Understanding Water Resources:
Resource Characteristics and Water Sector Planning in Bangladesh

S. Alam[2] , M. Chadwick[1], J. Soussan[1]

[1] ENVIRONMENT CENTRE, UNIVERSITY OF LEEDS

[2] BANGLADESH CENTRE FOR ADVANCED STUDIES

CONTENTS

ABBREVIATIONS AND ACRONYMS

ADB	**Asian Development Bank**
ASFA	**Aquatic Sciences and Fisheries Abstracts**
BADC	**Bangladesh Agricultural Development Council**
BARC	**Bangladesh Agricultural Research Council**
BBS	**Bangladesh Bureau of Statistics**
BCAS	**Bangladesh Centre for Advanced Studies**
BIDS	**Bangladesh Institute for Development Studies**
BRAC	**Bangladesh**
BWDB	**Bangladesh Water Development Board**
CABI	**Commonwealth Agricultural Bureau International**
CC	**Chowk Committees**
CPP	**Compartmentalisation Pilot Project**
CWMC	**Compartment Water Management Committees**
DOE	**Department of Environment**
DOF	**Department of Fisheries**
DFID	**Department For International Development**
EGIS	**Environment and GIS Support Project**
FAO	**Food and Agriculture Organisation**
FAP	**Flood Action Plan**
FCD	**Flood Control and Drainage**
FCD/I	**Flood Control, Drainage and Irrigation**
FPCO	**Flood Plan Coordination Organisation**
GOB	**Government of Bangladesh**
GPP	**Guidelines on People's Participation**
IDA	**International Development Association**
IPM	**Integrated Pest Management**
ISPAN	**Irrigation Support Project for Asia and the Near**
LGED	**Local Government Engineering Department**
MPO	**Master Plan Organisation**
NGO	**Non-Government Organisation**
NWMP	**National Water Management Plan**
NWP	**National Water Plan**
O&M	**Operation and Maintenance**

PRA	**Participatory Rural Appraisal**
RAS	**Research and Advisory Service**
RNRRS	**Renewable Natural Resources Strategy**
SCWMC	**Sub-Compartment Water Management Committees**
SPARRSO	**Space Research and Remote Sensing Organisation**
SRP	**Systems Rehabilitation Project**
SWC	**Soil and Water Conservation**
UNCED	**United Nations Conference on Environment and Development**
UNDP	**United Nations Development Programme**
WARPO	**Water Resources Planning Organisation**

ACKNOWLEDGEMENTS

The authors would like to give special

thanks to the:

• Bath Information and Data Services (BIDS) for use of their ISI database;

• Commonwealth Agricultural Bureau International (CABI) for use of their CABI database;

• Royal Tropical Institute and the for the use of their TROPAG AND RURAL database; and
• Cambridge Scientific Abstracts for use of their ASFA database.

EXECUTIVE SUMMARY

1 This review forms part of the Department For International Development (DFID) funded research project, "Sustainable Local Water Management Strategies in Bangladesh - Meeting Needs and Resolving Conflicts" (R6755). The project is funded through the Natural Resources Systems Programme, under the High Potential Production System portfolio of projects. It forms one of three components of the project development work, providing a synthesis of previous work in relation to the hydrological problems and processes and, approaches to water sector plaiuiing, in Bangladesh.

2. A considerable body of work and associated literature relating to both the hydrological regime and water sector planning in Bangladesh. The literature provides both an insight into the hydrology of the country's main river basins and its climate and of the resulting problems the population, planners and politicians face.

3. The various approaches adopted by planners in the past in their attempt to provide an adequate, efficient and stable supply of water to meet the many water resources management uses and functions that exist in Bangladesh are also well documented and critiqued

4. This review attempts to focus on the problems the unique hydrology, physiography and socio-economic conditions of Bangladesh pose to planners, and then goes on to outline and asses the various approaches used in an attempt to develop an appropriate water sector plan for the country. Through the review it is hoped to:

- assess the hydrological problems and processes that are operating in Bangladesh at a national level;

- outline regional and local variations in these problems and processes; and

- provide an analysis of the various approaches to water sector planning in Bangladesh over the last 10 years.

5. Much of Bangladesh, nearly 60 percent in fact, is less than six metres above sea level, and is located within the flood plains of the three great rivers, the Ganges, the Brahmaputra and the Meghna (Hofer and Messerli 1997). Bangladesh is criss-crossed by over 200 rivers which form a complex and ever-changing pattern. These rivers cover some seven percent of the land area (Haggart et al 1994). These river systems drain a total catchment area of about 1.72 million square kilometres laying in India, China, Nepal, Bhutan and finally Bangladesh, of which, only eight percent of the catchment area lies within the country itself (Ahmed et al, 1994). As a result, huge inflows of water enter the country during the rainy season (July -September) on their

way to the Bay of Bengal. About 90 percent annual rainfall also occurs in period (Chowdhury and Azizul 1990).

6. A vast area of Bangladesh is also affected by riverbank erosion in every year. According to BWDB 1200 km of riverbank are under active erosion in every year (Ahmed 1994). Land loss due to riverbank erosion in the highest along the Jamuna, where the erosion rate is estimated to be between 139 and 353 hectares per year. Erosion, can be termed as a silent disaster, which takes away the life-support systems of whole families. Comparison of different hazards in Bangladesh illustrates that cyclones have the most dramatic consequences but place riverbank erosion is second, not in terms of deaths, but in terms of the process of impoverishment and creation of landlessness that results.

7. Thus the vicious circle is created as in the dry season, due to declining water levels and reduced velocity in the river flow, as a result, in part, of greater off-take upstream, numerous chars (sandbars) have formed in the river seriously affecting navigation and fisheries (Khan 1995).

8. There is much concern about the potential consequences of climate change and sea level rise. It is estimated that a 10 percent rise in total rainfall will increase the run-off depth by 18-22 percent depending on the region. Inundation low coastal areas would have the effect of pushing brackish water zones inland, causing stream flow salinity to rise. One of the more certain and worrying likely events is that cyclones which already effect coastal areas are likely to become more frequent and of greater severity (BOAS el al 1994).

9. Predictions of the affects on agriculture are also of concern. According to the report on Climate Change in Asia (ADB 1994), total agriculture production of the country will decline by the year 2030 any where between 0.8 to 2.9 million metric tons of potential outputs may be lost respectively 13-24 percent of projected output in the affected zone.

10. The ecological consequences of climate change and sea level rise are also likely to be great. It is estimated that 75 percent of the Sundarbans, the main forest of the country and one of the largest single-tract mangrove in the world be lost due to the inundation. The Sundarbans constitute the largest mangrove forest in the world covering an area of about 1,000,000 ha of which about 60 percent lies within Bangladesh and the remaining in India. About one third of the total area consists of water in the form of rivers, channels and tidal creeks. It represent an area with an extremely rich diversity of plant and animal species (BCAS el al, 1994) including one of the last remaining habitats of the Royal Bengal tiger.

11. Cropping patterns in Bangladesh are multifarious and varied according to the crops being growing the agro-ecological region, the soils and associated factors. The major crops of amon rice and jute during the monsoon rains and HYV boro rice during the

dry season. Other crops such as potatoes, oilseeds, pulses and vegetables are also grown in the winter months usually.

11. Over the last three decades groundwater has been abstracted from the aquifers within the major parts of the country to meet the irrigation demand as well as to supply water for domestic and industrial purposes. The trend growth rate of areas irrigated by tubewells has been around 9 percent over the last decade. However, comparison of the growth of tubewell irrigation between the late eighties and early nineties reveals a slowdown of growth (from 10.59 percent during 1984/85-1989/90 period to 7.65 per cent during 1990/91-1994/95 period). This attributed to a deceleration in the growth in both STW and DTW irrigation in the early nineties compared to the late eighties.

12. The Ganges water dispute dates back to 1951 when Bangladesh was the eastern province of the Federation of Pakistan and is well documented (Kvaloy 1992, Postel 1994, Postel 1996, Ohlsson, 1996, Dixit and Mirza 1997). The dispute over the Ganges revolves around the question of how it's water is to be shared for the five dry-season months. During the rest of the year, there is sufficient water in the Ganges for India to draw off some of it without causing problems for Bangladesh. However, in the dry season the average minimum discharge to Farakka is falling below 55,000 cusecs, of which India wishes to divert 40,000, whilst Bangladesh argues it needs virtually all of it to avoid environmental problems.. Increased upstream withdrawal in northern India has further lowered the dry-season flow at Farakka, further complicating the situation. In 1993 Bangladesh received only 7,000 cusecs in the most acute period. It is believed flow at the Farakka is now nearer 45,000.

14 Water is the mainstay of Bangladesh and also the main cause or means of disasters. It's great rivers: the Ganges-Padma, the Brahmaputra-Jamuna, the Meghna, and their associated tributaries discharge about 5 million cubic feet per second into the Bay of Bengal at peak periods. The annual sediment load of the rivers has been estimated between 1.5 and 2.4 billion tons (Rahman 1990). This vast outflow is second only to that of the Amazon system, whilst in breadth and total annual volume the Padna-Lower Meghna is the third largest river in the world. The complexities and scale of these rivers, linked to the country's physiography, extremes and variability in climate and the socio-economic vulnerability of the population all go to create a pressing, extremely difficult situation to manage. The term water management has different meanings to different people. Management has been defined as the process and activity of carrying out the task so that a number of diverse activities are performed in such way that a defined objective is achieved by the combined efforts of a group of people (Fernch and Saward 1975, Ghani 1987).

15. At the macro level, water resource planning started within a broad framework of Flood Control, Drainage and Irrigation (FCDI). The government of Bangladesh (GoB), through BWDB, has so far completed 544 projects, of which 24 are recognised as irrigation projects (Ahmed 1998). Most of the FCDI projects, particularly the big ones, are characterised by delays in completion, cost overruns, poor maintenance and

very little cost recovery. Critics hold that FCDI projects raise river beds and prevent siltation on lands which are consequently deprived of nutrients and become geomorphologically risk prone (Hossain 1989).

16. Water users and development agencies all pursued their development efforts independently and inevitably conflicts surfaced among various uses and users. The GoB, through the Master Planning Organisation (MPO), established the National Water Plan (NWP) to co-ordinate utilisation among users and maximise the benefits from water sector investments. The first phase of the NWP, which was published in 1986, contained substantial amounts of information and analyses. These were primarily based on a conventional assessment of the water resources base (concentrating mostly on surface water) and sectoral patterns of demand, with projections of both used as the basis for defining needs, scarcities and planning priorities. The second phase, which was published in 1991, was based on the same approach, but was rather overtaken by the advent of the Flood Action Plan.

17. In 1987 and 1988, Bangladesh affected by the two severest floods on the record. The 1988 flood in particular was catastrophic and occurred as a result of the synchronisation of the peak floods on the major rivers (Abbas 1989). More than 60 percent of Bangladesh was affected. The flood claimed the lives of at least 1500 people, countless livestock and poultry, and washed away or damaged innumerable houses, schools, roads, bridges and standing crops (Shahjan 1989). Some 81,831 sq. km were affected. Crops covering 4.26 million hectares of land were totally damaged while that of 3.28 million hectares were partly damaged (Matin 1989). Immediately after the flood, the President estimated crop damage to be in the order of three million tons. The extent of total loss is estimated to be equivalent to 50 billion Taka (Ahmed 1989).

17. The proposals were eventually reviewed in July 1989 by the GoB and World Bank, who then recommended an integrated approach for flood mitigation based on the concept of "controlled flooding" to be implemented over next 20 to 30 years (Nishat 1990). Based on the studies carried out by a joint team of local and expatriate experts `eleven guiding principles' were drawn up on which the Flood Action Plan (FAP) was based (World Bank 1989). Since this time, flood control, irrigation and drainage projects (FCDIs) have accounted for about half of funds spent on water development projects.

18. Criticism of the FAP was almost immediate and led many organisations in the voluntary sector began to mobilise support for an anti-FAP campaign. This also led to the production of several highly critical publications.

20. In 1995, as a consequence of the combination of the continued anti-FAP campaign, the concerns expressed by the donor community over both this campaign and the viability of technically-based solutions and, not least, the findings of the FAP studies themselves, the need for a new approach to water resources management in

Bangladesh was accepted. In response to this, the GoB produced the Water and Flood Management Strategy (FPCO 1995). It recommended a five-year programme which involved the preparation of a national water management plan, strengthening of water sector organisations responsible for planning, construction, and operation and maintenance, as well as the implementation of a compact portfolio of high priority projects.

21. This was in part an approach which reflected an acceptance of the reality that major interventions based on a concerted programme of structural investments was only "a long-term possibility if the macro-economic, environmental and other issues could be satisfactorily addressed" (FPCO, page 1). This mixture of principles and pragmatism has become characteristic of the approach to the water sector in Bangladesh in recent years and persists to the time of writing. Part of this process is the emergence of a new dialogue between the government, the NGOs who were the most verciferous critics of FAP and other constituencies on the way forward.

22. This emerging consensus is reflected in the First Draft National Water Policy, which was published towards the end of 1997. Although still a draft and not yet established national policy, this document enshrined the acceptance, at the policy level of government at least, of the basic concepts associated with integrated water resources management. It established the need to take account of both all aspects of water resources and all types of uses of these resources. It is based explicitly on the recognition of the need to integrate all stakeholder interests in decision-making, enshrines principles of participatory development as the central tenet for water resources management and establishes the need for a process of structural reform to the institutional context of the water sector in Bangladesh as a pre-condition for effective management of these critical resources. At the time of writing, this draft policy document was being discussed, but the general direction of the discussion has demonstrated both the commitment of the GoB to this approach and the generally positive response which it has elicited from most commentators.

23. This report has reviewed a wide range of issues concerned with water resources and their management in Bangladesh. In doing so, the authors have been conscious that there has been a tremendous amount written on these issues (hence the length of the annotated bibliography which accompanies the report), but that these many texts rarely provide a coherent overview to the sector as a whole. This report seeks to provide this.

24. What is clear from the discussion set out above is that these issues can only be understood as part of a dynamic and evolutionary process, or rather series of parallel processes. The resources themselves are inherently dynamic, being characterised by great variability over time and space and by temporal change in some of their most basic characteristics. Similarly, the patterns of demands placed upon these resources are both variable and changing, with growing populations, new patterns of economic activities, new technological opportunities and changing aspirations and expectations

leading to increased and multiple demands on the water resources base. Finally, the nature of approaches to the management and planning of these resources is in the middle of a dynamic change of major importance that, if followed through, will alter the whole institutional context within which local-level water resources management takes place.

25. It is hoped that the analysis presented here will, in conjunction with parallel reports on rural change and indigenous technical knowledge, help to contextualise the field research programme which lies at the heart of this project. Taken together, these reports provide a background against which the field research results can be understood. They have also been of central importance in assisting the researchers to understand what issues should be examined in the field (and indeed have been fundamental to changes in the original research proposal to include more work on the analysis of issues such as domestic water quality and comparative studies of other areas of Bangladesh). It is hoped that other researchers will find them of similar value.

CHAPTER 1: INTRODUCTION

I.1.Background

This review forms part of the Department For International Development (DFID) funded research project, "Sustainable Local Water Management Strategies in Bangladesh - Meeting Needs and Resolving Conflicts" (R6755). The project is funded through the Natural Resources Systems Programme, under the High Potential Production System portfolio of projects. It forms one of three components of the project development work, providing a synthesis of previous work in relation to the hydrological problems and processes and, approaches to water sector planning, in Bangladesh.

A considerable body of work and associated literature relating to both the hydrological regime and water sector planning in Bangladesh. The literature provides both an insight into the hydrology of the country's main river basins and its climate and of the resulting problems the population, planners and politicians face.

The various approaches adopted by planners in the past in their attempt to provide an adequate, efficient and stable supply of water to meet the many water resources management uses and functions that exist in Bangladesh are also well documented and critiqued. The period immediately after the implementation of the FAP in particular, led to the production of a plethora of reports, books and research papers. Furthermore, there was rarely a day when some aspect of the FAP was not discussed in the country's national papers.

This review attempts to focus on the problems the unique hydrology, physiography and socio-economic conditions of Bangladesh pose to planners, and then goes on to outline and asses the various approaches used in an attempt to develop an appropriate water sector plan for the country.

Through the review it is hoped to:

• assess the hydrological problems and processes that are operating in Bangladesh at a national level;

• outline regional and local variations in these problems and processes; and

• provide an analysis of the various approaches to water sector planning in Bangladesh over the last 10 years.

During this period, two thirds of Bangladesh is vulnerable to flood and almost every year between one third to one fourth of the country goes under water (Nishat 1990).

The processes involved are not simple and are a consequence of a series of factors that singularly or in combination create flood conditions in Bangladesh: huge monsoon inflows of water from upstream, heavy monsoon rainfall over Bangladesh, low floodplain gradient, and congested drainage channels found in many areas, and, in coastal areas, tide and storm surges which can have devastating impacts.

Effective management of these water resources could control floods, prevent droughts, provide energy, create jobs and enhance environmental quality in each riparian country. However, badly or ineffectively managed such hydrological extremes linked to anthropogenic induced factors can lead to immense suffering through direct loss of life, or through a decline in the populations livelihood system as a result of crop and livestock loss, infrastructure damage and water borne diseases.

The flood problems in Bangladesh are complex and multifaceted. There are multiple consequences including other than the initial raise in water levels and its associated destruction. For example, post flood waterlogging is also a recurrent problem in many areas but one that is frequently overlooked (Adrian 1994).

The financial cost of floods is also severe, particularly one as poor as Bangladesh. The loss caused by floods in Bangladesh in a normal year is of the order of US $175 million; but in extreme cases, the damage may exceed US $1 billion dollars. The 1988 flood damage was the worst in history, totalling US $1.13 billions, with the industrial sector being worst-hit followed by agriculture (Ahmad 1994).

Insufficient rainfall or rainfall variability are the main causes of drought especially in the pre-monsoon and post monsoon period. About six percent of the total land area is the extremely drought prone, experiencing drought nearly every year.

Though, drought has a severe affect on rural people livelihood as well as national economy, there still appears to be little being done to establish a comprehensive management plan and the required associated measures.

CHAPTER 2: THE HYDROLOGICAL CONTEXT

2.1 .Introduction

A rhythm in the annual water cycle dominates life in Bangladesh: excessive water during the monsoon causing flood and insufficient water during the dry season creating drought situation. The major sources of water in Bangladesh rainfall, river and ground water are closely related. Much of Bangladesh, nearly 60 percent in fact, is less than six metres above sea level, and is located within the flood plains of the three great rivers, the Ganges, the Brahmaputra and the Meghna (Hofer and Messerli 1997). Bangladesh is criss-crossed by over 200 rivers which form a complex and ever-changing pattern. These rivers cover some seven percent of the land area (Haggart *et al* 1994). These river systems drain a total catchment area of about 1.72 million square kilometres laying in India, China, Nepal, Bhutan and finally Bangladesh, of which, only eight percent of the catchment area lies within the country itself (Ahmed *et al,* 1994). As a result, huge inflows of water enter the country during the rainy season (July -September) on their way to the Bay of Bengal. About 90 percent annual rainfall also occurs in period (Chowdhury and Azizul 1990).

