1] Khan H.R., Water Development Activities and their Impact on Wetlands, IUCN: Glan Switzerland. 1993.

Over exploitation of forest produce in the Sundarban is adversely affecting the natural ecology of the mangroves causing changes in forest structure and species composition and may have a long term effect on flora and fauna. The volume of Sundari stands has decreased by about 40%, since 1959, and fuelwood harvesting has increased faster than of wood. The Naf river estuary in Taknaf and Chakaria Sundarban which used to have extensive lagoons swamps and mud flats, have been cleared to yield place to shirimp farming, salt production and rice cultivation.[2]

LAND RECLAMATION

The newly acereted land in the wetlands has to be improved to maximize agricultural production and this can be accomplished by.

a. desalinization of the soil by leaching.

b. Controlling soil salinity by water management practices.

At the end of dry season salinity concentration in new soils in high necessitating preleaching to reduce salt content of the top soil to allow germination of paddy seeds. After ploughing the soil, the farmers subdivide the selected plots into smaller units by bunds to hold monsoon rains. The rain water dissolves the salt in top soil and leaches it out either by percolation or rainoff.

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[2] Verghese B.G., Waters of Hope, Oxford and IBH Publishing House Pvt. Ltd. (1990), New Delhi.

As the underlying soil and ground water are saline resalinization occurs, which can be controlled by water management and agro practices. Development of polder lands can be planned and promoted in cooperation with the farmers, if it is going to yield benefits moreover, conjunctive use of both surface and ground water should take place to maintain the water table balance.

ENDANGERED SPECIES

The adverse effects of recent developments in the wetlands can be easily discerned in the dwindling populations of the natural fauna. The sunderbans provide a natural habitat to ensure long time survival in the wild of the world's largest genetically viable population of the Royal Bengal Tiger (Panthera tigris). The globally endangered estuarine crocodile (Crocodylus porosus) which was recorded upto 1950 in Chakaria Sunderbans has now disappeared from this greatly degenerated and disturbed habitat.

There is also a broad consensus among the researchers that Susu population (the Gangetic dolphins), found in Ganges, Brahmaputra and Meghna system in the Karnaphuli river are dwindling. The proliferation of dams and barrages in the rivers systems has undoubtedly had a serious adverse impact on the susu resulting in the fragmentation of the aggregate population. Recognizing the rapid decline in dolphin

population, IUCN/SSC/Cetacean specialist group has recommended public awareness programmes targeted at fisherman and people living along the banks of river to highlight the endangered status of this species, and to establish sanctuaries.[3]

FUTURE ACTIONS

The wetland management strategies need to be directed at enriching wetland habitat, with the component biological resources and also addressing the needs of the resident human population. The goal of conservation should not be to stop wetland development but to ensure that it is done in such a way which minimizes the environmental costs.

Key sites where biophysical conditions influence large areas have to be identified. These include sites visited by internationally migrating species. Disturbance free Zones for nesting and roosting birds have to be established as sanctuary.

Methodologies for afforestation of important swamp forest species like hijal and koroch should be developed. An integrated inter disciplinary environmental monitoring programme should be under taken.

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[3] Wet Lands of Bangladesh, Bangladesh Water Development Board, 1994, Dhaka.

Water management in most wet land areas is weak or non existent. The rivers in Bangladesh carry an annual silt load of 2.4 billion tone. This implies that even without human interference, some of the wet lands would be silted up. The total ban on the development of the existing wetland is not likely to be acceptable to local people. Instead of planning to protect all wetlands it will be easier to priorities ecologically sensitive ones. The protective measures have to undertaken within the framework of national planning. The destruction of Chakoria Sundarbans is a case in point. Here shrimp culture at the cost of mangrove forest not only caused loss of bio diversity but has undermined the very basis of shrimp culture by disturbing the natural nutrient cycle. The area is now exposed to cyclone storms and tidal surges.