During this period, two thirds of Bangladesh is vulnerable to flood and almost every year between one third to one fourth of the country goes under water (Nishat 1990). The depth and impact of these inundation's varies, with rural production and life well adapted to, and to a large measure dependent upon, some level of inundation, but vulnerable to flooding that is too deep or occurs at the wrong time. The processes involved are not simple and are a consequence of a series of factors that singularly or in combination create flood conditions in Bangladesh: huge monsoon inflows of water from upstream, heavy monsoon rainfall over Bangladesh, low floodplain gradient, and congested drainage channels found in many areas, and, in coastal areas, tide and storm surges which can have devastating impacts.

Effective management of these water resources could control floods, prevent droughts, provide energy, create jobs and enhance environmental quality in each riparian country. However, badly or ineffectively managed such hydrological extremes linked to anthropogenic induced factors can lead to immense suffering through direct loss of life, or through a decline in the populations livelihood system as a result of crop and livestock loss, infrastructure damage and water borne diseases.

2.2. The Ganges, Brahmaputra & Meghna River Basins

The Ganges begins life at the Gongotri glaciers in the Himalayas at an elevation of about 7010 metres near the Indo-China border. It flows in a south-easterly direction and in its lower reaches flows eastward, entering Bangladesh near Rajshahi west Bangladesh. The

length of the river is about 2520 km. After entering Bangladesh, it flows south-east for about 257 km where it joins the Brahmaputra. The Ganges catchment covers an area of 1,087,300 sq. km spread over India (860,000 sq. km.), Nepal (147,480 sq. km), China (33,520 sq. km.) and Bangladesh (46,300 sq. km.) (Khan 1994).

The Brahmaputra-Jamuna has a total catchment area 552,000 sq. km. China (270,900 sq. km), Bhutan (47,000 sq. kin.), India (195,000 sq. km), and Bangladesh (39,100 sq. km). The total length of the Brahmaputra is about 2900 km with an average discharge of over 19,000m $^{3/S}$ *(Table 2.2a).* The rivers collects snowmelt and June off from the high catchment lying in China, Bhutan, India and enter in Bangladesh in Rangpur district. After entering Bangladesh, the Brahmaputra flows southwards and joint with the Ganges (Padma) at Aricha Ghat, and then flows toward south-east and joins the Meghna river.

The Barak, the head stream of the Meghna River, starts in the hills of Manipur, India. The Barak bifurcates into two rivers near the Indo-Bangladesh border, the Surma and the Kushiyara which later join together near Aimiriganj to form the Meghna. The river flows in a south westerly direction to meet the Padma at Chandpur. The river is over 900 km long, of which 403 km is in Bangladesh.

Table 2.2a: The Average Discharge of the GBM rivers in Bangladesh

River	**Average Discharge m^3/sec**	**Average Annual Silt Runoff (tonnes/sq. km**
The Ganges	**11,610**	492
The Brahmaputra-Jamuna (Brahmaputra)	19,200	1,370
The Meghna	3,515	-

Source: (Chowdhury 1990)

2.3. Meteorology

The climate of Bangladesh is dominated by a tropical monsoon climate. High temperatures, heavy rainfall, excessive humidity and remarkable seasonal variations are the main characteristics of the climate of Bangladesh. Barman (1997) described four main seasons:

• pre-monsoon (March-May), the hot or summer season with the highest temperatures and evaporation rates, and occasional line-squalls (nor-westerns) with thunder storm rainfall and strong wind; tropical cyclones (typhoons) an liable to affect coastal areas;

• monsoon (June-September), the period of highest rainfall, humidity and cloudiness;

post-monsoon (October-November), a hot and humid period with decreasing rainfall, but sunny and with heavy dew at night; tropical cyclones are again liable to affect coastal areas; and

dry season (or winter), (December-February), the coolest, driest and sunniest period of the years.

The mean annual temperature is about 25°C and ranges between about 18°C in winter and 30°C in the pre-monsoon season. Extreme temperatures range between about 5°C and 43°C, except near the coast when the range is narrower. There are significant differences in seasonal temperatures across the country; generally, the highest pre-monsoon temperatures occur in the west, and length of the cool winter period is longer in the north then near the coast.

Rashid (1991) identified three main sources of rainfall in Bangladesh: the western depressions of winter, the early summer thunderstorms known as the Nor westerns (north-westerly), and the summer rains or monsoons from the south-west traders. The rainfall pattern is characterised by high variability between years both in terms of the time of onset and ending of the rainy season. Normally about 85 percent of the annual rainfall occurs between April and September. The mean variability for the whole of Bangladesh was calculated to be 19 percent with a range of actual variability between 10 percent and 28 percent. The lowest variability is observed in northern Sylhet, which is also the rainiest part of Bangladesh (Samsuddin et al 1974).

Within Bangladesh, the mean annual rainfall is lowest in the west (120-1500 mm) and generally in the north, east and south (over 2500 mm). Rainfall exceeds 5000 mm in the extreme north-east of Sylhet. For example, Chowdhury et al (1990) noted a maximum of about 5,690 mm at Lallakhal. Rainfall also increases towards south-east to about 3,600 mm near Coxs Bazaar.

Rainfall everywhere exceeds evapo-transportation rates in the monsoon season and for the year as a whole even in dry years. However, evapo-transpiration rates exceed rainfall during winter and in the first part of the pre-monsoon season.

Fog and mist are a common feature of the weather particularly from November to March. The humidity of the country is high throughout the year. March and April are the lowest months in the western part of the country, whilst in the east the lowest levels of humidity are recorded slightly earlier (January to March). The relative humidity is everywhere reaching over 80 percent during June-September.

Cyclones are common with in the coastal area of Bangladesh with the Meghna estuary almost acting like a funnel drawing in cyclones. The Chittagong and Cox's Bazaar coast, and a number of low lying islands, are particularly vulnerable to cyclones, of which, six on average develop in the Bay of Bengal every year. They generally arrive in early summer (April-May) or towards the end of the rainy season (September-November).

Between October 1960 and April 1991, cyclones came onshore 34 times, killing more than 700,000 people over the period. Wind speeds tend to range between 89 km to 225 km with most of the deaths attributed to the force of the three to seven metre high storm-waves that accompany their arrival (Mirza et al 1972).

According to several sources (Rashid 1991, Rahman et al 1994), in recent years the meteorological pattern has been erratic, with a reduction in the length of the cool, dry season. This could be a temporary phenomenon, however, many feel this may be to beginning of the long-term changes attributed to global warming caused by greenhouse gases.

2.4. Groundwater-Surface Water Interactions

Nearly the entire area of Bangladesh is underline by a body of groundwater ranging from a depth of 1 m to 1000 m (Khan 1990). Exceptions to this are the Chittagong Hill Tracts, Rajshahi high Barind and the Madhupur tracts, where groundwater usually occurs at shallow depth. The level of groundwater is found at or near ground surface during monsoon period (July to October).

The necessity of groundwater development for irrigation became a pressing need during the 1960s, In 1962 a project to drill 380 deep tubewells within Thakurgaon and Dinajpur area, north-west Bangladesh, was taken up by the East Pakistan Water and Power Development Authority (EPWAPDA), now Bangladesh Water Development Board (BWDB), and were completed in 1964 (Khan, 1990). At the same time the East Pakistan Agricultural Development Corporation (EPADC), now Bangladesh Agricultural Development Corporation (BADC), also started drilling of DTWs for utilising groundwater for irrigation in the prospecting areas within the country.

Today in the dry season (October to May) groundwater forms the major source of water available for agricultural production in many areas of the country. In addition, over 90 percent of the people of Bangladesh relies upon groundwater for potable water. According to the Master Plan Organisation (MPO, 1987), the national estimate of groundwater abstraction for irrigation was 6912 million m3/year and for potable water supplies and industrial consumption was approximately 900 million m3/year.

The interface between crop land and water is of vital importance as water, either through floods or as irrigation water, determines in association with land levels, much of the land use in a given season. In 1994/95, the total estimated area irrigated was just under 3 million ha. Of this, about 90 per cent is being irrigated by modern methods (tubewells, low-lift pumps and gravity irrigation). Tubewells alone irrigated 2.1 million ha or nearly 78% of the area under modern methods. The growth in area under irrigation has been explosive since the mid-eighties when siting, imports and prices of shallow tubules were deregulated and their procurement as well as distribution was privatised (Asaduzaman et al 1997).

Despite groundwater playing a vital role in the water resources development plan of the country as a whole, little attention appears to have been paid to the after-effects of abstraction of groundwater for both agricultural and domestic uses (Kahan 1990). Only in the past few years has there been increased awareness of the potential effects of unchecked utilisation of groundwater to meet the ever increasing demand. It has become increasingly apparent that a proper understanding of the potential and consequences of utilising this important resource is vital if the system is not to be disrupted or worse irrevocably damaged.

The underlying problem is there are no data relating to the extent, capacity and recharge capacities of groundwater in Bangladesh. There has been no comprehensive evaluation of groundwater potentials of aquifer zones beyond the depth of 300m for the vast majority of the country. It is possible that deep aquifers (300-1000m below surface) will have limited development potential because of greater depth of occurrence of the water bearing formation and mineralisation of water due to high temperature (MPO 1985).

According to Bangladesh Water Development Board (BWDB) and the United Nations Development Programme (UNDP), in a report in 1982, available groundwater nationwide is 19,640 million m^3 (Khan, 1990). However, in the Deep Tubewell Project Report which was prepared jointly by Food and Agricultural Organisation (FAO) and BWDB a year later, the total amount of available ground water is estimated to be 36,565 million m^3. On the basis of another BWDB report, the available recharge varies from 30mm to 300nun per unit area through the country based on soil strata and physiographic conditions, giving a total available recharge of about 14,800 million m^3' Again however there are major discrepancies in the data. An MPO report estimated the available recharge throughout the country to be 25,749 million m^3 (MPO 1987). Such variability in estimates of available groundwater and available recharge offer little to assist planners in developing a comprehensive groundwater management system.

However, whatever the figures, worrying signs are beginning to appear and to do so with increasing regularity. According to the consulting report on groundwater development and management in Bangladesh (Harms 1983), hundreds of STWs going dry in the Rajshahi district, with many HTWs sharing a similar fate. This is but one of many reports warning about dangers of over-investment in, and uncontrolled and unchecked extraction of, groundwater (REFERENCES). There are several other areas of Bangladesh where groundwater abstractions are causing an alarming decline in groundwater levels during dry season. These areas include parts of Rangpur, Dinajpur, Rajshahi, Bogra, Pabna, Comilla, Mymensingh and Dhaka districts. In recent years groundwater levels in the northern districts of Rajshahi and Bogra have experienced a depletion of up to 13 metres from the static water table (Khan 1991). As a result, most of the STWs and HTWs which have been installed to supply irrigation and drinking water in these areas have started to run dry as the pumping head has already gone beyond the maximum suction lift limit of these devices (Khan 1991). Estimates suggest that in recent years approximately 50,000 ponds and tanks within Barind tract, north-west Bangladesh, have dried up as a result.

This region is now facing acute shortage of water for surface irrigation, drinking, and fish culture during dry season which ultimately threaten the sustainability of the environment.

These activities have also had knock on effects. Changes in groundwater level are thought to be responsible for subsidence in many areas (Khan 1989). Salinity is an ever-increasing problem, the result of unchecked extraction in many parts of south-east of Bangladesh including Brahmanbaria, Chandpur and Noakhali districts (Khan 1991). Continuous use of poor quality groundwater for irrigation is also leading to degradation of soil properties and will ultimately hamper the growth and yield of crops. Decreased dry season flow of major rivers particularly in the south-west due to infrastructural developments such as the Farakka barrage and increased irrigation in India are forcing people to increase their levels of groundwater abstraction. This has lead to subsurface sea water intrusion of major aquifers and subsequent groundwater quality deterioration (Halcrow, Scott Wilson and Partners 1996).

According to a study undertaken by Khan and Basak (1986), excessive amounts of iron were found to be present in the groundwater in parts of Dinajpur and Madhupur districts north-west Bangladesh. It has been also reported in recent years that excessive amounts of other harmful minerals such as have been found in water supplies as a direct consequence of over extraction of groundwater in Bogra, Dinajpur, Satkhira and other northern districts of the country. Arguably the most pressing environmental issue of the day in Bangladesh at the present time is the presence of toxic levels of arsenic in water supplies in various parts of the country. A Bangladesh Centre for Advanced Studies (BCAS) study suggested 49 districts (more than half of Bangladesh) are at risk of arsenic contamination (BCAS, 1997). About 220,000 people are thought to be suffering from arsenic related diseases ranging from melanosis to skin cancer. The shallow tubewells water in some areas of Chandpur, Barisal, Jesore and Kushtia are heavily contaminated by arsenic ranging from 0.01 to 3.0 milligram per litre. The water of 56 percent of tubewells are above the WHO recommended maximum tolerable limit of 0.05 mg/l.

Pollution of surface water bodies is a further threat to water supplies, and is inextricably linked to groundwater quality. The water in rivers, lakes, ponds and soils naturally contains a variety of dissolved substances which can be transported to the shallow aquifers during wet season. Application of fertilisers, particularly nitrogen in agricultural lands can add nitrate to the ground water in shallow aquifers through leaching or direct percolation. The content of dissolved salts and chemical fertilisers pass into groundwater aquifers over a period of years, leading to increases in salinity and nitrate levels in groundwater. Excessive salinity of groundwater is undesirable for irrigation as well as for drinking and industrial purposes. Bacterial contamination of groundwater in rural and urban areas from organic residues such as crop residues, homestead wastes, animal manure and sewage sludge, etc. is of concern in relation to human health. Again, groundwater polluted with chemical pesticides can pose great danger to drinking water supplies for human being and also for livestock (Khan 1991). Pesticides residues exceeding the WHO standards have been found in groundwater by projects in both rural

areas (NMIDP 1995a and 1996b) and urban areas (18-DTP 1996). The residues found were mainly persistent pesticides, such as Heptachlor and DDT.

2.5. The Realities of Life: Flood, Drought, Erosion & Siltation

2.5.1. Floods

Two thirds of Bangladesh is vulnerable to flood and almost every year between one third to one fourth area goes under water. If flood comes early, late or are higher than the normal year can be disastrous loss of crops, livestock, infrastructure and human life. According to Brammer *et al* (1993) approximately 25 percent of Bangladesh goes under water in a normal year. When high flood levels occur more than 60 percent can be submerged.

The flood problems in Bangladesh are complex and multifaceted. There are multiple consequences including other than the initial raise in water levels and its associated destruction. For example, post flood waterlogging is also a recurrent problem in many areas but one that is frequently overlooked (Adnan 1994).

The financial cost of floods is also severe, particularly one as poor as Bangladesh. The loss caused by floods in Bangladesh in a normal year is of the order of US $175 million; but in extreme cases, the damage may exceed US $1 billion dollars. The 1988 flood damage was the worst in history, totalling US $1.13 billions, with the industrial sector being worst-hit followed by agriculture (Ahmad 1994).

2.5.2. Drought

Insufficient rainfall or rainfall variability are the main causes of drought especially in the pre-monsoon and post monsoon period. About six percent of the total land area is the extremely drought prone, experiencing drought nearly every year. Bangladesh has experienced two major droughts, in 1979 and 1989, in the last 12 years, which affected almost the entire country. 1989 was the worst condition of drought ever recorded in the last forty years (Kafiluddin 1991) during which time a vast number of canals, small rivers and water bodies dried up.

Though, drought has a severe affect on rural people livelihood as well as national economy, there still appears to be little being done to establish a comprehensive management plan and the required associated measures. Bangladesh is a country has been gripped with a preoccupation with flooding whilst the consequences of drought have quietly continued to grow. Rapid deforestation, and siltation of rivers and other water bodies all continue to increase the harmful situation.

2.5.3. Erosion

A vast area of Bangladesh is affected by river bank erosion in every year. According to BWDB 1200 km of river bank are under active erosion in every year (Ahmed 1994). Land loss due to river bank erosion in the highest along the Jamuna, where the erosion rate is estimated to be between 139 and 353 hectares per year (Elahi and Rogge 1990). Of eroding river banks it is estimated that 65 percent occurs on the main rivers, 5 percent on minor rivers 14 percent of the seasonal rivers and 16 percent on the tidal rivers (Kamal 1988). Ahmed (1994) said, channel shifting is a major outcome of river erosion. During the last 200 years, the Jamuna has shifted laterally about 19 km. The Ganges-Padma has migrated eastward during the last 400 years leaving the right bank distributors like the Ichamati, Bhairab, Chitra, Bhadra, Nabaganga and Kumar almost moribund. The Meghna has shifted about 3.3 km. in the last 16 years.

Erosion, can be termed as a silent disaster, which takes away the life-support systems of whole families. Comparison of different hazards in Bangladesh illustrates that cyclones have the most dramatic consequences. Riverbank erosion is second, not in terms of deaths, but in terms of the process of impoverishment and creation of landlessness that results. Riverbank erosion has significant socio-economic and environmental impact in Bangladesh. It adversely affects the ecosystem, navigation, planned agricultural development and drainage. Serious inland water navigational constraints occur due to erosion, shifting of channel and channel migration. It is estimated that annually, 100 000 people are displaced due to river erosion and property worth several million Taka is washed away by the rivers (Hofer *et al* 1998). These people lose their homes, land and livelihood and become rural landless labours and /or squatter in urban areas.

2.5.4. Siltation

Sedimentation of the Padma (Ganges) river down stream of Farakka barrage has increased siltation in the bed thereby reducing the carrying capacity of the river in Bangladesh (Khan 1995). During flood, the river, now with a reduced storage capacity, is topped more easily resulting in increased flood damages to property and crops and increasing the threat of loss of life.

Thus the vicious circle is created as in the dry season, due to declining water levels and reduced velocity in the river flow, as a result, in part, of greater off-take upstream, numerous *chars* (sandbars) have formed in the river seriously affecting navigation and fisheries (Khan 1995).

According to Rashid (1991) the situation has been exacerbated excessive destruction of the natural vegetation in all the head-waters of the major rivers. This has led to extensive erosion and transport of sediment downstream which has increased siltation downstream.

2 6. Climate Change & Sea Level Rise

Actual observations indicate that there has been little or no increase in the average amount of temperature in Bangladesh over forty years. However, rainfall has shown an increase. This is likely to continue in future and is expected to lead to increased surface run-off with severe consequences for flooding. It is estimated that a 10 percent rise in total rainfall will increase the run-off depth by 18-22 percent depending on the region. Drainage congestion and flooding, therefore, are expected to intensify in terms of area affected, duration and depth with time (ADB 1994). A similar set of scenarios are expected in relation to sea level rise. About 11 percent of the area of the country and 5 percent of the present population (6.5 million) are under threat of inundation and loss of land if a 45cm sea level rise occurs by the year 2070 (ADB 1994). For a one metre rise, the figures are estimated to be 21 percent and 14 percent respectively.

Actual physical loss of land would only be one of many consequence of SL rise. According to the summary report of BCAS et al (1994), the primary physical effects of the agents of climate change which are considered in the study are the following:

• *Inundations* in the main flood plains of the Bangladesh rivers, characterised by the extension of the flood vulnerable area, the depth of flooding in unprotected areas and the risk of flooding in protected areas. Inundations are affected by climate changes and also by regional developments in watersheds and developments within the country.

• *Low flow conditions,* which mainly are a function of the upstream developments and the subsequent water flows across the Indian-Bangladesh borders. They are represented by: the length of time during which water levels fall below certain critical values and the minimum water levels.

• *Salt water intrusion* along the major rivers, as a function of sea level rise and the reduction of fresh water discharge in the rivers during the dry periods.

• *Flash floods,* considered to be a function of changes in monsoonal precipitation and drainage congestion in the river systems.

• *Drought,* Two special indices represent the drought sensitivity of Bangladesh in the Kharif and the Rabi seasons. They are a function of changes in temperature, evapotranspiration and local precipitation, assuming frill water availability in the surface and groundwater systems.

• *Storm surges* caused by cyclones are assumed to change in intensity.

• *River and coastal morphology.* The physical agents of climate change have impacts on coastal and river erosion and accretion processes measured as a changes in the erosion/accretion balance.

There are many additional consequences of such a sea level rise. Inundation low coastal areas would have the effect of pushing brackish water zones inland, causing stream flow salinity to rise. These effects would be most pronounced during the dry season. Salinity intrusion in surface water systems would reduce the possibilities of using stream flow as a source of water for irrigation and drinking. Moreover, low lying areas would also experience soil salinity and ground water salinity problems. Upstream river discharges and flood protecting infrastructure would also be affected. Changes in river water levels changes in bed levels as the sediments carrying capacity of rivers adjusts to the new hydrology would occur, the effects of which are unclear. Changes in rivers levels will not necessarily result in increased flooding however as river level changes may result in increased floodplain deposition. One of the more certain and worrying likely events is that cyclones which already effect coastal areas are likely to become more frequent and of greater severity (BCAS *et al* 1994).

Predictions of the affects on agriculture are also of concern. According to the report on Climate Change in Asia (ADB 1994), total agriculture production of the country will decline by the year 2030 any where between 0.8 to 2.9 million metric tons of potential outputs may be lost respectively 13-24 percent of projected output in the affected zone. These losses increase dramatically after 2030 under both the scheme and in sea level rise scenarios. Moreover, 75 percent of the Sundarbans, the main forest of the country and one of the largest single-tract mangrove in the world be lost due to the inundation. The Sundarbans constitute the largest mangrove forest in the world covering an area of about 1,000,000 ha of which about 60 percent lies within Bangladesh and the remaining in India. About one third of the total area consists of water in the form of rivers, channels and tidal creeks. It represent an area with an extremely rich diversity of plant and animal species (BCAS *el al,* 1994). ADB (1994) stated, if there is a 1 in rise of the sea level, the Sundarban will vanish forever. Such losses will have three major impacts: a major loss in biodiversity, potential adverse impacts on the global climate through loss of a natural sink and on the local climate, and thirdly a loss of supply of bio-mass, the major source of energy in the country. They also and act as one of the few remaining habitats for a wild variety of species including the Royal Bengal tiger.

The macroeconomic impacts of this will be extremely severe. Loss would be a financial burden for Bangladesh as this precious habitat provides an main sources of forest products. The annual loss in GDP by 2010 is to be US I billion dollars with predictions suggesting this would rise to nearly 5 billion dollars by 2070. There are also some numerous social consequences linked to their decline. Increased unemployment, overcrowding in urban areas, and increase in the environmental refugees would all occur if this habitat is continues to degrade.

CHAPTER 3: THE DYNAMICS OF WATER USE

3.1.Introduction

To most, mention Bangladesh and people think of catastrophic floods. Furthermore, floods are perceived as negative and destructive. However, in Bangladesh people make a distinction between abnormal floods and the normal annual floods of the rainy season. People are fully aware of the benefits, not only in terms of providing water for monsoon crops but also as a means of replenishing soil fertility and as part of the growth and reproductive cycle of fish (Kualoy 1994). The abnormal floods in 1987 led to 2,000 deaths and ruined properties but the rice yield that year was one of the highest ever recorded.

3.2.Changing Patterns of Use

Land use in Bangladesh is primarily for agriculture. About 79 percent of the total land in 1989-94 are cultivated (World Bank 1996), of which 60 percent is in crop production. Homestead, cities and inhabited lands occupy about 20 percent which forest are officially considered to come up to I percent although the latter figure is generally accepted to be a gross overestimate due to major deforestation taking place. Bangladesh has some of the world's best tropical forest vegetation which mangrove forest in the Sundarbans on the coast and other forest in the hill region of Chittagong, Sylhet and Mymensingh. The forests are important sources of economically useful timber such as teak. They are also repositories of many exotic and rare species of plants and animals. Fuelwood, along with animal dung and crops residues provide about 70 percent of the energy requirements in the rural sector.

Cropping patterns in Bangladesh are multifarious and varied according to the crops being growing the agro-ecological region, the soils and associated factors. The major crops of amon rice and jute during the monsoon rains and HYV boro rice during the dry season. Other crops such as potatoes, oilseeds, pulses and vegetables are also grown in the winter months usually.

Although there is heavy rainfall, irrigation is necessary almost everywhere to grow winter for the boro and rabi crops. At present 2.1 million hectares of all crops (mostly rice) are irrigated. Two types of irrigation systems exist in Bangladesh, one based on traditional practices which is in rapid decline and one based on modern methods which has undergone huge expansion in the last decade. Total acreage under modern irrigation has risen by almost 7 percent annually since 1973 while acreage under traditional irrigation has shown a downward trend (0.5 percent). Modern irrigation methods include low lift pumps (LLPs), shallow and deep tubewells (STWs and DTWs). Most of the irrigated land is used for cereals (90 percent) particularly high yielding varieties of rice and wheat. The

total land under irrigation is about 30 percent in 1989-94 (World Bank 1996) of the land under agriculture Total irrigated area in 1988-89 was estimated about 2.47 million ha (Rashid 1991). It is estimated that 7.5 million ha. of land are suitable for irrigation (World Bank 1996).

Over the last three decades groundwater has been abstracted from the aquifers within the major parts of the country to meet the irrigation demand as well as to supply water for domestic and industrial purposes. Dug well was the oldest methods to abstraction of groundwater. Now there are four types of tubewells used in the country. These are: deep tubewells (DTW), shallow tubewells (STW), deep set shallow tubewells (DSSTW), hand tubewells (HTW) and manually operated shallow tubewells for irrigation (mosti). The differences on the types of tubewells are based on the type of setting of pumping apparatus and depth of which it can affect the water table; they have very little to do with the depth of the well. All the pumping technologies compete for the same groundwater resource according to their water lifting capability. According to the Third Five Year Plan (Planning Commission 1985), total potential area for irrigation was estimated to be about 4.45 million hectare.

The trend growth rate of areas irrigated by tubewells has been around 9 percent over the last decade *(Table 3.2a),* (Abdullah *et al* 1997). This was propelled by growth of irrigation by STWs (10.94 per cent) during this period (1984/85- 1994/95). Areas irrigated by deep tubewells registered a slower growth -only 4.08 per cent during the period. A comparison of the growth of tubewell irrigation between the late eighties and early nineties reveals a slowdown of growth (from 10.59 percent during 1984/85-1989/90 period to 7.65 per cent during 1990/91-1994/95 period) in recent years. This attributed to a deceleration in the growth in both STW and DTW irrigation in the early nineties compared to the late eighties.

Slowdown of growth is observed to be more pronounced in the case of surface water irrigation whose share in total irrigation has decreased from 49.4 per cent in 1984/85 to 29.4 percent in 1994/95. In fact, areas irrigated by low lift: pumps as well as canals and traditional means of irrigation registered a negative growth in recent years. This tendency, combined with the slowdown in groundwater irrigation as mentioned above contributed to considerable deceleration in the growth rate of the total irrigated areas during the early and mid nineties (only 2.56 per cent) compared to the late eighties (8.39 per cent).

The importance of openwater fish production, particularly floodplain fish production for nutritional and economy of the rural people, changes in the openwater aquatic ecosystem caused by flood control and drainage (FCD) and flood control, drainage and irrigation FCDI) projects are described by Ali (1997). He stated, the water resources including their natural spread and hydrology are being continuously modified and controlled in the name of water resource development to make available more dry lands for rice production. These modifications, changes and controls of water resources have become a threat to the continuation of the abundance of natural (wild) fish and prawn, which rural people catch and consume as free common goods.

About 10 percent of the total population arc fully dependant or occasionally dependant on fishing for their livelihood in the whole year or a part of a year (Ali 1997). In the rural area almost somebody from village every household harvests fish from waterbodies throughout the year. A significant portion of the farmers are using surface water for irrigation and a large number of poor people are using for boat navigation. Surface water is use for fish culture and for rotten of jute which is the main cash crop of Bangladesh. People also use it for bathing, washing, domestic purpose, cattle washing, homestead gardening etc..

Table 3.2a: Trend Growth Rates of Ground and Surface Water Irrigation in Bangladesh

Modes	**1984185-1994195**	**1984185-1989190**	**1990/91-1994/95**
A. **Ground Water**			
1. Shallow tubewells (STW)	10.94*	12.67*	9.50*
2. Deep tubewells (DTW)	4.08*	6.32*	2.57
3. Hand tubewells (IITW)	-1.49	5.74	-4.35***
Sub-Total	8.79*	10.59*	7.65
B. ***Surface*** **Water**			
1. Low-lift pumps (LLP)	3.03 * *	7.30*	-4.18**
2. Canals	0.94	2.06	-2.66***
3. Traditional	-1.34	5.82	-10.14
Sub-Total	1.02	5.82**	-6.21 * *
Total Irrigation	5.69*	8.39*	2.56**

(Source: Abdullah *et a,* 1997)[1]

Mortuza *et al* (1995), provide evidence that the total fish stock has decreased by 23 percent (check with Sarder) to 67 percent. They suggest nine species of fishes have now reached critical levels.

Miah (1986) emphasises the need to utilise effectively the fishery resources of the country and stressed the need for adequate knowledge of scientific cultural methods and proper management practices. He also described the socio-economic and management constraints in the connection with rice/fish culture regarding there with a few possible measures.

All rivers and their tributaries overflow their banks and flood extensive areas of the low-lying lands during the monsoon season from May to October. Bangladesh has 9,300,000 ha of floodlands, including 2,834,000ha of paddy fields, inundated for four months of the year. Bangladesh also an estimated 1,400,000ha of permanent open inland-waters (Cited

I Note : Trend growth rates have been computed by fitting semi-log functions to the data. *,**,*** denote statistical significance at 1%, 5% and 10% probability levels respectively.

by Ali 1997). Ali also cites statistics provided by the MPO (1987a, 1987b), that the total area of floodplains was 6,300,723ha in the past, of which 814,114ha no longer flooded as a consequence of flood protection measures, leaving a balance of 5,486,609 ha as of 1985. About 3.36 million ha of floodplains were protected from flooding by 1990 through the construction of 7,024 km embankments, 3,017 km of drainage channels, 6,884 hydraulic structures, 1,064 river closures, and 3,888 bridges and culverts.

3.3. The Politics of Water

The Ganges water dispute dates back to 1951 when Bangladesh was the eastern province of the Federation of Pakistan and is well documented (Kvaloy 1992, Postel 1994, Postel 1996, Ohlsson, 1996, Dixit and Mirza 1997). It originated when India planned to construct a barrage at Farakka, 18 kilometres upstream from the East Pakistan (Bangladesh) border, for the diversion of water to supplement dry season flow on the Bhagirathi-Hooghly River. In spite of Pakistan's objections, India carried on with the project and started construction in 1962. The demand of the growing Calcutta and its port as well as agricultural needs of the state of West Bengal determined India's decision to go ahead with the design. With the independence of Bangladesh in 1971, it was expected that the dispute would be resolved to the mutual advantage of both neighbours in view of the assistance India provided Bangladesh during the liberation struggle. However, the political realities in both countries blocked the path of a negotiated settlement of the dispute. The construction of the Farakka Barrage and the feeder canal were completed at the beginning of 1975 and in the same year, they were commissioned on a trial basis, following the reaching of an short-term agreement signed by India and Bangladesh.

The assassination of pro-Indian President of Bangladesh, Mujibur Rehman in August 1975 marked the deterioration in bilateral relations. From January 1976, India unilaterally started to divert the Ganges dry season flow at Farakka and the new leadership of Bangladesh raised the issue in international fora. In 1977, when a new government took office in India, both the countries came to an agreement to share the Ganges dry-season water for five years. They also pledged to work on finding a long-term solution to the question of how to share the river's dry-season flow.

For the augmentation of the dry season flow, in 1978, both countries put forward their respective proposals. The Bangladeshi scheme proposed the building of upstream storage dams in Nepal, whilst India proposed a scheme to divert water from the Brahmaputra river to the Ganges through a link canal across Bangladesh. It was important for Bangladesh to involve Nepal in the project since it was seen to be more difficult for India to break a trilateral agreement than a bilateral one. India, however, only wanted to work for augmenting the Ganges at a bilateral level with Nepal because of her desire to divert the increased flow for use in it's southern part, which is chronically short of water. As a consequence of these widely differing approaches and agendas, it is not surprising that no agreement was reached. Since the 1977 agreement expired in 1982, there have been two more agreements between the contesting parties to share the rivers dry-season flow on a

short-term basis. However, from November 1988 until December 1997, there was no agreement in force and India withdrew water at its own will. Due to successive failures of the bilateral negotiations, Bangladesh has started to internationalise the Ganges water issue. In October 1993 it put the question before the UN General Assembly and Commonwealth Heads of Governments Meeting (CHOGM).

The dispute over the Ganges revolves around the question of how it's water is to be shared for the five dry-season months. During the rest of the year, there is sufficient water in the Ganges for India to draw off some of it without causing problems for Bangladesh. However, in the dry season the average minimum discharge to Farakka is falling below 55,000 cusecs, of which India wishes to divert 40,000, whilst Bangladesh argues it needs virtually all of it to avoid environmental problems.. Increased upstream withdrawal in northern India has further lowered the dry-season flow at Farakka, further complicating the situation. In 1993 Bangladesh received only 7,000 cusecs in the most acute period. It is believed flow at the Farakka is now nearer 45,000.

India's withdrawal of water upstream is based on the argument that it has sovereignty over the water resources flowing in its territory. Bangladesh does not posses the powers that, for example Egypt does, to safeguard its own requirements. The huge population growth and intensified use of water in the agricultural sector has been multiplying the frequency and level of scarcity in the Ganges basin. A Joint River Commission has been established since 1974 but holds advisory powers only. The conflict has fallen short of force simply because of the dominance of one parry. However, the unarmed character of the conflict should not lead to an underestimation of the strength of feeling, especially given the general decline in Indo-Bangladeshi relations over the past 20 years (Corell and Swain 1995).

The need and advantages of a long-term solution are clear. This would help in the control of flooding, reduce the problems associated with drought, provide cheap energy, assist human resources development and poverty alleviation and halt degradation of environment in each co-riparian state (Khan 1994). The stability, or rather reduced uncertainty would also led to economic benefits as agricultural production could take place with less time need for the building in of contingencies.

Ahsan (1994) examined in a preliminary way the question of co-operation among Bangladesh, Bhutan, India and Nepal the riparian states of GBM region or so-called Easter river. He said, the area is rich in water resource but there is no regional approach to their development. It is important to promote co-operation to generate public awareness about the benefits. Initiative of co-operation by way of shaving of information about one another's future plans and programs as relevant.

The various dimensions of an integrated management and development of the GBM river basins has bead developed in this paper. The non-integrated nature of the decision to build the Farakka Bangladesh has been highlighted. Water sharing point in the integrated approach is surely water sharing arrangement among the co-riparian countries. In this

contains a long-term argument forth sharing of the Ganges water between Bangladesh and India at Farakka is an important element. Similarly, there are nagging water related problems between India and Nepal which cal for urgent resolution. In this whole process of inter-country integration, there is a crucial need of political will at the highest level in each of the countries generating positive approaches and transparency in the negotiations for moving forward together towards a better further, discarding the path of exclusion and hence privation and self-abnegation. The other dimension of integration will need to be developed simultaneously in order to pursue socio-economic development vigorously as opportunities are created by inter-country cooperation on water issues.

Water resources development had been and will continue to be a key factor in the economic development and the fabric of life of the people of Bangladesh. Failure to develop the water resource of the GBM river with an integrated and comprehensive approach towards optional utilisation of water resources causes suffering of millions of Bangladesh from the misery of higher, disease, hardship, and poverty (Nishat 1992).

Abbas (1992) stated that co-riparian cooperation is necessary for a lasting solution of the problem and optimum development of the water resources of the river basins. Bilateral discussion between Bangladesh and other co-basin states of the Ganges and Brahmaputra river basin an now in progress about the flood problem. It is hopped that these bilateral actions will lead to broader regional cooperation.

CHAPTER 4: WATER MANAGEMENT AND WATER SECTOR PLANNING

4. Introduction

Water is the mainstay of Bangladesh and also the main cause or means of disasters. It's great rivers: the Ganges-Padma, the Brahmaputra-Jamuna, the Meghna, and their associated tributaries discharge about 5 million cubic feet per second into the Bay of Bengal at peak periods. The annual sediment load of the rivers has been estimated between 1.5 and 2.4 billion tons (Rahman 1990). This vast outflow is second only to that of the Amazon system, whilst in breadth and total annual volume the Padna-Lower Meghna is the third largest river in the world. The complexities and scale of these rivers, linked to the country's physiography, extremes and variability in climate and the socio-economic vulnerability of the population all go to create a pressing, extremely difficult situation to manage.

4.2. Water Management : The Concept

Traditionally, water management in Bangladesh for agriculture, 'fisheries, domestic use and cottage industries has relied on rainfall and river water. Modern methods of low lift pumps, deep tubewells and irrigation canals have led to the utilisation of surface and the ground water for agriculture during the dry season, and more recently during the wet season to. The main constraint for the growth of agricultural production through irrigation during the dry period is the scarcity of surface and ground water when it is needed most (Hossain 1991).

The term water management has different meanings to different people. Management has been defined as the process and activity of carrying out the task so that a number of diverse activities are performed in such way that a defined objective is achieved by the combined efforts of a group of people (F'ernch and Saward 1975, Ghani 1987).