Strategies for sustainable development

People's livelihood and national economy are dependent on the continued productivity of soil, water forest and fisheries. Without taking vigorous action to prevent further degradation of these natural resources, increase in food production and the economic development cannot be sustained. Any conservation programme ultimately depends the users of the resources who are the key to sustainable development and need to be fully involved in every programme of which they are beneficiaries. Wetlands are special biotic reserves should be managed along with research, monitoring, evaluation and planning for their sustainable development.

International Collaboration

Recognizing the environmental, social and economic consequences of wetland loss, Bangladesh has initiated some national action programmes to address the conservation needs.

Ramsar Convention

Named after the town of Ramsar, Iran, where it was adopted in 1971, has specific objectives of conserving wetlands of international importance. Bangladesh designated 59,600 ha of Sundarbans when it became signatory to the convention in 1992. This has now been extended to formulation and implementation of plans to promote the wise use of wetlands. The wise use of wet lands are defined as sustainable utilization, of them for the benefit of human kind in a way compatible with the maintenance of the natural properties of ecosystems.

Another International collaborating agency is the World Heritage Convention which serves to conserve objects of "out standing universal value that are part of natural and cultural heritage of the world. The inclusion of sites in the World Heritage list can serve as powerful argument in securing international support for their conservation and management.

The Bonn Convention signed in 1979 by Federal Republic of Germany and IUCN Environmental Law Centre, aims to conserve migratory wild animals including birds regardless of the origin and nature of the threats they're facing. This in principle, canaddress all kinds of conservation issues in an integrated way such as pollution habitat protection etc.

The Biological Diversity Convention signed at the Earth Summit in Rio de Janerio in June 1992 by 150 govt provides a framework to enable the governments to decide how best their bio diversity can be conserved. The convention commits governments to promote inter governmental cooperation and with the NGO's and private cooperations. It is hoped it will be another powerful, tool to assist developing nations to pursue their conservation programmes.[4]

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[4] Environmental Services Group, WWF - India, Sponsoured by NORAD, Royal Norwegian Embassy, New Delhi, Oct., 1986.

CHAPTER - 5

CHAPTER V

THE REGIONAL PICTURE

Bangladesh covers only about 8% of the ganges - Brahmaputra - Meghna basins and is the farthest downstream country. India, Nepal, China, (Tibet), and Bhutan share the basin with it, but only India and to a much less extent Nepal and are relevant to its water relationship at present and in the future. Cooperation among the Co-riparian of the basin is clearly very desirable, but competition, exploitation of power positions, water dispute, and failure of transborder cooperation have been the rule[1].

For this reason, the 1989 Eastern Waters study concluded with regret that "the quest for a broad cooperative regional approach to water development is likely to delay rather than hasten" the water arrangement, and investments that can benefit the population of each country. Unfortunately no change in the nationalist perspectives that regional governments and population bring to using the basins" water resources was in sight. The South Asian Association for Regional cooperation (SAA RC) excluded the difficult subject of water from its purview for fear that water conflict would over whelm the embryonic organization.[2]

Contention over dry season water, no nearer a solution than in 1989, rose in intensity. India completely surrounds the deltaic plain of Bangladesh, and all of its

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[1] Verghese, B.G., Waters of hope, Oxford and IBH Publishing Co Pvt. Ltd., New Delhi, (1990).

[2] M.D. Ali. Radosevich, (ed.), Water Resources of Asia, Dakha,(1993).

40 or more externally sources rivers flow in through Indian. Territory the Ganges, Brahmaputra and Meghna, each enters Bangladesh from somewhat different terrain but generally, India like Bangladesh is intensifying dry season cultivation and increasing the use of both river water and related ground water in areas upstream of Bangladesh. The eastern subcontinent as a whole is almost certainly approaching an over all shortage of October - May river water in relation to the growing agricultural, domestic and other needs for dry. season water traditionally met from surface sources. More over, river courses are slowly shifting, altering the discharge of water into one country or another and among the subregions of a country. These considerations, of course, turn the spot light onto alluvial ground water as a substitute for surface water.

The most visible theatre but by no means the only one, for playing out this water use conflict of interests between India and Bangladesh is the Ganges basin. The Ganges enters Bangladesh after traversing U.P. BIHAR and West Bengal, which them selves have large and growing populations and intensifying sifting dry season agriculture. In the seventies india built the Farakka barrage just inside its border with Bangladesh. In the rainy season with its gates lifted, the Farakka barrage does not affect the flow of the river, but in the dry season it was capable of diverting almost the entire ganges flow, via a 40,000 cusec (cubic feet per second) canal into the Bhagirathi/Hoogly river, the western most distributary of the ganges, with in the Indian state of West Bengal.

In its original version the 1997 agreement on low season water sharing at the Indo - Bangladeshi border gave Bangladesh about 63% of the water and both sides

also agreed to seek ways to augment dry season water availability. India's augmentation proposal was a canal crossing north West Bangladesh to bring Brahmaputra water to the ganges in India. Bangladesh however was totally opposed to such link canal. In 1988, India complaining of a lack of co-operation from Bangladesh on augmentation declined to renew the water sharing agreement. Bangladesh complained that since 1988, the amount of water coming across the border at the low point of the year has declined, to as little as 9,500 cusecs in March 1993. which would be about a third of the guaranteed minimum stipulated between 1977 and 1982.

In therefore seems clear that in 1977 and the period there after India used the short - term water sharing agreements too pressurize Bangladesh into cooperation on Water augmentation that is, to obtain Dhaka's consent to the link canal. The ploy failed, and the lapse of the agreements left the two countries in a dead - lock.

The Bangladesh government insistently raised the damaging effects of lost dry season surface water especially on the south western part of the country. Those effects included general increased dryness in that part of the country that impedes dry season cultivation, aggravates the difficulties of the Ganges - Kobadak irrigation project and threatens the water supply for Khulna, as well as causing as increased inflow of salty ocean water into the delta because of reduced outflows of fresh river water[3]. Prime Minister Zia raised this matters with Indian P.M. Rao in 1993 and was promised

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[3] Q.K. Ahmed, N. Ahmed and K.B. Sajjadur Rasheeed (ed) Resources. Environment and National Development with particular reference to Ganges - Brahmaputra - Barak Basins, (1993)

discussion of ameliorative steps, but these apparently had not materialised Begum Zia made a plea to world opinion about it - the centre piece of her speech to the 48th United Nations general Assembly in the fall of 1993[4]. In frequent statements - ments by representatives of the Bangladeshi government, the subject was cast as an Indian abuse, of the human right of the affected population and of the environment. This grievance became a perennial because a perennial item in the Dhaka press.

The South West Regional FAB study (FAB 4)[5], gave considerable stress to the increasing dryness and salinity in that area, high lighting the gradual silting up of the off take of the Gorai river, a principal distributary of the ganges and the most important single carrier of surface water to the South West region, which includes the famous Sunderban delta forest. The Gorai currently takes no water from the ganges during the dry season and it is feared that if this persists the goral may be cut off in the wet season as well, which would greatly reduce the flow of surface water to south west Bangladesh. The very volumes of silt carried by the ganges rule out keeping the gorai open through dredging. The solution discussed in FAB 4 is to raise the level of the ganges[6]. Means barrage between the Gorai off take and the junction with the Brahmaputra, which would send water down to the Gorai course. Such river works would cost billion of dollar, displace tens of thousands of people, and for this

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[4] Bangladesh POT - 1993.

[5] U.N. Report on FAB - 1993.

[6] James Boyce - Birth of a Megaproject, The political Economy of Flood Control in Bangladesh, Journal of Social Studies, (52) April, 1991.

international funding would require a firm understanding with India on how much water will be available in the Ganges as it enters Bangladesh[6]. This lead back to the impasse with India on exactly that point.