Bishop (1974) defined water management in a comprehensive way as the space-time - quantity alteration of the water resource in and between various water uses to meet societal goals. He further emphasised water management technology is a combination of science and art that requires application of knowledge of water, soil, climate, crops, and their interactions together with inputs and management for agricultural production.

Angeles (1986) using the term in relation to agriculture, defined water management as "the integrated process of diversion, conveyance, regulation, measurement, distribution and application of rational amounts of water at the proper time and removal of excess water from the farm to promote increased production in conjunction with improved cultural practice".

Wickham, Valera and Singh (1977) took a slightly different view emphasising the multiple nature of the term and the practice. To the farmer good water management may be mean being able to grow a crop with adequate water from the beginning to the end of growing season and to have enough water to plant second crop with the same year. On the other hand, to the irrigation system management personnel, good water management means careful application of water to the field so that over -irrigation and drainage losses are reduced.

4.3.Historical Context of Water Management

4.3.1. Pre Colonial Period

There is little concrete evidence to suggest how the pre-Mogal government had organised their water management system. Fortunately, there are abundant records that refer to water management during the Mogul period. The Mogul provincial government maintained an independent body, with its own budget, to manage and monitor embankments, roads, bridges, and river dredging, known as *pulbandi daftar or pushtabundi.* The functions of the *pulbandi dafter* were delegated to the local zamindars who received the budgetary allocations from the government in the form of a deduction from land revenue collected by them from the parganas under their charge. To supplement the central budget the zamindars were allowed to raise further funds, if necessary, locally by imposing *abwabs* and *mahtuts* on the *raiyats.* To repair the roads embankments or erect a new or to dig canals and *nalas* to safeguard the lands and crops from inundation or draught remained obligatory to the zamindars of the period. The zamindars had to take regular steps to protect their crop fields from being flooded during the rainy season. Apart from these responsibilities, the zamindars had to render assistance to similar kind of work sponsored by the government.

Great importance was given to the regular maintenance of bridges, roads, embankments and other water works. To keep constant watch on their conditions there was a class of field menials called *paushban.* They also known as *astapahari* or *atgarias.* Any breach in the public works was at once reported to the zamindars who then alert the *gramsaranjami* or village establishment for taking timely action. The village *gramsaranjami* was a body of village officials and volunteers in charge of making and maintaining the water works including the dredging of rivers. The village *panchayat* or village elders under whose direction *gramsaranjani* worked, were ultimately responsible for the upkeep of its own works and for that the village people often required beggar or free labour.

All works of flood and irrigation management within the limits of a mouza were looked after by the village *panchayet,* and similarly, all works of the same nature within a zamindari were looked after by the concerned zamindars, and the process ascended up to the supreme government.

For maintaining the rivers the zamindars, under the instruction of the central government, maintained *chowkis* or rivers establishments for keeping the river navigable and safe. As

it was a costly affair, the government levied tolls on the users of rivers, specially inter district trading boats.

One may say that Bengal's agricultural prosperity during per-colonial period was due to the highest priority that was paid to water management. The pre-colonial regimes took agriculture as the basis of their power, and hence all possible measures were taken to improve husbandry and product crops from preventable nature calamities. Therefore, rods, embankments, bridges, and canals were constructed with the view to achieve a power preservation and distribution of water in the situation of floods and droughts (Ahmed 1991).

4.3.2. Colonial Period

During the British period the *pulbandi defter* was abolished, the state support to the glampanchayet was withdrawn, the *gramsaranjami* was dissolved and so were the river *chowkis* zamindars were relived of this traditional *pulbandi* duties. As a result, the zamindars and tenants of central Bengal neglected the clearing of the canals and the repairing the banks. Over time the neglect of water management led to a number of serious problems for the region. Embankments, reservoirs and tanks gradually declined due to a lack of maintenance. Water logging, drainage, salinity and silting up of the river beds and canals and at times sudden changing of course by rivers become the salient features of the water system in the province (Ahmed 1991). The cumulative result was frequent flooding.

According to Ahmed (1991), the gross insensitivity of the ecology of the province was also formed the mainstay for the railway construction programme undertaken in this part of the province in 1897. The railways also created problems of waterlogging in various part of the province. The area to the east of Kulaura-Sylhet railway line was particularly badly affected.

4.3.3. Post Colonial Period

Prior to the partition of the sub-continent in 1947 there was no planned effort to develop irrigation or mitigate floods in areas which now constitute Bangladesh. People were left to adjust to the whims of nature till recent times (Nishat 1992). As early as September, 1947 the attention of the government was drawn to the conditions of rivers and rivulets, canals and marshes, ditches and drains which needed re-excavation. Innumerable canals and a large number of rivers had been silted up such as Ichamati in Dhaka, Karatoa, Ichamoti in the north Bengal, the Gazna beel in Pabna, and Satla Beel in Barisal. The canals between the Brahmaputra and the Dhaleshwari were in bad step. The situation deteriorate every year.

Immediately after independence (1947), a Five Year Road Plan was initiated by the government which set a target of five thousand miles of good road in the province. By August 1951 work on two thousand miles was nearing completion. The very ambitions

scheme of road building should an equally large degree of callousness towards the ecology of the province. The hinging of many, the priority was worn. The suggested that irrigation should have received priority over road building.

The unprecedented 1954 and 1955 floods triggered attention to development of water resources by underscoring the need to revise the benign neglect towards the water sector. UNDP assistance was sought and in 1957 the Krug Mission reviewed the situation and investigated projects to develop the large rivers and prepared the first major study report. The Krug Mission considered remedial flood control measures, such as the proposal for barrage on the Brahmaputra (at Bahadurabad) and on the Padma (near Faridpur) to divert monsoon flood flames and utilise water for irrigation (Nishat 1992). The setting up of East Pakistan Water and Power Development Authority (EPWAPDA) in 1959 followed the mission report. The EPWAPDA was assigned the responsibilities for water resources development, that as to plan, design, construct, operate and maintain mater development scheme (Nishat 1990).

When the East Pakistan Agricultural Development Corporation (EPADC) was aerated in 1961, its charge included implementation of small-scale irrigation projects through low-lost pumps and tube wells. EPWAPDA prepared a water master plan in 1964 which proposed a long-term programme for integrated development of land and water resources during the twenty years from 1965 to 1985; its goal was attainment of self-sufficiency in food grains for the growing population by 1975. The plan identified 51 major development projects throughout the country and there major barrages on the Ganges, the Brahmaputra and the Meghna IBRD/IDA (1964). A major embankment programme, the coastal and Brahmaputra right Embankment under the master plan was drawn up by International Engineering Consultants (IECO). Irrigation at this stage was integrated with Flood Control & Drainage (FCD). A World Bank mission reviewed the plan in 1966 and proposed a serviced development strategy for achieving agricultural self-sufficiency that was built around incremental, rapid, and small projects requiring limited institutional support. The Bank emphasised improved agricultural practices, inputs in areas not affected by severe flooding, and winter cropping during flood-free months.

In the 1960s in respect of minor irrigation was the model developed by Akther Hamid Khan of Comilla Cooperative fame (Ahmed 1991). He introduced a thana irrigation programme with the aim to use to the fullest extent the available resources by mobilising the local people where BADC was to give supportive services by setting up workshop in each then to provide necessary technical inputs. Then the Thana Irrigation Programme (TIP) was essentially a programme to form irrigation cooperatives and install irrigation equipment at suitable sites. It was based mostly on Low Lift Pumps (LLP), but Deep Tubewells (DTW) were not excluded.

This programme brought about a green revolution in Comilla by the late 60s 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). The experience of IRDB and BRDB is well documented

now to suggested that the minor irrigation technology lacked the kind sustenance within the IRDP/BRDB strategy which it had received from the people of Comilla under the leadership of Akter Hamid Khan (Ahmed 1991).

Towards the late 1960s irrigation become an important concerned minor irrigation stated getting attention in the official policy. EPADC was emphasis on minor irrigation continued throughout the 1970s.

4.3.4. Bangladesh Period

Following Bangladesh's Liberation in 1971, the water wing of EPWAPDA was changed to Bangladesh Water Development Board (BWDB) and the EPADC to the Bangladesh Agricultural Development Corporation (BADC). In 1972 the World Bank completed a Land and Water Resources Sector Study. That 1972 study attached high priority to small and medium sized, quick-yielding, low-cost, labour-intensive projects, deferring long-term, large-scale projects. Which this background Bangladesh launched three plans following the same incremental irrigation strategy during the years of 1973-1978, 1979-1980 and 1981-1985.

At the macro level, water resource planning started within a broad framework of Flood Control, Drainage and Irrigation (FCDI). The government of Bangladesh (GoB), through BWDB, has so far completed 544 projects, of which 24 are recognised as irrigation projects (Ahmed 1998). Most of the FCDI projects, particularly the big ones, are characterised by delays in completion, cost overruns, poor maintenance and very little cost recovery. Critics hold that FCDI projects raise river beds and prevent siltation on lands which are consequently deprived of nutrients and become geomorphologically risk prone (Hossain 1989).

Development of other water use sectors did not attract as much attention and support as the agricultural sector. The navigation sector in particular suffered. As the development of the road sector took place in earnest, rivers were allowed to silt up and the total length of navigation route gradually shrunk so that today " Bangladesh has been known as a land of rivers; water navigation remains the cheapest, if not the major, mode of transport. The rivers of Bangladesh, provide about 5,000 kilometres of inland waterways, of which about 1,000 kilometres is seasonal. However, almost all the minor and medium sized rivers in the upper parts of the country silt up during the dry months, virtually eliminating navigation. Siltation is a prominent in major rivers also, and shoal formation hinders steamer and ferry services" (Nishat 1992)

The fisheries sector also suffered as more and more water bodies were drained to bring in more land under winter cultivation. This was further aggravated by inflexible flood control infrastructures that were constricted and prevented the process of natural stocking of the inland water bodies through the migration of young fish from the main spawning grounds.

The water user and development agencies all pursued their development efforts independently and inevitably conflicts surfaced among various uses and users. The GoB, through the Master Planning Organisation (MPO), established the National Water Plan (NWP) to co-ordinate utilisation among users and maximise the benefits from water sector investments. The first phase of the NWP, which was published in 1986, contained substantial amounts of information and analyses. These were primarily based on a conventional assessment of the water resources base (concentrating mostly on surface water) and sectoral patterns of demand, with projections of both used as the basis for defining needs, scarcities and planning priorities. The second phase, which was published in 1991, was based on the same approach, but was rather overtaken by the advent of the Flood Action Plan (see below).

The NWP paid maximum attention forward increasing food grain production through rapid expansion of groundwater development projects and easy-to-construct flood control and drainage schemes. In preparing the NWP, the Master Plan Organisation (MPO) compiled all available relevant data and established a baseline. It assessed the resources available and demands at various future projections and development scenarios. Options for water resources development based on a long-term view have shown that the surface waters of the main rivers would be the decisive factor to a long-term sustained development, but this analysis failed to appreciate many of the complexities of water resources and their management in Bangladesh. It certainly fell far short of being an integrated, comprehensive plan, with inadequate analysis of the dynamics of sectoral interactions or the nature of resource-use relationships. The NWP was consequently a classic example of comprehensive water sector planning in the era before an integrated water resources management approach gained wide acceptance. The emergence of such an approach in Bangladesh is discussed below.

4.4. The 1987 and.1988 Floods

In 1987 and 1988, Bangladesh affected by the two severest floods on the record. The 1988 flood in particular was catastrophic and occurred as a result of the synchronisation of the peak floods on the major rivers (Abbas 1989). More than 60 percent of Bangladesh was affected. The flood claimed the lives of at least 1500 people, countless livestock and poultry, and washed away or damaged innumerable houses, schools, roads, bridges and standing crops (Shahjan 1989). Some 81,831 sq. km were affected. Crops covering 4.26 million hectares of land were totally damaged while that of 3.28 million hectares were partly damaged (Matin 1989). Immediately after the flood, the President estimated crop damage to be in the order of three million tons. The extent of total loss is estimated to be equivalent to 50 billion Taka (Ahmed 1989).

A number of articles and letters appeared in the daily newspapers and periodicals regarding the floods and potential solutions. Abbas (1989) critically reviewed all the arguments as to the causes of the flood and concluded that heavy rainfall in the upper catchment, particularly of the Bralnnaputra was the principle reason. He disagreed that

problems relating to siltation, caused by erosion in the upper reaches of the catchment were a key cause. However, several researchers disagree (Hofer et al 1997). After looking at the hydrological data, Hofer et al concluded that the unusually high hydrological input from the Meghalaya Hills and that this correlates well with the flood dimension in Bangladesh. He concludes that rainfall in the Maghalaya Hills was important, perhaps even decisive, in causing the devastation whilst high water levels in the India Ganges plain, were less important.

4.5. The Evolution of FAP

The 1987 and 1988 floods and consequent donor interest stimulated the GoB to undertake a comprehensive review of the planning approach of on going activities. Immediately after the floods, work began on a range of flood policy and flood preparedness studies. The majority of these were carried out by professionals from Japan, France and USA.

Haggart *et al* (1994), provide one of the most succinct, if somewhat populist, summaries of the process that led to the development of Bangladeshi's Flood Action Plan (FAP). The French government, spurred on by the then French First Lady, Danielle Mitterrand who witnessed the floods first hand and whom pledged to mobilise international support, appointed a team of 30 volunteers to find as they famously termed it at the time, "a permanent solution" to Bangladesh floods. The French engineers proposed high embankments should be built along both sides of the countries three main rivers. The walls were to be an average of 4.5 in high and to extend along 3,000 to 4,000 kilometres of river, and was estimated to cost $5-10 billion.

The Japanese and Americans, wary of letting the French get the inside track on the inevitable contracts to implement whatever plan emerged, developed their own flood control schemes. The Japanese and American approaches were sceptical of large infrastructural developments. The US team in particular suggested an alternative approach which recommended measures to reduce the vulnerability of people living in flood-prone areas, improved forecasting and warning systems and better information sharing and dissemination with countries upstream (Haggart *et al* 1994).

The proposals were eventually reviewed in July 1989 by the GoB and World Bank, who then recommended an integrated approach for flood mitigation based on the concept of "controlled flooding" to be implemented over next 20 to 30 years (Nishat 1990). Based on the studies carried out by a joint team of local and expatriate experts `eleven guiding principles' were drawn up on which the Flood Action Plan was based (World Bank 1989). Since this time, flood control, irrigation and drainage projects (FCDIs) have accounted for about half of funds spent on water development projects.

Despite this, the benefits have been less than envisaged and numerous negative impacts have developed. There are a number of reasons for this, including cost and time overruns (due to a number of factors such as land acquisition) and problems in the operation and

maintenance of projects. There is a tendency to see projects as being finished when the physical works are complete. Insufficient attention is paid to ensuring adequate water control. Problems in the operation and maintenance of projects have also been common, as is indicated by the frequent cutting of embankments by the public and malfunctioning of regulators and water control structures (Nishat 1990).

According to the FPCO (1995), the FAP started with 11 main components and 15 supporting studies and pilot projects. The main components were made up of several regional and urban planning studies, feasibility studies for projects and special programmes on flood forecasting, early warning, and flood preparedness. The supporting studies were intended to provide the planning principles, criteria and data inputs for the planning studies. During its first five years, the FAP evolved from its original focus on physical control interventions to a more comprehensive approach towards water management. Despite coming under fire from developmental experts and environmental activists almost from the start, there were some notable achievements of the FAP in the first few years. These included the formulation of standard guidelines for project assessment, participatory planning and environmental impact assessment. A manual for EIA was also prepared. National and International workshops were organised where a number of experts, NGOs and donors were attended. Yet despite these achievements and the major adjustments the FAP has undergone, there are still numerous areas that need addressing. Soussan *et al* (1995) noted the keys ones, which included:

- considerable strengthening and restructuring of FPCO, WARPO and BWDB and improvements in their links to other government agencies are required before any substantial water development programmes can be contemplated. Future institution building would require a clear perspective of the role of the private sector. The necessary legal and regulatory environment for including private investment in water resource development will have to be ensured;
- future development and testing FAP's participatory approaches to planning, implementation, O & M, and evaluation are needed;
- a proper emphasis on poverty, employment, resettlement, and gender bias is required if socially acceptable development is to take place;
- the guidelines for environmental impact assessment and research and training programmes, carried out under FAP, need to be build on and expanded in a more decentralised, regional programme for suitable development; and
- the different FAP regional and associated project planning studies will have to be brought together into an overall national water plan.

Flood protection projects remain a somewhat controversial subject in Bangladesh. The Brahmaputra right embankment is frequently breached by the erosion of river banks and polder embankments in the Chalan Beel in the north-west are frequently cut by people who feel their lives or crops are threatened either by higher, confined river levels or by

water ponded inside embankments when high external river levels prevent drainage through sluices. Poor maintenance also leads to breaching of embankments and embankments along tidal rivers are regularly cut by shrimp farmers to let brackish water onto their land, which makes paddy land saline (Brammer *et al* 1993).

Engineering knowledge and local or indigenous knowledge can conflict with each other, because the FAP planners have ignored the knowledge developed by the rural contains the analysis of the statements and accounts of the chase, which gives the synthesis about these coping strategies and actions during flood and erosion which an recurring phenomena and have an inherently part of this would (Schmuck-Widman 1996).

4.6. The Rising Tide of Unrest

Given the context of Bangladesh, it is difficult to imagine a set of issues that could have aroused stronger emotions and responses than the FAP. Criticism of the FAP was almost immediate and was founded on several fronts. Firstly was the democracy argument. The government of the day was that of General Ershad, who took power after a military coup in 1982. This led, in part, to the second criticism, the fact there was virtually no public consultation regarding FAP. The FAP contained assurances of beneficiary involvement but virtually none took place.

As a consequence, many organisations in the voluntary sector began to mobilise support for an anti-FAP campaign. This led to several highly critical publications. Amongst the first was that by Research and Advisory Services (RAS), a well respected NGO based in Dhaka. Their publication was carried out as an independent review outside the framework of the FAP (RAS 1992). The report is possibly the best at setting out the social and historical context of the FAP, highlighting the importance of the process of construction and operation of FCD/I structures in the previous decade in determining the form of the FAP. The report was highly critical of the FAP stating that there had been, and continued to be, virtually no participation in the process. They concluded that the process for participation outlined was minimal and that the experiences to date suggested that the minimal standards for participation laid out in the FAP were not even being met.

Adrian (1991), like many, questions the wisdom of spending millions of dollars on FAP, and questioned whether in the long-term FAP projects will be found to have been at all beneficial to the people of Bangladesh.

The book "Rivers of Life" by BCAS and Panos (Haggart *et al* 1994) is possibly the best known critic of the FAP. BCAS had, and continues to be one of the most active critics of FAP from its inception. The book is based on the findings of a number of Bangladeshi journalists who aimed to produce a non-technical book based on a balanced look at the FAP. The result was, like that of RAS before it, a scathing attack of the FAP and the FAP process. The book highlighted the lack of participation and debate regarding FAP and

crystallised environmental concerns of many of the proposed schemes. Many others publicised the lack of participation of the proposed recipients of the benefits of the FAP.