Bangladesh and India were making competing claims for what appears to be an inadequate regional rational supply of dry season river water. Such trans boundary disputes have the same basic nature, even if their details always vary. There is no international law to offer clear cut solutions to such impasses but when they can be negotiated or adjudicated in a setting influence by international legal thinking, two sometimes conflicting principles traditionally are cited to legitimise claims one is that the possessor of water may dispose of it on his territory as he is able and he the sees fit, the second is that past or current use of water demonstrates a need for it and makes the claim to it legitimate and compelling These principles have been made more detailed and subtle by the non biding but respected International Law Associations "Helsinki" rules for trans boundary water negotiation abjudication (International Law Association, 1967), which in turn are reflected in as yet un ratified drafts of united Nations International Law Commission[7].

The Helsinki rules provide that a claim to disputed water is weakened to some extent if a country has alternative sources to substitute for it. Bangladesh felt that to maintain its claim to the Ganges water it must show both that the denial of water it formerly received, is causing it damage and that it has no usable substitute. The desire to demonstrate reliance on river water and thereby increase the strength of

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[7] M.D. Ali and Radosevich (ed), Water resources of Asia, Dhaka 1993.

Bangladesh case against Farkka diversions, has been among the reasons lack the lac of BWDB support for the use of ground water in the Ganges - Kobadak project area of the south west region.

Till Nov. 1996 the impasse with India on surface water had changed little in its essentials. No major concessions by India nor changes in Bangladesh attitude were in view. The dry season water problems were not limited to the ganges; there is an Indian water control structure on the Teesta and one likely to be built in the future on the Meghna. Even without barrages. More over Indian dry season use pattern were reducing flowing annually into Bangladesh on many of the more than 40 minor rivers that cross the border. The cumulative effect increased dry seasons abstractions on all incoming water courses by its all surrounding upper riparian was becoming a great deal more serious. Therefore the response to a reduction in dry seasons river water for a high rainfall and alluvial land such as Bangladesh, would be shift to ground water, since ground wafter much water is recharged annually by the local river flows of the wet seasons as well as by overtly turning ground water for irrigation in the South West, refuses to weaken its claim on regional surface water from India.

Indo - Bangla Accord (Dec. - 1996)

From March 11 - 20

India	-	33,930 cusecs.
Bangladesh	-	35,000 cusecs

From March 21st - 30th

India	-	35,000 cusecs.
Bangladesh	-	29,688 cusecs.

The Indo - Bangladesh treaty on the sharing of Ganga waters signed in December last year was expected not only quench the two countries need for water but able to wash away the hate and suspicion that divided them. But hardly five months later the agreement is in danger of being reduced to a meaningless document. It is not that the two neighbours could not abide by the clauses of the treaty. It turns out that the treaty talked about water that just isn't there.

The agreement was arrived at on the basis of the average availability of water between 19449 and 1988. But the water flow has declined drastically since 1988, especially after U.P. and Bihar began drawing 25,000 - 45,000 cusecs thought lift irrigation projects before the waters reached Faraka barrage in North Bengal. Predictably the treaty began to falter with the onset of the dry season.

Between March 11th and 20th, this year India was to get 33,931 cusecs under the treaty but ended, up getting only 19,000 cusecs on an average and on March 17, it get only 18,000 cusecs all time low.

Bangladesh too is losing out. During the same period - March 11 March 20 - it is stated to have received only 21,000 cusecs against the agreed share of 35,000 cusecs. And during the next day cycle of March 21 to March 30, its share further dipped. The flow measured at Harding Bridge in Bangladeshi's West Rajsahi district

was a pitiable 6,457 cusecs on March 27. Two days later it improved by an other 2,000 cusecs still far short of 29,688 cusecs it was supposed to get.