Even the FAP's own reviews have frequently been less than positive about the process. A report by the Dutch Ministry of Foreign Affairs (MFA) concluded that two of the criticisms most frequently levelled at the FAP, namely its unwillingness to accord sufficient weight to supporting, non-technical studies, and that the leading institutions, primarily the FPCO but also the BWDB were insufficiently oriented to an integrated approach to water management were correct (MFA 1993). It states that FAP's attention to non-technical aspects of water management was far from convincing. It also states that past experience with BWDB projects shows that, while target-group oriented projects in water management are not impossible, they are laborious and achieve only small-scale success.

4.7. The Water and Flood Management Strategy and Beyond

In 1995, as a consequence of the combination of the continued anti-FAP campaign, the concerns expressed by the donor community over both this campaign and the viability of technically-based solutions and, not least, the findings of the FAP studies themselves, the need for a new approach to water resources management in Bangladesh was accepted. In response to this, the GoB produced the Water and Flood Management Strategy (FPCO 1995). It recommended a five-year programme which involved the preparation of a national water management plan, strengthening of water sector organisations responsible for planning, construction, and operation and maintenance, as well as the implementation of a compact portfolio of high priority projects.

This was in part an approach which reflected an acceptance of the reality that major interventions based on a concerted programme of structural investments was only "a long-term possibility if the macro-economic, environmental and other issues could be satisfactorily addressed" (FPCO, page 1). This mixture of principles and pragmatism has become characteristic of the approach to the water sector in Bangladesh in recent years and persists to the time of writing. Part of this process is the emergence of a new dialogue between the government, the NGOs who were the most verciferous critics of FAP and other constituencies on the way forward.

This emerging consensus is reflected in the First Draft National Water Policy, which was published towards the end of 1997. Although still a draft and not yet established national policy, this document enshrined the acceptance, at the policy level of government at least, of the basic concepts associated with integrated water resources management. It established the need to take account of both all aspects of water resources and all types of uses of these resources. It is based explicitly on the recognition of the need to integrate all stakeholder interests in decision-making, enshrines principles of participatory development as the central tenet for water resources management and establishes the need for a process of structural reform to the institutional context of the water sector in

Bangladesh as a pre-condition for effective management of these critical resources. At the time of writing, this draft policy document was being discussed, but the general direction of the discussion has demonstrated both the commitment of the GoB to this approach and the generally positive response which it has elicited from most commentators.

CHAPTER 5: CONCLUSION

This report has reviewed a wide range of issues concerned with water resources and their management in Bangladesh. In doing so, the authors have been conscious that there has been a tremendous amount written on these issues (hence the length of the annotated bibliography which accompanies the report), but that these many texts rarely provide a coherent overview to the sector as a whole. This report seeks to provide this. We have felt that this is a particularly critical task at the time of writing and within the context of the project of which this report forms a part.

What is clear from the discussion set out above is that these issues can only be understood as part of a dynamic and evolutionary process, or rather series of parallel processes. The resources themselves are inherently dynamic, being characterised by great variability over time and space and by temporal change in some of their most basic characteristics. Similarly, the patterns of demands placed upon these resources are both variable and changing, with growing populations, new patterns of economic activities, new technological opportunities and changing aspirations and expectations leading to increased and multiple demands on the water resources base. Finally, the nature of approaches to the management and planning of these resources is in the middle of a dynamic change of major importance that, if followed through, will alter the whole institutional context within which local-level water resources management takes place.

It is hoped that the analysis presented here will, in conjunction with parallel reports on rural change and indigenous technical knowledge, help to contextualise the field research programme which lies at the heart of this project. Taken together, these reports provide a background against which the field research results can be understood. They have also been of central importance in assisting the researchers to understand what issues should be examined in the field (and indeed have been fundamental to changes in the original research proposal to include more work on the analysis of issues such as domestic water quality and comparative studies of other areas of Bangladesh). It is hoped that other researchers will find them of similar value.

Ahmad, Q.K., Nilufar, A. and Shajahan R.K.B., (eds.) (1994)
Resources, Environment and Development in Bangladesh: With Particular Reference to the Ganges, Brahmaputra and Meghna Basin
Academic Publishers, Dhaka, Bangladesh

Ahmed, K. (1991)
Institutional Aspect of Sustainable Development: A Case Study on Water Resource Management.
IUCN/NORAD, Dhaka, Bangladesh

Ahsan, A. (1994)
The Prospects of Regional Co-operation for the Development of the Water Resources of the Eastern Rivers of South Asia In: Ahmad, Q.K. *et al* (1994) *Management of International River Basins and Environmental Challenges*
Academic Publishers, Dhaka, Bangladesh

Ali, M.Y. (1997)
Fish, Water and People
University Press Limited (UPL), Dhaka, Bangladesh

Asaduzzaman, M. and Kazi, A.T. (1997)
Rice and Fish: Environmental Dilemmas of Development in Bangladesh. In; Growth or Stagnation? A Review of Bangladesh's Development 1996
The University Press Ltd., Dhaka, Bangladesh

Barman, ? (1997) (need details)

BBS (1997)
Statistical Pocketbook of Bangladesh 1996
Bangladesh Bureau of Statistics (BBS), Dhaka, Bangladesh

BCAS, Resources Analysis Ltd. and Approtech (1994)
Vulnerability of Bangladesh to Climate Change and Sea Level Rise
Bangladesh Centre for Advanced Studies, Resource Analysis and Approtech Consultants Limited.

Brammer, H. (1997)
Agricultural Development Possibilities in Bangladesh University Press Limited (UPL), Dhaka, Bangladesh

Brammer, H.M., Asaduzzaman, M. and Sultana, P. (1993)
Effects of Climate and Sea-Level Change on the Natural Resources of Bangladesh
Bangladesh Unnayan Parishad (BUP), Dhaka, Bangladesh

Chowdhury, K. H. and Azizul, H. B. (1990)
Environmental Processes: Flooding, River Erosion, Siltation, and Accretion - Physical Impacts. In: Rahman, A. et al (eds.) Environmental Aspects of Surface Water Systems of Bangladesh
University Press Limited (UPL), Dhaka, Bangladesh

Corell and Swain (1995) (details needed)

Dixit, A. and Mirza, M.Q. (1997) Who's Afraid of Farakka's Accord? *HIMAL South Asia, January/February*

Elahi, M. and Rogge, J.R. (1990)
Riverbank Erosion, Flood and Population Displacement in Bangladesh
Riverbank Erosion Impact Study (REIS), Jahangirnagar University, Savar Dhaka, Bangladesh

FAO/World Bank (1981)
Bangladesh Deep Tubewell Project Report Food and Agriculture Organisation, Rome

FPCO (1995)
Bangladesh Water and Flood Management Strategy
Flood Plan Coordination Organisation (FPCO), Dhaka, Bangladesh

Ghani, A. (1987)
Improved Water Management for Rice Irrigation System in Bangladesh
DPhil Thesis, Agricultural and Irrigation Engineering, Utah State University, Logan, Utah, USA

Halcrow, Scott Wilson and Partners Ltd. (1996) *Groundwater Development Potential and Limitations (Draft)*
Ministry of Agriculture, Government of Bangladesh, Dhaka, Bangladesh

Hamid, M.A. (1981)
Irrigation Technology, Rural Institutions and the Rural Poor in Bangladesh. In: Greeley, M. and Michael, H. (eds.) Rural Technology, Rural Institutions and the Rural Poor
CIRDAP, Comilla, Bangladesh

Hassen, N. (1988)
Water Use and Operational Procedures of a Farm Reservoir in Tarlac
Masters Thesis, Institute of Graduate Studies, Central Luzon State University, Munoz, Nueva, USA Ecija, Philippines

Hofer, T. and Messerli, B. (1997)
Floods in Bangladesh; Process Understanding and Development Strategies Institute of Geography, University of Beren, Switzerland

Hughes, R., Adnan, S. and Dalal-Clayton, B. (1994)
Floodplains or Flood Plans? A Review of Approaches to Water Management in Bangladesh
International Institute for Environment and Development (IIED), London

Islam, M. (ed.) (1997)
Gangar Pani Bantan Chukti O Antarjatik Prekkhit Dibya Prokas, Banglabazar, Dhaka, Bangladesh

Kafiluddin, A.K.M. (1991)
Disaster Preparedness for Bangladesh Floods and Other Natural Calamities Salauddin and Taslim Jahan, Dhaka, Bangladesh

Khan, A.H. (1994)
Development and Management of International River Basins: The Ganges Issue In: Ahmad, Q.K., Ahsan, A., Rasheed, KB.S, and Khan, A.H. (1994) Management of International River Basins and Environmental Changes
Academic Publishers, Dhaka, Bangladesh.

Khan, A.H. (1995)
Ganges Water Sharing: An Overview. In: Hasna, J. M. (ed.) Women for Water Sharing Academic Publishers, Dhaka, Bangladesh

Khan, L.R. (1989)
Effects of Groundwater Abstraction Inside Dhaka, Bangladesh City. *Bangladesh Quest, 1, 2*

Khan, L.R. (1990)
Groundwater Resource Development and its Environmental Impacts in Bangladesh Perspective
Quest Bangladesh, 2, 1

Khan, L.R. and Basak, B.C. (1986)
Suitability of Groundwater for Irrigation use in Sadar and Trishal Upazilas of Mymenshingh Districts.
‚Journal of Agriculture, 11, 4

Kvaloy, F (1992)
NGOs and People's Participation in relation to the Bangladesh Flood Action Plan Norwegian Ministry of Foreign Affairs, Oslo

Matin, M.A. and Hussain, A. (1989)
Hydrological Aspects of 1989 Flood. In: Ahmad, M. (ed.) Floods in Bangladesh Community Development, Dhaka, Bangladesh

Miah, M.I. (1986)
Prospect of Fish-Culture in Rice-Fields in Bangladesh *ADB News, xiii, 2*

Mirza, M.M.Q. and Subrata, P. (1992) *Prakritic Durjog O Poribesh*
Centre for Environmental Studies and Research (CESR), Dhaka, Bangladesh

Mortuza, M.G., Parween, S. and Hossain, M.A. (1995)
Impact of Flood Control and Drainage (FCD) Project of Fishes in the River Barnai *Bangladesh Journal of Zoology, 23, 2*

MPO (1985)
National Water Plan Project In: MIWD & FC Final Draft Report, Vol. II Ministry of Irrigation Water Development and Flood Control Dhaka, Bangladesh

MPO (1987)
The Ground Water Resource and its Availability for Development In: MIWD & FC Report No. 5, Ministry of Irrigation Water Development and Flood Control Dhaka, Bangladesh

MPO (1984)
National Water Plan Project
Master Plan Organisation and HARZA Engineering Company International, Dhaka, Bangladesh

Nishat, A. (1990)
Background Paper on Water Resources and Flood Control
Department of Water Resources Engineering, Bangladesh University of Engineering and Technology, Dhaka, Bangladesh

Nishat, A. (1992) *Bangladesh's Opportunity Cost*
The Lyndon B Johnson School of Public Affairs, The University of Texas at Austin, USA

Radosevich, G.E. (1983)
Ground Water Development & Management in Bangladesh: Institutionalising a Strategy (need details)

Rahman, A.A., Huq, S. and Conway, G.R. (1990) *Environmental Aspects of Surface Water Systems of Bangladesh* University Press Limited (UPL), Dhaka, Bangladesh

Rashid, H.E. (1991) *Geography of Bangladesh*
University Press Limited (UPL), Dhaka, Bangladesh

Sattar, A. (1992)
Water Management and Technology Adaptation for Direct Seeded Rice in an Irrigation System
D.Phil. Thesis, Institute of Graduate Studies, Central Luzon State University, Munoz, Nueva Ecija, Philippines.

Schmuck-Widman, H. (1996)
Living with the Floods: Survival Strategies of Charland Dwellers in Bangladesh Duisberg-Gesellschaft E.V., Berlin, Germany

Shajahan, M. (1989)
The Devastating Flood of 1988. In: Ahmad, M. (ed.) Floods in Bangladesh Community Development Library, Dhaka, Bangladesh

Shamsuddin, S. and Rafique, A. (1974) Variability of Annual Rainfall of Bangladesh
Journal of the Bangladesh National Geographical Association, 2, 1

Sir MacDonald and Partners (1982)
Water Balance Studies (North- Bengal) Final Report.
Bangladesh Water Development Board and United Nations Development Programme, Dhaka, Bangladesh

Sobahan, R. et a1.888 (1997)
Growth or Stagnation? A Review of Bangladesh's Development 1996 University Press Limited (UPL), Dhaka, Bangladesh

Soussan, J., and Koudstall, R. (1995)
Final Evaluation Study of' the Systems Rehabilitation Project: Main Report Ministry of Foreign Affairs, The Hague.

Soussan, J. (1998)
Final Evaluation Study of'the Systems Rehabilitation Project: Main Report Ministry of Foreign Affairs, The Hague

Soussan, J. and Datta, A. (1998)

Final Evaluation Study of the Systems Rehabilitation Project: Social and Economic Impacts
Ministry of Foreign Affairs, The Hague.

Soussan, J., Savenije, H. and Rijsberman (1998) *Water for the Future*
Ministry of Foreign Affairs, The Hague

Swain, A. (1993)
Conflicts over Water: The Ganges Water Dispute *Security Dialogue, 24, 4*

World Bank (1996)
Social Indicators of Development
John Hopkins University Press, London, UK

ANNOTATED BIBLIOGRAPHY

6.1 Introduction

This annotated bibliography has been produced to support the review of indigenous knowledge and water resource. It forms part of the Department For International Development (DFID) funded research project, "Sustainable Local Water Management Strategies in Bangladesh - Meeting Needs and Resolving Conflicts" (R6755). The project is funded through the Natural Resources Systems Programme, under the High Potential Production System portfolio of projects. It forms one of three components of the project development work, providing a synthesis of previous work relation the hydrological problems and processes and, approaches to water sector planning, in Bangladesh.

This review attempts to focus on social and economic trends in rural Bangladesh, both in terms of the general analysis of trends in rural and agrarian change and in the more specific context of work on changing patterns of use of and participation in water resources management. It also aims to look at the institutional issues and the organisational set-up of local water management systems within the context of the wider social settings and dynamics of rural Bangladesh. Through this it is hoped to identify the institutional and policy settings which are best suited to the implementation of an integrated and sustainable water resources management strategy. Finally the review highlights the central importance of the social and institutional context of water resources management in mitigating conflicts, allocating scarce resources and understanding the relationships between water resources and other dimensions of livelihood systems and resource relationships.

6.2.Scope of Study

Relevant literature contained within CABI, TROPAG/RURAL and ISI databases, along with material held in the University of Leeds library system are included. Some abstracts have been taken from the abstracting journals. Where this has occurred, the source is referred to in the database field. All other abstracts have been written by the authors and are referred to as Leeds/BCAS.

6.3.Analysis

6.3.1. General information

The bibliography has been prepared to help inform researchers gain a better understanding of the hydrological problems and processes and, approaches to water sector planning, in Bangladesh, and how and why these came about.

6.3.2. Sectional analysis

Each of the references has been placed in one of three sections that are considered to be main topic areas in relation to hydrology and water sector planning. These are:

• Hydrological Context of Bangladesh

• Dynamics of Water Resources Use

• Water Management and Water Sector Planning

6.4. Collection of material

Leeds University Library provides access to major literature databases held on CD-ROM. These are: CABI, BIDS (ISI and ISSI) and TROPAG AND RURAL. These were searched using keywords. The university libraries database was also searched. A number of libraries in Bangladesh were also searched for relevant material.

Each reference has been assigned to a single section as described above and a set of keywords to aid identification of the reference.

Section A: Hydrological Context of Bangladesh

Author: ADB
Date: 1994
Title: Climate Change in Asia: Executive Summary, Regional Study on Global Environmental Issues
Source: Asian Development Bank, Manila, Philippines
Keywords: climate change, A
Abstract: The study investigates the implications of climate change for coastal zones, agriculture, forestry, water resources, energy and other vital sectors, in eight countries of the Asia Pacific region, namely Pakistan, India, Sri Lanka and Bangladesh in South Asia and Indonesia, Malaysia, Vietnam and the Philippines in Southeast Asia.

The issues of global climate change has highlighted and dramatised the serious problems the developing countries face in achieving sustained environmentally sound economic and social development. Responding to
Database: Leeds/BCAS

Author: Adrian, S.
Date: 1991
Title: Floods, People and the Environment
Source: Research and Advisory Services, Dhaka, Bangladesh
Keywords: flood protection, fap, impact assessments
Abstract: This study documents an examination of how the people of Bangladesh and its environment are affected by the multiple flood protection programmes that are imposed on the nation without thorough environmental and economic impact assessments. The practicability of the multi-million dollar FAP is also questioned critically and enlisted policy makers of Bangladesh and the donor community asked to seriously consider whether such FAP projects are at all beneficial to the people of Bangladesh in the long run.
Database: Leeds/BCAS

Author: Ahmad, M.
Date: 1989
Title: Deluge in the Delta. In: Ahmad, M. (ed.) Floods in Bangladesh
Source: Community Development Library, Dhaka, Bangladesh
Keywords: 1988, floods, politics, types, history, causes, flood control
Abstract: Most of Bangladesh is an active delta, as well as a flood plain, normally inundated up to a certain extent during the monsoon. Flood becomes devastating when it crosses its normal limit due to one or a combination of factors. Occasionally, the country is hit by "Catastrophic" floods which take heavy tolls on life and property. The flood of August-September 1988 was a catastrophic one unprecedented in this century. About 30 million

people were directly affected. Millions lost their home and other belongings. Heavy rainfall in the upper catchment areas of the major river basins has been identified as one of the major causes of this flood. Since the water of the three major river systems of the Ganges - Brahmaputra - Meghna, passes through Bangladesh territory to the bay of Bengal. Bangladesh becomes the recipient of excessive rainfall in the upper catchment outside its territory. To resolve the flood problem of Bangladesh, cooperation among the co-basin countries is indeed a necessary condition.

Database: Leeds/BCAS

Author: Ahmad, Q.K., Nilufar, A. and Shajahan R.K.B., (eds.)
Date: 1994
Title: Resources, Environment and Development in Bangladesh: With Particular Reference to the Ganges, Brahmaputra and Meghna Basin
Source: Academic Publishers, Dhaka, Bangladesh
Keywords: socio-economic, land, agriculture, forest, water, energy, environment transboundary water, the GBM region
Abstract: This book is an attempt at assembling a knowledge base; creating awareness about the dimension of sound exploitation of resources for national development; analysing constraints on fuller utilisation of resource and how such constraints may be removed within Bangladesh; and identifying areas of regional cooperation, particularly between Bangladesh and India, mainly in relation to sharing of river flows for beneficial use in each but also other areas.

The book has outlined the national perspectives in relation to the development and utilisation of water and other resources in the context of Bangladesh's national development goals. It has also argued that, given a strong interdependence in the GBM region among the co-riparian countries, especially among Bangladesh, India and Nepal, the sharing of water and other resources on a win-win, positive-sum basis must be the framework of agenda for cooperation and action - nationally and regionally.

Database: Leeds/BCAS

Author: Aziz, N., Kabir, S.M.H. and Ameen, M.
Date: 1984
Title: Effect of some Organophosphorus Insecticides on some Aquatic Insects
Source: Bangladesh Journal of Zoology 12 2
Keywords: organophosphorous insecticides, bioassay, aquatic insects, toxicity, tolerance
Abstract: Six organophophorus insecticides, viz., Sumithion, Supracide, Azodrin, Carbicron, Dimecron and Diazinon were bioassayed on five aquatic insects (dragonfly larva, adult rangatara longipes, Notonecta sp. and micronecta sp.). Mortality counts after 24-, 48-, 72- and 96 hours exposure indicated relative susceptibility of the test insects to the insecticides. Slunithion was the most toxic insecticide, followed by Supreacide, diazinon was the least toxic. Micronecta showed the greatest susceptibility to all the tested insecticides, followed by damsefuy larvae. Ranatra proved to be the most tolerant. Ranatra and micronecta or damselfy larvae are recommended to be included as the last insects for bioassay of pesticides before their recommendation for use in Bangladesh.
Database: Leeds/BCAS

Author: Bandyopadhyay, J. and Gyawali, D.
Date: 1994
Title: Himalayan Water Resources: Ecological and Political Aspects of Management
Source: 141
Keywords: Ganges, rivers, water resources, embankments, politics, ecology
Abstract: The sources of the Indus, Ganges, Brahmaputra, Irrawaddy, Salween, Mekong, and Yangtze rivers are in the Himalayas. The ecological aspects of water management and socio-economic and political issues in the Himalayas are reviewed. The variability of the water resources and the growth of pressures on water resources in the region are discussed. Foods and droughts are features of the region. Floods in the Himalayan foothills and in Bangladesh are described. Macrolevel storage and diversion of Himalayan waters are considered with reference to flood control embankments of Northern Bihar and high dams on Himalayan rivers. The Kosi Barrage project in Bihar and the Tehri Dam project on the Bhagirathi river in the Garhwal Himalaya are discussed. The micro-management of Himalayan rivers and the need for an institutional framework for future management are discussed.
Database: CABI

Author: BBS
Date: 1997
Title: Statistical Pocketbook of Bangladesh 1996
Source: Bangladesh Bureau of Statistics (BBS), Dhaka, Bangladesh
Keywords: statistics, bangladesh
Abstract: the 1996 issue of the 'statistical pocketbook of bangladesh is the 17th edition in a series. It is compendium of facts and figures on bangladesh published annually. Most statistics of this abridged annual have been compiled in the concerned wings of BBS.
Database: Leeds/BCAS

Author: BCAS, Resources Analysis Ltd. and Approtech
Date: 1994
Title: Vulnerability of Bangladesh to Climate Change and Sea Level Rise
Source: Bangladesh Centre for Advanced Studies, Resource Analysis and Approtech Consultants Limited.
Keywords:
Abstract: The summary report is a part of a set of three documents, which describe the concepts and the techniques used in the vulnerability assessment, detailed documentation of different analysis, overview of the system of Government and Planning in Bangladesh, and discusses in some detail institutional mechanisms for the water sector. The purpose of the summary report is to convey in a straightforward and yet scientifically accurate manner the main issues with respect to climate change and sea level rise and how they are likely to affect Bangladesh.
Database: Leeds/BCAS

Author: Begum, S., El-Sabh, M.L, Venkatesh, S., Denis, H. and Murty, T.S.
Date: 1996
Title: Storm Surges and River Flooding in Bangladesh: A Rising Challenge in a Changing Global Climate
Source: Kluwer Academic Publishers; Dordrecht; Netherlands
Keywords: flood control, natural disasters, hazards, management, hydrology, floods, meteorology, storms
Abstract: The occurrence and causes of natural disasters in Bangladesh, particularly flooding and cyclones, are discussed, with recommendations for disaster prevention measures.
Database: CABI

Author: Biswas, M.R. and Ali, S.M.A.
Date: 1974
Title: Effect of Water Hyacinths on the Hydraulic Capacity of Flow in Irrigation Ditches
Source: The Journal of the Institution of Engineers 14
Keywords: water hyacinths, water flow, flow depths, irrigation canals, channel erosion
Abstract: The presence of water hyacinths in irrigation ditches makes it conduit flow as a result the distribution of velocity of flow becomes dissimilar to that found in the open channel. Investigations here in this study reveal that higher degrees of retention of flow occurs at two-tenth depth and conversely the flow increases at the eight-length depth. Erosion to channel bed can, thus, be greater due to this impact of higher velocity of flow: although the growth of water hyacinths shows reduction in flow.
Database: Leeds/BCAS

Author: Blasco, F., Saenger, P. and Janodet, E.
Date: 1996
Title: Mangroves as indicators of coastal change
Source: Catena 27 3
Keywords: remote sensing, coastal communities, coasts, tides, monitoring, biological indicators
Abstract: In view of the unique biological characteristics of mangroves, it is of interest to assess the extent to which these ecosystems can be used as indicators of coastal change or rise in sea-level. From recent studies of mangrove mortality at several locations (including Guiana (from Northern Brazil to Venezuela), Gambia, Cote d'Ivoire, Kenya, India and Bangladesh), it appears that these coastal ecosystems are so specialised that any minor variation in their hydrological or tidal regimes causes noticeable mortality. Each species of mangrove (but particularly those belonging to the genera Rhizophora, Bruguiera, Sonneratia, Heritiera and Nypa) occurs in ecological conditions that approach its limit of tolerance with regard to salinity of the water and soil, as well as the inundation regime. If the duration of daily immersion were to be modified by tectonic, sedimentological or hydrological events, the species either readjusts to the new conditions or succumbs to unsuitable conditions. Consequently, the use of remote sensing data for mangrove ecosystems offers excellent potential as a tool for monitoring coastal change.
Database: CABI

Author: Brammer, H.M., Asaduzaman, M. and Sultana, P.
Date: 1993
Title: Effects of Climate and Sea-Level Change on the Natural Resources of Bangladesh
Source: Bangladesh Unnayan Parishad (BUP), Dhaka, Bangladesh
Keywords: climate, hydrology, socio-economics, landuse, water regime, surface water, groundwater, climate change, irrigation, flood protection, dynamic agriculture
Abstract: This brief document describes how the 110 million people who live in the low-lying deltaic country of Bangladesh are highly dependent upon an agricultural system that is finely attuned to a tropical monsoon climate and associated water regime. Any significant change in the climate and water regimes of Bangladesh is likely to have profound effects on biological resources. This in turn could have serious effects on the socio-economic systems of the country. Here, the effects of climate and sea-level changes on the hydrological and biological resources of Bangladesh are explored through four main questions: What is the current resource setting of Bangladesh? How might the water resources be affected by climate warning? How might crop agriculture be affected? How might other bio-resources be affected?
Database: CABI

Author: BRESS/DoF
Date: 1986
Title: Water Area Statistics of Bangladesh
Source: Fisheries Information Bulletin 3 **1**
Keywords: water area statistics
Abstract: This bulletin contains the statistics on the area of different types of water bodies of Bangladesh. The number and the total area of ponds by districts and upazila (thana) and the conditions (cultured, culturable and derelict) of pond in Bangladesh were estimated on the basis of the sample survey of ponds conducted by the Bangladesh Space Research and Remote sensing Organisation (SPARRSO) by using areal photograph and Satellite Imagery. The area of large water bodies like river & estuaries, beels baor, lake were also estimated in the same way. The total number of ponds in Bangladesh is estimated in to be 12,88,22 with an area of about 3.62.980 acre. A total of 28,32,792 ha of seasonal flooded area is suitable for fisheries in Bangladesh. The total area of inland waterbodies (River, estuaries, beels, baor, lake pond and shrimp farms) is 14,54,204 ha. of which a total of 87,300 ha. area has been found under shrimp farming in coastal area of Bangladesh in 1986. The total marine water area (Internal+EEZ) is 4,83,665 sq. nautical mile.
Database: Leeds/BCAS

Author: Chowdhury, K. H. and Azizul, H. B.
Date: 1990
Title: Environmental Processes: Flooding, River Erosion, Siltation, and Accretion - Physical Impacts. In: Rahman, A. et al (eds.) Environmental Aspects of Surface Water Systems of Bangladesh
Source: University Press Limited (UPL), Dhaka, Bangladesh
Keywords: surface water system, flooding, morphological aspects, bangladesh
Abstract: The book deals with the concept of the surface water system, rainfall, streams and rivers, hydrological region, flooding, surface water morphological aspects of bangladesh. The morphological aspects includes changing courses of the river, channel patterns, channel migration, wandering of the thalweg, sand bars and bedforms, alluvial plains, topographic descriptions and estuary and coastal belt.

The authors suggest the following future research: 1. The inflow and outflow of sediments including their quantity, properties, and seasonal variability. 2. rate of erosion and sedimentation in the alluvial plains, haors-beels, estuaries, and coastal belts, etc., 3. The cause and effects of channel migration both of major and minor rivers. 4. Process of siltation in the channel, at the confluence of tributaries, and 5. Impacts of man-induce changes in the drainage basins on the hydrological-geomorphological aspects of bangladesh.
Database: Leeds/BCAS

Author: Clarke, R.
Date: 1991
Title: Water: The International Crisis
Source: Earthscan Publications Ltd, London, UK
Keywords: freshwater, water scarcity, water needs, climate, degradation, resource wars, sustainable development
Abstract: This book states that only 3% of the world's water is freshwater and about one third of that is inaccessible. The rest is very unevenly distributed: parts of Canada and the amazon. Terrible and permanent water stress can be seen among other places, in the drylands of Africa, caused not just by drought but by poverty leading to poor land-management and overpopulation. This book describes the world's freshwater shortage and examines both the economics and the politics that led to it. The author considers the likelihood of resource wars breaking out over water control and he looks at the ways in which the development of countries is affected by water availability. In the face of an international crisis which few have considered seriously, this book is hopeful, that there are solutions.
Database: LeedsBCAS

Author: Elahi K.M. et al. (eds.)
Date: 1991
Title: Riverbank Erosion, Flood and Population Displacement in Bangladesh
Source: Riverbank Erosion Impact Study (REIS), Jahangirnagar University, Savar Dhaka, Bangladesh
Keywords: erosion, floods, population, bangladesh
Abstract: This is the outcome of this symposium and only a selection of the paper related to Bangladesh and directly concerned with specific issues of the objectives of this program was to draw together research cooperation between physical and social scientists and then to integrated their findings with the needs and existing policies of rural planners and government and non-government agencies.

This volume include twenty two papers including an introductory section arranged under three groups. Apart from the introduction, the first part is concerned with the structure and process of the physical dimensions of riverbank erosion and flood, the second with the range of demographic and socio-economic impacts, and the third looks into the issues related to displacement and resettlement of population. It has covered all the issues related to the dynamics and the impacts of riverbank erosion and flood in Bangladesh.
Database: Leeds/BCAS

Author: Halcrow, Scott Wilson and Partners Ltd. 888
Date: 1996
Title: Groundwater Development Potential and Limitations (Draft)
Source: Ministry of Agriculture, Government of Bangladesh, Dhaka, Bangladesh
Keywords: groundwater development, quality and limitations, development potential, constraints, policy, Bangladesh
Abstract: This paper is intended to support this study by evaluating the groundwater development potential for minor irrigation in bangladesh and its limitations. this study paper basically establishes a water balance for that part of bangladesh that can be irrigated by groundwater.

The report relies heavily on data and knowledge collected in earlier studies, reviewed all the existing sources of data, evaluation of the groundwater development, physical constraints to groundwater development. the implications of the groundwater development potential and the constraints to development are also described.
Database: Leeds/BCAS

Author: Hofer, T.
Date: 1993
Title: Himalayan Deforestation, Changing River Discharge, and Increasing Floods: Myth or Reality?
Source: Mountain Research and Development 13 3
Keywords: flooding, climate, deforestation, hydrology, floodplains, forests, land use, erosion
Abstract: Every year during the monsoon season catastrophic flooding on the plains of the Ganges and Brahmaputra rivers is reported as a result of human activities in the Himalayan region. This study investigates hydrological changes in the catchments of the Sutlej, Beas (both in Himachal Pradesh), Jhelum and, in greater detail, Chenab (both in Jammu and Kashmir) rivers during recent decades; it seeks linkages between river discharge and climate in the mountains, and flooding on the plains. Climatological data for the region are easily obtainable but hydrological information is restricted. Analysis of accessible data indicates that correlation between river discharge and precipitation is low and regression analyses show that trends are not statistically significant. Field observations of forest extent, land use, and erosion in the study areas suggest that there is no recent increase in forest cutting. Moreover, there is no evidence that flooding on the Gangetic plain has increased.
Database: CABI

Author: Hofer, T. and Bruno, M.
Date: 1997
Title: Floods in Bangladesh; Process Understanding and Development Strategies
Source: Institute of Geography, University of Beren, Switzerland
Keywords: flood process, people perceptions, causes of flood, flood history, highland - lowland interaction, risk assessment, river erosion, adaptation strategies
Abstract: The project and this synthesis paper were made possible through support provided by the Swiss agency for development and cooperation and the united nations University. The paper shows that floods are a normal process of the highland-lowland interactive system independent of human activities in the upper catchment. Neither the frequency nor the dimension of flooding has increased over the last 120 years. Precipitation and runoff in the Himalayas do not seem to be important causes of the floods in Bangladesh. The rainfall pattern in the Meghalaya hills, however, seem to be decisive. Comparing the three major river system, the Meghna catclunent is of primary importance, followed by the Brahmaputra catchment. The Ganges catchment plays only a minor role.

Where most politicians, Journalists and engineers perceive floods as the major hazard in Bangladesh, local farmers, consider river erosion a much bigger problem than monsoon floods. During abnormal floods life is hard,

but after the recession of the water the land is again available. Over generations people have developed sophisticated adaptation strategies to deals with floods. Erosion, however, can be termed as a silent disaster, which takes away the life-support systems of whole families. Cyclones are certainly the most critical and damaging hazards in Bangladesh. Technical interventions must be part of an overall, integrated concept for the management of natural hazards, in which river erosion receives a higher attention than floods. In the decision - making process regarding development priorities, ecological, socio-economical and technical considerations are equally important. The perception, experiences and strategies of local communities must be given high priority.

The paper has includes a number of tables, graphs, maps and photographs to show the real facets and figure with the text.

Database: Leeds/BCAS

Author: Islam, M.Z.
Date: 1994
Title: Regional Surface Water Availability During Dry and Monsoon Seasons in Bangladesh
Source: Journal of Irrigation Engineering and Rural Planning 26
Keywords: floods, drought, water resources, surface water, availability
Abstract: This study briefly describes available streamflow generated within Bangladesh, inflows from the Brahmaputra-Ganges-Padma-Meghna River (main river system), cross-boundary inflows from India, static water resources, instream storage potential, streamflow salinity, and water demands in different sectors, navigation, salinity control, fisheries and agricultural water use. Bangladesh has a two-fold water problem-too much in the monsoon season, causing devastating floods and too little in the dry season, causing severe droughts. Saline water intrusion occurs in the dry season from the Bay of Bengal and streamflow salinity increases up to 10,000 mumho/cm, especially in the Southwest (Passur River) and South Central (Baleswar River) Regions. It is recommended that an adequate water supply be ensured in both the monsoon and dry seasons through properly planned Barrage Projects.

Database: CABI

Author: Kafiluddin, A.K.M.
Date: 1991
Title: Disaster Preparedness for Bangladesh Floods and Other Natural Calamities
Source: Salauddin and Taslim Jahan Dilkusha, Dhaka, Bangladesh
Keywords: disasters, floods, natural calamities, Bangladesh
Abstract: This book provides guidelines to all interested and involved in natural disaster management within Bangladesh. Bangladesh has endured many catastrophes including the recurrence of devastating floods, cyclones, tornadoes, tidal surges, earthquakes and droughts. Resulting in the destruction of lives, millions of tons of foodgrain, peoples homes and their means of livelihood thus adversely affecting the economy, industry and public health. The causes of natural disaster are now scientifically explained and are generally understood. Mismanagement due to lack of prior planing often results in counter productive efforts.

This book attempts to highlight and disseminate knowledge regarding preparation for natural disasters, to administrators, meteorologists and even to the common individuals of Bangladesh.

It is also hoped that this publication will aid the development of national manuals. These will consider and highlight local resources for the prevention and mitigation of natural disasters.
Database: Leeds/BCAS

Author: Kamal, G.M.
Date: 1994
Title: Environmental Bibliography of Bangladesh
Source: Swedish International Development Authority (SIDA), Dhaka, Bangladesh
Keywords: environment, water management, environmental aspects, issue classification
Abstract: This book presents a detailed list of major environmental publications available in Bangladesh. This is a good attempt towards a comprehensive compilation of the environmental literature in the country. Though this is not a complete bibliography on environmental studies and literature of Bangladesh, there are a number of good references covering different issues related to the environment which can be classified into 26 categories. These include; Agriculture, Coastal Environment, Cyclones, Energy, Environmental Assessment, Environmental Law, Physical Environment, Fresh Water Fisheries, Marine Fishery, Floods, Forest, Social Forestry, Geology and Mining, Greenhouse Effects, Groundwater, Hazard and Disaster Management, Health and Nutrition, Land and Soil, Mangrove Ecosystem, Pollution, Remote-sensing, Socio-economic and

Environmental, Water Management, Wetland and Wildlife. A sector wise title index has also been developed and appended in alphabetical order.