Though the government of the two countries are not directly responsible for the drop in water levels, they are being blamed for not taking into account the water level in the Ganga in the last five years. India is now pressing for sharing of waters on a 50-50 basis by keeping the agreed formula under the treaty in abeyance, as long as water availability at Farakka is below 50,000 cusecs.[8]

Actual Share

March 11th	-	20th
India	-	19,000 cusecs
Bangladesh	-	21,000 cusecs
March 21st	-	30th
India	-	31,000 cusecs
Bangladesh	-	15,000 cusecs

Hence, this evaluation leaves us with a conclusion that Bangladesh should have proceeded to optimize its internal use of water resources rather than hoping for early gains from the dispute resolution.

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[8] India Today, March 1997.

CHAPTER - 6

CHAPTER VI

CONCLUSION

To sum up, Bangladesh represents a challenging case of socio economic and natural resources development. A fertile country of heavy rainfall, with a flat topography affected periodically by flooding and cyclonic storms and with high population density, it represents a classic opportunity for and examination of efforts in comprehensive water resources planning, development and management.

Excessive water during the monsoon and lack of it during the dry season are the factors which dominate the water resources situation in Bangladesh. Doubtless, on an annual basis, huge amounts of water are available in then country. But it is the amount of dry season availability which plays the most vital and critical role in the sustenance of national life and economy. With the rapid increase in population, demand for water in every sphere of national life is also increasing. In the face of ever increasing demand for water, the availability situation is not at all encouraging. Over explosion of ground water beyond its recharge capabilities will only bring an ecological adversity. Similarly, the surface water availability faces more and more setbacks. Gradual but considerable reduction in dry season flow in an increasing number of rivers due to upstream diversion across the borders pose a serious problem for Bangladesh. Such a trend if allowed to continue without corrective measures, is bound to bring manyfold adversities upon national life and economy in the long run.

The water resource situation therefore, immediately calls for conjunctive use of both ground and surface water, so that water table balance can be properly maintained.

Because of its over riding impact, better knowledge of floods and associated drainage problems and means to manage them is essential to the long run development of Bangladesh. The returns from existing flood control projects are not adequate. The flood control projects should be designed to provide improved water controls necessary for high, medium and low lands. Unless these are assured, flood control projects will not produce significant benefits.

Bangladesh's water land related problems are unique and attempts at experimentation are necessary to come up with solution, locally[1]

TOWARDS IRRIGATION UTILITIES

Bangladesh is now a days attempting to confront a number of policy issues such as rationalization of irrigation subsidies and enforcement of recently enacted legislation for collection of water rates in gravity projects; standardization of irrigation equipment especially engines; effecting better coordination among various agencies and enacting suitable water legislation (Third Plan, Dhaka, 1985). There is also a

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[1] Verghese B.G., "Water of Hope, Oxford and IBH Publishing company Pvt. Ltd., New Delhi, 1990

problem with short falls in utilization of the potential created. This has been attributed to inadequate delivery systems, especially to tailenders; inadequate operation and maintenance provisions, lack of training in on farm water management; lack of coordination between irrigation and extension agencies and high cost of operating low lift pumps, shallow tube wells and other equipment or diesel.[2] Low utilization of created potential is said to stem from a combination of organizational and technical problems some of which might hopefully be resolved by setting up water user groups and the development of an irrigation management product within the cooperative structure. Farmers education is necessary especially where modern schemes are introduced to replace traditional irrigation practices. Failure to understand farmer cropping and investment preferences is said to have resulted in poor success of the BARISAL irrigation.[3]

Minor irrigation through low lift pumps proved popular as it is in expensive and has quick pay off.

However there are limits to exploitation of this resource at current levels of water conservation.

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[2] Chaudhary AKM. Kamaluddin, Land Use in Bangladesh Regional Symposium on Water Resources Policy. Dhaka Aug. 1985.

[3] Khan Akbar Ali, Surface Water Strategy Policy and Laws in Bangladesh. Regional Symposium on Water Resources Policy in Agro-Socio-Eco Dev., Dhaka, Aug. 1985.