Database: LeedsBCAS

Author: Khan, A.H.
Date: 1995
Title: Ganges Water Sharing: An Overview. In: Hasna, J.M. (ed.) Women for Water Sharing
Source: Academic Publishers, Dhaka, Bangladesh
Keywords: problems of water, water agreement, impacts on bangladesh, negotiation on water sharing: ganges issue
Abstract: This publication considers: the water problem in Bangladesh, the Ganges water agreement, impacts of the Ganges water withdrawal on Bangladesh, negotiations regarding water sharing, morphological changes along major rivers during 1994 and 1995, siltation, groundwater and the environment. The paper includes two annexe including: agreement between the government of Bangladesh and the government of the Republic of India regarding sharing of the Ganges waters at Farakka, augmenting its flow and finally a report of the author's field trip to Rajshahi and Kushtia.
Database: LeedsBCAS

Author: Khan, L.R.
Date: 1990
Title: Groundwater Resource Development and its Environmental Impacts in Bangladesh Perspective
Source: Quest Bangladesh 2 **1**
Keywords: groundwater, abstraction, exploitation, environmental impacts, quality, pollution, ecological impact, aquifer depletion
Abstract: Groundwater plays a vital role in the development plan of water resources of Bangladesh. It has become an important source of irrigation and public supply in both rural and urban areas throughout the country. Due to the ever increasing demand for water for domestic, agricultural and industrial uses in the country, the exploitation of groundwater from major aquifers has taken place rapidly in recent years. Since the groundwater system is complex due to its inherent geohydrologic and hydraulic characteristics, excessive abstraction of groundwater will eventually create undesired results. As yet, very little attention has been given to the after-effects of unplanned exploitation of groundwater, such as the environmental effect of the depletion of aquifers.
Database: Leeds/BOAS

Author: Khan, L.R.
Date: 1989
Title: Effects of Groundwater Abstraction Inside Dhaka, Bangladesh City.
Source: Bangladesh Quest, BRB 12
Keywords: groundwater, hydraulic, agriculture, abstraction
Abstract: This document reviews several studies regarding the groundwater status in Bangladesh. Due to ever increasing demand of water for domestic, agricultural and industrial uses, the exploitation of groundwater from the major aquifers has taken place rapidly in recent years. Since the groundwater system is complex due to its inherent geohydrologic and hydraulic characteristics, excessive abstraction of groundwater will eventually create undesired results. As yet, very little attention has been given to the after-effects of unplanned exploitation of groundwater. Environmental effects of groundwater extraction include: the depletion of aquifer water levels, reduction in streamflows, quality constraints, change in the agro-ecological and aquatic system, and land subsidence, etc. have not been anticipated. This paper describes clearly the environmental consequences encountered due to the development of groundwater. Outlines revealing the environmental impacts of groundwater utilisation are also highlighted for optimum utilisation and management of groundwater in this country perspective.
Database: Leeds/BCAS

Author: Khan, L.R. and Basak, B.C.
Date: 1986
Title: Suitability of Groundwater for Irrigation use in Sadar and Trishal Upazilas of Mymenshingh Districts.
Source: Journal of Agriculture, BARC 114
Keywords: quality of groundwater, deep tubewell, groundwater for irrigation
Abstract: In this investigation attempts were made to determine the quality of groundwater in Sadar and Trisal Upazilas of Mymenshingh district. Water samples from 35 randomly selected deep tubewells within the study area were collected in order to analyse the chemical properties and to classify then according to their result concentration, sodium-adsorption rations (SAR), soluble sodium percentage (SSP), residual sodium carbonate (RAC) and boron contents. In this study most of the groundwater samples are found in low salinity groups. Boron contents in most of the samples are also within sample limit for irrigation even for sensitive crops. In general, deep tubewell water at different locations in Sadar upazila are found to be good to excellent quality for irrigation and the groundwater samples in Trisal area are found to be of permissible to good quality.
Database: Leeds/BCAS

Author: Mirza, M.M.Q. and Subrata, P.
Date: 1992
Title: Prakritic Durjog O' Poribesh
Source: Centre for Environmental Studies and Research (CESR), Dhaka, Bangladesh
Keywords: cyclone, flood, riverbank erosion, drought and earthquake, green house effect.
Abstract: The book, covers all facets of the natural disasters such as; Flood, Cyclone, Erosion, Earthquake and Drought, Effect of Green house in future of Bangladesh. History, Impact and causes each of the events are describes in the book. There is a number of Maps and table are presented in the book to understand the facets and figures of major incidents occurred in Bangladesh. Though, It's written in Bengali, it is a useful document for both general readers and experts of the relevant aspects.
Database: Leeds/BCAS

Author: Mosaraff, H., Islam, A.A. and Saha, S.K.
Date: 1987
Title: Floods in Bangladesh - Recurrent Disaster and Peoples Survival
Source: University Press Limited (UPL), Dhaka, Bangladesh
Keywords: floods, local rainfall, overland storage, siltation, drainage, hydrology, vulnerable area, social impact, drainage, flood response, flood control, master plan
Abstract: This book contains an analysis of the causes of floods with a thorough probe into why there can not be any easy solution to them. It also presents the findings of a survey conducted by the authors to assess the nature and magnitude of people's suffering during floods and how they survive them. The authors attempt to review the flood control strategies and programmes that have been pursued in the country since the 1960s to overcome the enormous problems of the yearly inundation.
Database: LeedsBCAS

Author: Moslehuddin, A.Z.M., Laizoo, S. and Egashira, K.
Date: 1997
Title: Fertility Status of Bangladesh Soils - A Review
Source: Journal of the Faculty of Agriculture 413
Keywords: fertility, upland soils, organic matter, phosphorus, calcareous soils, terraces, paddy soils, nutrients, yields
Abstract: The fertility status of Bangladesh soils was critically evaluated by reviewing the studies carried out in universities and research institutes in Bangladesh. Almost all upland soils are low in organic matter and deficient in N. Phosphorus availability to the crops is a problem mainly in calcareous soils of Ganges floodplain and acidic soils of terrace and hill

areas. Status of K is not a great problem in floodplain areas, but terrace and piedmont soils are not capable of supplying enough K to the crops. Although P and K deficiencies are not severe, addition of these two nutrients is essential to increase yields. Paddy soils remain under water during the growing period that causes unavailability of S and Zn for rice crops. Other dryland crops also face the problem of S and Zn deficiencies in many areas of Bangladesh. Bo was deficient in some areas. Coarse-textured soils of Old Himalayan piedmont plain, brown hill soils and grey floodplain soils of the northern part of the country were Mg deficient. The Ca reserve of many floodplain soils is depleting due to decalcification process and deficiency of Ca is probable in the near future. Deficiencies of Cu and Mn were reported but very rare. The overall fertility status is not satisfactory; the need for fertility conservation is stressed.

Database: CABI

Author: MPO
Date: 1987
Title: The Ground Water Resource and its Availability for Development
Source: Report No. 5, Ministry of IWD & FC, Govt. of Bangladesh
Keywords: groundwater recharge, bangladesh
Abstract: This is a technical report on the Groundwater Resource and its Availability for Development in Bangladesh. The groundwater recharge process, model calibration and verification, time-series simulation of catchment recharge, groundwater development potential, utilisation of groundwater and data appraisal and sensitivity analysis are described in this report.

The report has includes MPO Groundwater Model 'data requirement and programme option', Multiple aquifer system, Review of existing Groundwater studies as at December 1983 and Comments on Technical Report no.5 by BARC and Water Investigation Directorate.

Database: Leeds/BCAS

Author: Nishat, A.
Date: 1992
Title: Bangladesh's Opportunity Cost
Source: The Lyndon B Johnson School of Public Affairs, The University of Texas, Austin, USA
Keywords: water resources, optimal utilisation, flood/drought management, flood vulnerability, salinity
Abstract: This article has been inserted in the document of The Ganges-Brahmaputra Basin, edited by David J Eaton in 1992.

Water resources development has been and will continue to be a key factor in the economic development and fabric of life of the people of Bangladesh. Failure to develop the water resources of the Ganges, Brahmaputra, and Meghna rivers with an integrated and comprehensive approach towards optimal utilisation of water resources causes suffering of millions of Bangladeshis from the misery of hunger, disease, hardship and poverty.

The paper includes three maps of the location of major river networks, flood vulnerable areas and salinity variability areas and a graph of mean monthly discharge of three major rivers in Bangladesh.

Database: Leeds/BCAS

Author: Radosevich, G.E.
Date: 1983
Title: Ground Water Development & Management in Bangladesh: Institutionalising a Strategy
Source: Unknown
Keywords: ground water law, ground water extraction, ground water conditions, water management, water balance, irrigation, strategy
Abstract: This report was prepared for the International Agricultural Development Service and the Ministry of Agriculture (MOA). The objective was the development and management of the ground water of Bangladesh, institutionalising a strategy. The Report deals with approach and development status, the seriousness of the situation, the need for legal intervention, government action, analysis, recommendations for ground water law, general suggestions and conclusions. It has bibliographical references, appendices and a number of maps.
Database: Leeds/BCAS

Author: Rahman, A.A., Huq, S. and Conway, G.R.
Date: 1990
Title: Environmental Aspects of Surface Water Systems of Bangladesh
Source: University Press Limited (UPL), Dhaka, Bangladesh
Keywords: environmental aspects, surface water systems, water resource development, physical environment, surface water abstraction, fisheries, environmental changes,
Abstract: The book is a compilation of contributions from eminent experts from Bangladesh and abroad on water related issues from different disciplines including the natural, engineering, health and social sciences which give an up to date review of the state of knowledge on all environmental aspects relating to surface water systems of Bangladesh.

There are 22 chapters in the book. Each chapter has a list of references at the end of the chapter and most of the chapters have sufficient numbers of tables, maps and figures. This is a very useful book regarding surface water systems in Bangladesh.

Database: LeedsBCAS

Author: Rahman, A.K.A.
Date: 1989
Title: Freshwater Fishes of Bangladesh
Source: The Zoological Society of Bangladesh, Department of Zoology, Dhaka, Bangladesh University, Bangladesh
Keywords: fishes, bangladesh, freshwater farms, estuarine species
Abstract: The present book dealing with freshwater bony fishes only, provides scientific descriptions of 260 species under 145 genera and 55 families. The list, however includes several species whose occurrence in Bangladesh have earlier been reported by many authors. Besides the truly freshwater farms, this book includes a good number of estuarine species which may occur in rivers and other freshwater areas in Bangladesh during some part of their life.

Database: LeedsBCAS

Author: Rashid, H.E.
Date: 1991
Title: Geography of Bangladesh
Source: University Press Limited (UPL), Dhaka, Bangladesh
Keywords: physiography, hydrography, climate, soil conditions, land-use, agriculture, natural resources, industry, economic development, environmental issues
Abstract: This book, first published in 1977 and revised in 1991, covers all facts of the geography of Bangladesh. It provides more details on physiography, hydrography, climate, soil conditions and land use, agriculture, natural resources and industry trade and commerce, history and economic development than any other regional book written about Bangladesh. The latest revision includes a new chapter on environmental issues.

Database: LeedsBCAS

Author: Schmuck-Widman, H.
Date: 1996
Title: Living with the Floods: Survival Strategies of Charland Dwellers in Bangladesh
Source: Duisberg-Gesellschaft E.V., Berlin, Germany
Keywords: flood, Bangladesh, drought, crisis management, flood action plan, life stories, char-dwellers, indigenous knowledge, engineering knowledge, survival strategies
Abstract: This is the output of research conducted by the author in six char villages of the Gabsara Union belonging to Bhuapur thana in the district of Tangail. The book deals with the knowledge and perception of the rural people in terms of survival strategies while living with the floods.

The publication reveals that the Flood Action Plan (FAP) undertaken to control the floods in Bangladesh, is an example of how engineering knowledge and local or indigenous knowledge can conflict with each other. The FAP planners have ignored the knowledge developed by the rural people over centuries of how to live with floods. The book contains the analysis of the statements and accounts of the char-dwellers, which gives the synthesis about their coping strategies.
Database: Leeds/BCAS

Author: Shamsuddin, S. and Rafique, A.
Date: 1974
Title: Variability of Annual Rainfall of Bangladesh
Source: Journal of The Bangladesh National Geographical Association 2 **1**
Keywords: variability of rainfall, spatial distribution of variability
Abstract: This is the out come of a research on climatology. Data were collected from sixty two meteorological stations out of a total 297 stations. Rainfall data were analysed and rainfall variation and distribution are shown in Maps. The study has two aspects. From purely climatological point of view, the study indicates an inverse relationship between mean annual rainfall and variability of annual rainfall of Bangladesh. This result is in conformity with findings in other parts of the globe. But there are specific case where the inverse relationship is not valid, i. e. the relationship between the mean annual rainfall and variability is direct instead of being inverse. The cause for such anomalies is not clear and need to be investigated in detail. The investigation will not only help to explain the variability characteristics but will also bring forward information useful for agricultural and irrigation planning.
Database: LeedsBCAS

Author: Sharifullah, A.K.
Date: 1991
Title: Floods: Recurrent Natural Disasters in Bangladesh
Source: Journal of Rural Development 212
Keywords: natural disasters, floodplains, flood control, rural development
Abstract: Following an outline of the geomorphology and physiography of Bangladesh, information is provided on this country's major rivers: the Brahmaputra, Ganges and Meghna. Floods occurred frequently in Bangladesh throughout its history, and have been due mostly to deforestation in upriver regions beyond the country's borders, the silting up of river beds, the simultaneous flooding of different rivers, and the unplanned construction of roads, embankments and highways. No major development work for controlling floods was undertaken until 1947, when the Irrigation Department of the new province of East Pakistan was set up. Achievements to date in flood control are outlined. The real solution to successful control is seen to lie in regional cooperation. Although, the difficulties associated with finding political solutions mean that Bangladesh should use all means at its disposal to formulate effective flood control strategies.
DE: Natural-disasters; Floodplains- flood-control; rural-development
Database: CABI

Author: Siddique, A.B.M.
Date: 1989
Title: Impact of Flood on the Economy of Bangladesh. In: Ahmad, M. (eds.) Floods in Bangladesh
Source: Community Development Library, Dhaka, Bangladesh
Keywords: sub-sectors impacts, flood control/irrigation system, effect on health, effect on education and effect on economy
Abstract: The devastating flood of 1988 had significant impact on the economy of Bangladesh. It adversely affected all socio-economic sectors of the country. In total 53 of the 64 districts covering 322 of the 460 upazilas of the country, was badly affected. Area wise the flood waters reached approximately 102,000 of the 144,000 sq. Km. of the national territory and directly affected about four crores people out of the total population of 10 crores.

National aggregates of flood damage were updated daily by the Relief Operations and Flood Situation Monitoring Cell of the President's Secretariat. In the month following the recession of flood waters the flood damages were estimated by respective Ministries and Agencies. The estimates are more or less preliminary and subject to further changes after detailed survey and investigation.
Database: Leeds/BCAS

Author: Sir MacDonald and Partners
Date: 1982
Title: Water Balance Studies (North- Bengal) Final Report.
Source: Final Report, BWDB/UNDP
Keywords: groundwater development, resources capability and constraints, nutrition and health, agrochemical pollution, bangladesh
Abstract: this is the final report comprises the main report, soils and agriculture, groundwater, engineering, environment, economics. it has six chapter such as : 1. introduction, 2. land resource capability and constraints, 3. effect of groundwater development on shallow water sources, 4. human nutrition and health, 5. agrochemical pollution, and 6. forest and firewood.
Database: Leeds/BCAS

Author: Te-Slaa, B., Mortar, F.C., Laboyrie, H., Kirby, C. (ed.) and White, W.R.
Date: 1994
Title: Erosion Control of the Meghna River, Bangladesh
Source: John Wiley & Sons, Chichester, UK
Keywords: flooding, hydrology, river regulation
Abstract: The Meghna river drains an area of 77000 km2. The lower Meghna conveys melt- and river water from the Ganges and Brahmaputra rivers and from the upper Meghna basin to the sea. Disastrous flooding occurred in 1987 and 1988, leading to international interest in helping to find a long-term solution to flood problems in Bangladesh. A long-term strategic development plan of the Lower Meghna was required. As part of a long-term plan, a preliminary assessment was made of a possible river training scheme aiming at complete regulation of the Lower Meghna, incorporating protection works at Eklashpur, Chandpur and Haimchar. The environmental and socio-economic impact of river training are discussed.
Database: CABI

Author: United Nations Economic Commission
Date: 1956
Title: Glossary of Hydrological Terms Used in Asia and the Far East
Source: United Nations Publications, USA
Keywords: hydrology, terminology, flood control
Abstract: This useful publication, mainly dealing with a glossary of hydrologic terms used in Asia and the Far East, is issued with a view to standardising terminology in order to facilitate the exchange, among countries of the region, of knowledge and experience in the field of water resource development.
Database: Leeds/BCAS

Author: Zaman, M.Q.
Date: 1993
Title: Rivers of Life: Living with Floods in Bangladesh
Source: Asian Survey 33 10
Keywords: floods, flood control, erosion, rural development
Abstract: During each monsoon season, almost all of Bangladesh's deltaic plain is submerged for about half the year. Rice and fish, the country's main staples, need flood water to grow and flourish. Jute, the country's principal cash crop, is also highly dependent on flood water. The annual flood during the monsoon makes the land fertile by providing moisture and fresh silt to the soil that are vital to crop production. The destructive impact of the flooding is usually limited by the adjustments that peasants inhabiting the floodplain regions have historically made, adapting their agricultural practices, cropping patterns and settlements to the annual deluge. But the high or abnormal floods, associated with widespread damage to standing crops, properties and loss of human life are viewed as calamity or disaster. These occur only about once every ten years. However, the last decade has experienced four. This paper outlines the main floods, showing that they stimulated international interest in finding a solution to the flood problem. A review of Bangladesh flood control strategies suggests that solutions to date have been single minded for mitigating floods by building dams and dykes. Floods have been narrowly viewed as a natural phenomenon requiring some technological fixes to modify the physical processes. A holistic approach to flood and erosion problems needs to be taken, to note the complex interactions of all aspects of how people traditionally have organised, produced and survived within the physical constraints. This article expands on the position to develop an alternative to the prevention of floods through structural measures.
Database: CABI

Section B: Dynamics of Water Resources Use

Author: Abdullah, A. and Quazi, S.
Date: 1997
Title: Recent Development in Bangladesh Agriculture: Crop Sector. In: Sobahan, S. (ed.) Growth or Stagnation? A Review of Bangladesh's Development
Source: University Press Limited (UPL), Dhaka, Bangladesh
Keywords: rice production, non-rice production, problem of minor irrigation, foodgrain markets, chemical fertiliser, agriculture extension, bangladesh
Abstract: This is the review of the crop sector development in bangladesh. it has include trends in rice production, trends in non-rice production, trends in acreage expansion for crop production, problems of minor irrigation development, public involvement in foodgrains in bangladesh, urea distribution and price, role of agricultural extension in development, participatory approach to extension, and the achievements. the author includes a number of tables with source and a number of references with this paper.
Database: Leeds/BCAS

Author: Ahmed, N.
Date: 1990
Title: Temporal Changes in Agricultural Land Use in Bangladesh. In: S. Huq et al. (eds.), Environmental Aspect of Agricultural Development in Bangladesh
Source: University Press Limited (UPL), Dhaka, Bangladesh
Keywords: agriculture, land-use
Abstract: This paper describes the present agricultural land-use in Bangladesh and the changes that have occurred over time. The author used agricultural census reports and other BBS data. Some case studies are also presented, indicating the nature of changes which have occurred in spatial land-use within the country.
Database: Leeds/BCAS

Author: Ali, M.Y.
Date: 1997
Title: Fish, Water and People
Source: University Press Limited (UPL), Dhaka, Bangladesh
Keywords: fish, floodplains, fishermen, beels, water pollution
Abstract: this book is an unique collection and compilation and compilation of the scattered information about aquatic living resources and their habitats in the open waters of bangladesh. Different components of the open inland - waters of bangladesh and their roles in collection of the life cycles of different species of fish and prawn are described. the importance of open water fish production, particularly in the floodplains and the impacts of

flood control, drainage and irrigation projects on openwater aquatic ecosystems in different regions of the country are presented in some details. Water pollution caused by discharge of untreated industrial effluents, domestic wastes, and agro-chemicals into surface water and their impacts on aquatic organisms including fishes and prawn are also focused in this book. This book will be helpful to policy makers, planners, administrators, scientists, researchers, academics and people who might be interested to pursue further studies and formulate policies to sustain populations of fish and other aquatic animals and their habitats in bangladesh.