The shallow tubewell project was proceeding cautiously with the state renting equipment to irrigation groups. Partly out of an anxiety to hasten the pace and partly in response to donor pressure, the STW programme was dramatically expanded in preference to deep tube wells and on the plea of looming resources crunch, was privatized. This however led to unplanned expansion strongly criticized by some observers with tube well running dry in some areas, as spacing requirements were ignored. Equipment was mismatched in some cases, resulting in unproductive investments. The programme therefore gave rise to rural brokers who expedited loan sanctions for a fee and to "Water Lords". As small and marginal farmers were unable to meet financial conditionalities, bigger farmers stepped in to offer their land for the sitting of tubewells, thereby gaining control over both ownership and operation of these assets.[4]

As far as surface schemes are concerned Bangladesh ran into difficulties in designing and operating large life schemes such as ganges-kobadak project, in the south west with 3 very large 36 cumec pumps. According to one observer the project has not been able to meet its objectives as result of a mistaken technological choice[5].

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[4] Saukhat Ali, A.M.M., Ground Water Policies, Option and Laws in Bangladesh. Regional Symposium on Water Resources Policy in Agro-Soci-Eco-Dev., Dhaka, Aug.1985

[5] Khan, Hamidur Rehman. Water Resource Dev. in Bangladesh Problem and Prospects. Regional Symposium on Water Resources Policy, in Agro-Socio-Eco-Dev., Dhaka Aug. 1985.

Nevertheless; despite a cost in learning experience, there has been an expansion in irrigation. All over the basin there has to be more emphasis on better planning and design of projects and more careful attention to irrigation policy in partnership with the farmers. But which farmers? Unless a minimal programme of agrarian reform is implemented, the benefits will in large areas go to the bigger and more affluent farmer and the objective of stabilizing agricultural yields at even higher level may be long delayed or never fully realized.

TOWARDS FLOOD AND CONSERVATION

About 2.6 to 3 million hectares of Bangladesh are flooded annually. In an abnormal year, the figure may touch 6.5 million hectares some 45% of the total area as happened in 1955 and 1974[6] Two third of the country was inundated in the unprecedented 100 year flood of 1988. According to official figures, the total area vulnerable to floods is 8.28 million hectares of which only 32% had been protected by 1984-85 leaving 5.7 million hectares still at risk (Bangladesh Third Plan, Dec. 1985). But since control of upper catchment area is not within the country's reach, floods cannot be banished but has to moderated. One has to live with them through sensible flood plain management good forecasting mechanisms and preparedness. If the large and rising sums spent on disaster relief of diverted to conservation and management programmes, the result would be really rewarding.

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[6] Khan, Tauhidual Anwar, Water Resource Situation in Bangladesh, Regional Symposium on Water Resource Policy in Agro-Socio-Eco-Dev., Dhaka Aug., 1985

TOWARDS LAND AND CONSERVATION

As Bangladesh faces problems of bank and tidal erosion as well as surface erosion with tremendous pressure on vegetation and biomass, as primary source of non commercial energy and feed stock, Jhumia rehabilitation project has been taken up in the Sangu water shed. A similar programme has also been undertaken in 3 water sheds of the Karnaphuli catchment above the Kaptai lake and hydroelectric station.

The real lesson to be learnt from above is that both flood and drought, land and water management go hand in hand. Soil and water conservation hence should be taken up as an integrated Watershed Management Programme with people's participation.

TOWARDS REGIONAL COOPERATION

Another outstanding fact that emerges from the study is that regional cooperation in the harnessing of the Eastern Himalayan rivers, offers to all the countries gains far beyond anything that can be achieved by isolated national efforts. The present impasse is not preliminatory a product of technical differences. More central, however has been the legacy of political mistrust based on a variety of considerations.

It fears and mistrust are to be overcome and broad political framework for cooperation are to be worked out, these are most likely to be accomplished at the

summit or near summit levels, preceded of course by careful and sustained preparatory effort by plenipotentiaries who have the mandate to transcend narrow perspectives and take a more long term and wide view. This would ensure attention to linkages and a consideration of various trade offs. [7]

There have been times when the climate in one or other country has a appeared propitious for such talks or agreements. These windows of opportunity have remained open for limited periods after which a new conjunction of political factors on one side or another has vitiated the atmosphere until the emergence of another concatenation of events. However this does not mean that till some new window of opportunity opens or can be created, nothing else need to be done. The magnitude, complexity and diversity of the GBM region calls for a whole range of technical, hydrological, seismic, geological, socio-economic and ecological data and careful project planning and costing. This would be immensely be useful to decision makers and would ease the way for multilateral funding and create a seance of confidence in the minds of likely investors or donors.

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[7] Verghese, Iyer, Ahmad, Pradhan and Malla, Converting Water into wealth, Konarak publisher, New Delhi, 1994.

TOWARDS SUCCESS OF FLOOD ACTION PLAN :

As known to us, the FAP aim at identification, planning, design and construction of projects which are technically, economically, environmentally and socially feasible.

However to attain sustainability the FAP projects must be designed to protect and enhance the environmental, quality. In the process of human intervention in the natural system therefore full accounting of environmental parameters would be necessary in order to prevent negative impacts. While all the regional studies under the FAP have incorporated rigorous scrutiny of pertinent environmental issues, in order for the policies and recommendations be anchored on the ground, perceptions of the local people must find full expression in the process of analysis and policy and project formulation

Only if environmental considerations, genuine participation of all socio-economic groups and an improved level of operation and maintenance can be properly built into FAP, it can develop into an integrated water management programme.[8]

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[8] Ahmad Q. K. Ahmad Nilufar Sajjadur K.B. Rasheed (eds) Resources, Environment and National Development with particular reference to GBM basins, Academic Publisher, Dhaka, 1993

BIBLIOGRAPHY

BIBLIOGRAPHY

Documents

Asian Development Outlook, Oxford University Press, Hongkong.

Bangladesh towards 21st Century, Published by Ministry of Information, Govt. of the Peoples Republic of Bangladesh, Dhaka.

The Cambridge Encyclopedia of India, Pak, Bangladesh, Sri Lanka, Nepal, Bhutan and Maldives, Sydney and New York.

Bangladesh Documents, Ministry of External Affairs, New Delhi.

Master Plan Organization, National Water Plan, 1985-2005. Ministry of Irrigation, Water Development and Flood Control in Cooperation with UNDP and World Bank, Dhaka, December 1986.

Power, Water and Flood Control Ministry Govt. of Bangladesh, Proposal for Augmentation of the Dry Season Flow of the Ganges, Dhaka, March 1978.

UN/UNDP, Hydrologial Condition of Bangladesh 1982.

UNDP. Bangladesh Flood Policy Study. Final Report Bangladesh Ministry of Planning Dhaka, May 1989.

World Bank and Govt. of Bangladesh (1992), Proceedings of the 2nd Conference on FAP, Dhaka.

Books

Abbas, B.M.," Water Resources Development and Flood Control in Bangladesh," Dhaka 1971.

Ahmed Q.K., Ahmed Nilufer, Rasheed K.B., " Resources, Environment and Development in Bangladesh (with particular reference to the GBM basin)", Accadamic pub.1994.

Anwar Jamal, "Geology of Coastal Area of Bangladesh and Recommendation for Resource Development and Management", National Workshop on Bangladesh Coastal Area Resources Development and Management, Dhaka, Oct.1988.

Choudhury, M. and Siddiqui M.H.,"Towards a National Water Plan in Bengladesh, Regional Symposium on Water Resource

Policy in Agro-Socio-Economi Development", Dhaka, August 1985.

Choudhury, A.K.M., Kamaluddin, "Land use in Bangladesh, Regional Symposium on Water Resources Policy in Agro Socio-Economic Development", Dhaka, August 1985.

Crow Ben," The Politics and Technology of Sharing the Ganga", Ph.D. thesis for University of Edinburgh, 1980.

Crow, Ben and Lindiquist, Alan, "Development of the River Gangas and Brahmaputra The Difficulty of Negotiating a New Line", Minieographed, October 31, 1989.

CrowBen and Lindquist, Alan, "Development of the River Gangas and Brahmaputra: The Difficulty of Negotiating a New Development Policy and Practice Research Group", the Open University", Faculty of Technology Milton Keyes, U.K., Feb'90.

James, Paul H., "Water Resources of the South Asian Region", From world Bank Proceedings of the Ground Water Seminar an Technical Session Washington, may 1986.

Khan, A.H. and S. Miahi (1983), "The Brahmaputra River Basin Development" in Munir Zaman et al (eds.) "River Basin Development", Tycooly International, Pub.Ltd., Dublin.

Khan, Hamidua Ralman, "Water Resources Development in Bangladesh, Problems and Prospects, Regional Symposium on Water Resources Policy in Agro-Socio Economic Development", Dhaka, August '85.

Khan H.R., "Water Development Activities and their Impacts on Wetlands in Fresh Water Wetlands in Bangladesh, and Approaches for management" IUCN Gland, Switzerland

Khan, Jallhidul Anwar, "Water Resources Situation in Bangladesh Regional, Symposium on Water Pesons Policy in Agro-Socio Economic Development", Dhaka, August 1985.

Mazumdar, R.C., "The History of Bengal", Vol., Vol.II, publishing Dhaka University.

Miah, M. Maniruzzaman, "Floods in Bangladesh: A Case for Regional Cooperation", Presented at ICSAC, Seminar, N.D., Feb.1989.

Nishat, Amin and Chaudhury, Sahjahan Kabir, "Water Quality Problems and Needs for Integrated Control in Bangladesh",

Regional Symposium on Health Resource Policy in Agro Socio-Economic Development", Dhaka August'85.

Verghese B.G., "Waters of Hope", Oxford and IBH Publishing Co., 1990.

Verghese B.G., Iyer R.R. (eds.), "Harnessing the Eastern Himalayan Reivers: Regional Cooperation in South Asia", Konark Pub. Pvt. Ltd., New Delhi 1993.

Articles:

Azam Jean Paul. "Impacts of floods on rural wages in Bangladesh", Bangladesh Development Studies 21(1). Mar 93, 1-14.

Beycee Jemes K, "Birth of a mega project the political economy of flood control in Bangladesh", Journal of Social studies (52) April 91.

Brammer H, "Flood in Bangladesh-Flood mitigation and environmental aspects", Geographical Journal 156(2) July 90.

Clusters Peter. " Banagladeshs FAP-A critique", Economic and Political weekly 28(29-30) 17-24 July 93.

Haque C.Emdad and Zaman M.Q, "Human responses to riverine hazards in Bangladesh : A proposal for sustainable flood plain duvelopment", World Development. 21(1) Jan 93.

Islam Nahid, Ganges Water Dispute-Environmental and related compacts on Banagladesh. BIIS Journal 12(3) July91.

Islam Nezrul, " Let the Delta be a Delta. Am essay in dissent en flood problems in Bangladesh.", Journal of social studies. (48), APril 90.

Karim M.Iqbal, " Development of Bangladesh-Mobilisation of land, water, human resource". BIIS Journal. Oct 89, 427-62.

Maih M. Manirujjan," Floods in Bangladesh, a case for regional cooperation," South Asia Journal 31 (1-2) July - Dec 89.

Palmer Jenes R.W., " Sustaining serendipity? ground water- irrigation, growth of agricultural production and poverty in Bangladesh.", Economic and political Weekly. 27 (39) 26th Sept 92.

Potten David " Impact of flood control in Bangladesh", Asian Affairs. 25(2); June 94, 156-162.

Rob Md. Abdur, " Flood hazard in Bangladeh; nature, causes and control", Asian Profile 18(4) . Aug 90.

Zaman M.Q "Rivers of life: Living with flood in Bangladesh", Asian Survey 33(10); Oct 93, 985-96.