Database: LeedsBCAS

Author: Ali, M.Y.
Date: 1997
Title: Fish, Water and People
Source: University Press Limited (UPL), Dhaka, Bangladesh
Keywords:
Abstract: This book is an unique collection and compilation and compilation of the scattered information about aquatic living resources and their habitats in the open waters of Bangladesh. Different components of the open inland - waters of Bangladesh and their roles in collection of the life cycles of different species of fish and prawn are described. The importance of open water fish production, particularly in the floodplains and the impacts of flood control, drainage and irrigation projects on openwater aquatic ecosystems in different regions of the country are presented in some details. water pollution caused by discharge of untreated industrial effluents, domestic wastes, and agro-chemicals into surface water and their impacts on aquatic organisms including fishes and prawn are also focused in this book. This book will be helpful to policy makers, planners, administrators, scientists, researchers, academics and people who might be interested to pursue further studies and formulate policies to sustain populations of fish and other aquatic animals and their habitats in Bangladesh.

Database: Leeds/BCAS

Author: Ameen, M.U.
Date: 1987
Title: Fisheries Resource and Opportunities in Freshwater Fish Culture in Bangladesh
Source: DANIDA, Noakhali, Bangladesh
Keywords: freshwater, fisheries resources, fish culture, ecology
Abstract: The present book deals with the status and opportunities of freshwater ponds as a fishery resource in Bangladesh, on the basis of ecology, fish

production, limnology, freshwater habitats occurring in Bangladesh and aquaculture practises. Fish production possibilities, prospects of exotic fish culture in Bangladesh are also included.

Database: Leeds/BCAS

Author: Anon
Date: 1990
Title: Bangladesh: Environment and Natural Resource Assessment
Source: World Resources Institute and Centre for International Development and Environment, Washington D.C.
Keywords: natural resources, environment, bangladesh, fisheries, pollution, water management, aquaculture
Abstract: This report summarises the findings and recommendation of preliminary analysis of current environmental and natural resource management issues in Bangladesh and their relation to the country's economic growth and development. The assessment is based on a review of the principal sources of information on this subject and consultations with government officials donor agencies, the private sector and knowledgeable individuals in Bangladesh.

Various efforts are needed to check further declines in the productivity of inland fisheries, stemming from over fishing, environmental pollution, and poorly designed flood control, irrigation and drainage and infrastructure development projects. Non-stable development of shrimp production can be increased for the development of small-scale aquaculture among rural communities and at the household level.

Database: Leeds/BCAS

Author: Asaduzzaman, M. and Kazi, A.T.
Date: 1997
Title: Rice and Fish: Environmental Dilemmas of Development in Bangladesh. In; Growth or Stagnation? A Review of Bangladesh's Development 1996
Source: The University Press Ltd., Dhaka, Bangladesh
Keywords: land use, land environment, water, cropping pattern, land degradation, fisheries, fisheries resources degradation, FCD/l, policy for sustainable development
Abstract: The present paper reviewed most of the aspects of land, land use, land environment, land degradation, cropping pattern, economy of land, fisheries in Bangladesh, employment of the fisheries sector, degradation of the fisheries resources, causes of degradation, impacts of the FCD/I projects, perceptions of fishermen, environmental impacts of shrimp culture in bangladesh and towards a policy for sustainable development.

there are a number of tables and references in the text to highlight the present status of the present sector in bangladesh.

Database: Leeds/BOAS

Author: Aziz, M.A.
Date: 1974
Title: Simple Methods of Surface Water Treatment for Domestic Use
Source: Journal of the Institutions of Engineers 4
Keywords: water treatment, purification, turbidity, bacterial counts, domestic water, quality, health
Abstract: This paper represents an attempt to show experimentally the simple methods of surface water treatment for domestic uses both for urban and rural areas of Bangladesh. Two important water quality parameters; turbidity and micro-organisms were taken into consideration for investigation because of their public health significance. The treatment methods adopted were plain sedimentation, sedimentation with alum and disinfection with bleaching powder. The water samples were collected from various sources in and around Dhaka, Bangladesh and investigations were carried out. The experimental results were critically discussed.

A simple household purification plant was developed with locally available cheap indigenous materials. A few experimental runs were carried out to purify water based on the experimental findings and the plant was found to be successful in operation.

The shortcomings of the experimental plant and the limitations of the results were critically discussed and conclusion drawn.

Database: Leeds/BCAS

Author: BBS
Date: 1984
Title: The Survey of Ponds - 1982
Source: Bangladesh Bureau of Statistics, Dhaka, Bangladesh
Keywords: ponds, fish resources, nature and type of ponds
Abstract: a random sample survey of ponds was carried out in the months of February and March 1982 in rural areas of all the districts (except Chittagong Hill tracts) excluding reserved forest and tea gardens. the total number of ponds was estimated to be 1.86 million of three 18.4 percent were derelict, i.e., completely out of use. The number of non-derelict ponds was estimated to be 1.54 million, with a standard error of 2.2 percent. the average area of a derelict pond was 0.17 acres. The ponds accounted for nearly 40% of the total inland fish catch. Major carp accounted for about 60% of the total catch and live fish (koi, singi, magur

etc.) for about 25% of the non-perennial ponds were used mainly for fishing and nearly 70% of the owners of ponds not being used for fishing reportedly lack of finance as the season for non-use. only about 2% the non-perennial ponds were cultivated during the dry months. practically all the ponds were owned privately either singly (47%) or jointly (52%). in 41% of ponds no spawn/fry was released. about 53% of the operators did not sell fish at all, 13% sold 1/4 of the catch, 16% sold 1/2 the catch and 13% sold 3/4 of the catch.

Database: Leeds/BOAS

Author: BCAS
Date: 1994
Title: Wetlands of Bangladesh
Source: Bangladesh Centre for Advanced Studies, Dhaka, Bangladesh
Keywords: wetlands, bangladesh, wildlife
Abstract: This publication was undertaken to bring together available information on the wetlands of Bangladesh under one cover as a reference document. Most of the material was drawn from existing published and unpublished accounts.

Database: Leeds/BCAS

Author: Bhuiyan, A.K.M., Hannan, A., Chua, L.A. and Calilung, V.J.
Date: 1995
Title: Farmers Trade-offs and Decision Tree Model in Past Management: Some Theoretical Considerations
Source: Journal of The Asiatic Society of Bangladesh 212
Keywords: farming, crop modelling, pest management
Abstract: Crop modelling is an important analytical tool in farming systems research, specifically in making crucial decisions in pest management practises. This paper attempts to critically examine the farmers decision model in pest management based on some theoretical considerations and discusses the trade-offs they may choose. It offers some useful parameters and insights which may, in turn, help in the design of successful research and extension programmes as well as pragmatic farming systems interventions.

Database: Leeds/BCAS

Author: Brammer, H.
Date: 1997
Title: Agricultural Development Possibilities in Bangladesh
Source: University Press Limited (UPL), Dhaka, Bangladesh
Keywords: environment, background information on bangladesh, development approach, planning and development, crop diversification, review of development issues
Abstract: This book includes selected papers on crop suitability with soils and agriculture development in Bangladesh. It provides background information on Bangladesh's physical characteristics to assist readers in understanding the rationale for crop selection, soil management possibilities in different parts of the country. Focussing on specific disaster-prone and difficult environments, provide a comprehensive review of regional aspects of development. The potential for production of HYV rice, wheat and other cereals, and review experience with wheat cultivation. However, crop suitability and crop diversification a synthesis of the principles of agricultural development and crop suitability assessment includes in this book.
Database: Leeds/BCAS

Author: BSS
Date: 1984
Title: The Survey of Ponds - 1982
Source: Bangladesh Bureau of Statistics, Dhaka, Bangladesh
Keywords: ponds, fish resources, ownership
Abstract: A random sample survey of ponds was carried out in the months of February and March 1982 in rural areas of all the districts (except Chittagong Hill Tracts) excluding reserved forest and tea gardens. The total number of ponds was estimated to be 1.86 million of these 18.4 percent were derelict, i.e. completely out of use. The number of non-derelict ponds was estimated to be 1.54 million, with a standard error of 2.2 percent. The average area of a derelict pond was 0.17 acres. The ponds accounted for nearly 40% of the total inland fish catch. Major carp accounted for about 60% of the total catch and live fish (Koi, Singi, Magur etc.) for about 25% of the non-perennial ponds were used mainly for fishing and nearly 70% of the owners of ponds not being used for fishing reported lack of finance as the reason for non-use. Only about 2% the non-perennial ponds were cultivated during the dry months. Practically all the ponds were owned privately either singly (47%) or jointly (52%). In 41% of ponds no spawn/fry was released. About 53% of the operators did not sell fish at all, 13% sold 1/4 of the catch, 16% sold 1/2 the catch and 13% sold 3/4 of the catch.
Database: LeedsBCAS

Author: CPP
Date: 1996
Title: The Press Speaks .....on the Compartmentalisation Pilot Project
Source: Euroconsult, Lahmeyer, BETS, and House of Consultants, Dhaka, Bangladesh
Keywords: flood action plan, compartmentalisation
Abstract: The purpose of the document is to bring all these media view points under one cover. This version with original reports and English translation is produced specially for overseas readers.
Database: Leeds/BCAS

Author: FAO
Date: 1972
Title: Bangladesh Land and Water Resources Sector Study, Volume vii, Water
Source: FAO, Rome, Italy
Keywords: water distribution, ground water, rainfall, runoff, surface water conditions, cropping patterns, seasonal rainfall
Abstract: Of the four Technical Reports (No. 20, 21, 22, and 23) that comprise this volume. The 1st Technical Report (No. 20), describes the problems in Bangladesh as one of uneven water distribution in timing and space - too much water over a major part of the country during monsoon and a limited amount available for irrigation in the dry season .., Ground water .. The second Tech. Report (No.21), documents in more detail the magnitude of this important water sources. Analysis of rainfall, runoff and surface conditions ... The activities upstream which may affect land and water development efforts are analysed in the 3rd Tech. Report, in this volume (No. 22), rainfall and cropping patterns are intimately related. A detailed probability analysis of seasonal rainfall pattern is given in Technical Report No. 23.
Database: Leeds/BCAS

Author: Ghani, A.
Date: 1987
Title: Improved Water Management for Rice Irrigation System in Bangladesh
Source: D.Phil Thesis, Agricultural and Irrigation Engineering, Utah State University, Logan, Utah, USA
Keywords: water management, system education, rice production models, model verification
Abstract: this study was conducted in the Ganges-Kobadac irrigation system in bangladesh which has-total irrigable area of 141,700 (ha) and pumping capacity of 153 cros. three secondaries, three tertiaries and fifty observation paddies were selected to represent the head , middle and tail reaches of a main, secondary and tertiary canals respectively. seasonal

data on water production status, use of inputs and rice varieties and daily data on rainfall, evaporation, seepage and percolation and water flow were recorded at each of the nine tertiaries during 1981-1985.
Rice production models for two growing seasons (aus and amon) and irrigated area models (irrarm) were developed. Irrigation models estimates of irrigated areas were in close agreement with actual values for both aus and amon season. However, the goodness of fit was better for the aus season than for the amon season.

Adaptation of proposed pump operation schedule and crop calendar, improvement in implementation of rotation schedule and water distribution were major recommendations.

Database: Leeds/BOAS

Author: Glaser, M.
Date: 1989
Title: Water to the Swamp? Irrigation and Patterns of Accumulation and Agrarian Changes in Bangladesh
Source: D.Phil. Thesis, University of Bath, UK
Keywords: mechanised irrigation, agrarian reform, shallow tubewells, productivity potential, new technologies, micro-level economy
Abstract: This thesis is based on fieldwork in one main and seven other villages in one area of Bangladesh. It examines patterns of resource accumulation by different household categories and changes in the form and meaning of agrarian relations which occur with the introduction of STW irrigation. It is argued that under present conditions of low non-agricultural incomes and declining per capita land resources in rural Bangladesh, a transformation towards a more expansionary, capitalist rationale of production and appropriation is taking place in agriculture. The field work material shows how under more secure, higher-productivity condition facilitated by irrigation, agrarian relations are being restructured by producers and appropriations to exploit the productivity potential of new technologies such as mechanised irrigation.

The comparison between the main and the seven other villages in this research shows that such restructuring of agrarian relations towards output and productivity objectives takes different forms and has different development outcomes depending on micro-level political economy conditions. The thesis uses the distinction between "forms of market" (or exploitation) and "modes of production" to differentiate between common patterns of transformation and divergent micro-level development outcomes of technological changes.

Database: Leeds/BCAS

Author: Hamid, M.A.

Date: 1981

Title: Irrigation Technology, Rural Institutions and the Rural Poor in Bangladesh. In: Greeley, M. and Michael, H. (eds.) Rural Technology, Rural Institutions and the Rural Poor

Source: CIRDAP, Comilla, Bangladesh

Keywords: irrigation technology, modern and traditional technology, bangladesh

Abstract: the paper deals with the irrigation technology, rural institutions in bangladesh. it has covered the growth of irrigation technology in bangladesh, impact if irrigation technology, impact on productivity, impact on employment, impact on net income, factors responsible, the suggested framework and the words of wisdom.

Database: Leeds/BOAS

Author: Hassen, N.

Date: 1988

Title: Water Use and Operational Procedures of a Farm Reservoir in Tarlac

Source: Masters Thesis, Institute of Graduate Studies, Central Luzon State University, Munoz, Nueva, USA Ecija, Philippines

Keywords: water management, farm reservoir technology, irrigation, soil moisture, water balance, water status, decision-making

Abstract: The general objective of the study was to determine the water use characteristics of farm operational procedure in an area with small farm reservoir technology and compare them with a rain-fed area in central Lulon, Philippines. The research selected two types of farm reservoirs with 1.4 in depth of water for comparison. A partial budget method of economic analysis was used; the farmer gained more benefit with small farm reservoir technology compared with farming without. Higher benefit could have been obtained by the reservoir owner if he had used the reservoir water for irrigation of more rice area in the wet season and munghean crop in the dry season.

Database: Leeds/BCAS

Author: Huq, S.

Date: 1995

Title: Unstable Land Use in Bangladesh can the Process be Reversed?

Source: Department of Environment, Dhaka, Bangladesh

Keywords: land use, land ownership, agriculture, soil, fertility, erosion, pollution

Abstract: This final report briefly describes the physical and sociological aspects of land use management and provides some ideas for the environmental

planners and policy researchers. It is primarily a review of existing available documents on similar aspects such as land, soil, environment,sustainable land use, institution and policy aspects, recommendations, conclusion and bibliography.

Database: LeedsBCAS

Author: Huq, S., Rahman, A.A. and Conway, G.R. (eds.)
Date: 1990
Title: Environmental Aspects of Agricultural Development in Bangladesh
Source: University Press Limited (UPL), Dhaka, Bangladesh
Keywords: agricultural development, ponds, pesticides, soil quality
Abstract: The publication draws together a series of commissioned papers from experts in various fields related to agricultural development and surface water systems, presented at two BCAS organised workshops. These included: Environmental Aspects of Agricultural Development, Concepts and Issues on Agriculture and the Environment, the Development of Farming Systems Research, Crop Livestock Interaction, Uses of Ponds, Women in Homestead Agriculture, Issues surrounding Sectoral Composition and Characteristics, Temporal Changes in agriculture and characteristics, temporal Changes in Agricultural Land Use, The Decline of Soil Quality, Consequences of Increased Pesticide Use, Water Control and Productivity, Groundwater Abstraction, Environmental Perception and Agriculture, Local Organisations and Adaptations of Irrigation Technology and Rapid Rural Appraisal and Farming Systems research Methods in Bangladesh are described in this book.
Database: Leeds/BCAS

Author: Hye, H.A.
Date: 1985
Title: Decentralisation Local Government Institutions and Resource Mobilisation
Source: Bangladesh Academy for Rural Development, Kotbari, Comilla, Bangladesh
Keywords: decentralisations, local resource mobilisation, participatory rural development
Abstract: The evaluation of a four day international seminar on "Decentralisation Local Government Institutions and Resource Mobilisations", organised by Bangladesh Academy for Rural Development (BARD). 16 papers referring to group reports and recommendations from the seminar appended in this volume are of great significance.

This publication could be implemented when making policy decisions and as the basis for further research by the academic community.

Database: Leeds/BCAS

Author: Islam, A.I.
Date: 1978
Title: Irrigation Water Distribution Process in Spatially Stratified Areas of the Ganges-Koabdak Project of Bangladesh
Source: D.Phil. Thesis, Asian Institute of Technology, Bangkok, Thailand
Keywords: irrigation water distribution, water adequacy, water supply, seepage, percolation, losses
Abstract: The study was conducted in the Ganges-Kobdack Project of Bangladesh during the Kharif -1 (Dry) season of 1978. Different aspects of water use for lowland rice and the corresponding irrigation water supply in the selected areas of the project were studied.

The study found that seepage and percolation losses varied from 3.88 to 6.96 mm/day and the net water use i.e. evapotranspiration, seepage and percolation ranged from 7.82 to 10.90 mm/day in different areas. Water supplied through the canals was found to be greater than the actual requirement and comparatively higher water supply was observed at the upstream areas. Also, no definite schedule of water supply was found to exist in the system. High water use efficiency was noted at downstream areas compared to upstream areas, indicating excessive loss of water in upstream areas. However, water adequacy was observed to be higher in the areas near to the source of water.
Database: Leeds/BCAS

Author: Islam, N.
Date: 1992
Title: Indo-Bangladesh Common Rivers: The Impact on Bangladesh.
Source: Contemporary South Asia 1 2
Keywords: water resources, rivers, environmental impact
Abstract: Bangladesh has both a seasonal abundance of water, leading to flooding, and seasonal droughts. Its surface water resources are very vulnerable, as =90% of the river catchment system is located outside the country. Disputes over the 57 rivers common to India and Bangladesh are discussed. Hydrological changes due to diversion and blockage of rivers in India have the following consequences for Bangladesh: (1) siltation and flooding; (2) decreased soil moisture and increased salinity, leading to desertification; (3) decreased water levels; and (4) decreasing upstream flow, leading to saline intrusion into coastal lands and damage to the mangrove forest.
Database: CABI

Author: Jupp, B.P, Rahman, B. and Whitton, B.A.
Date: 1995
Title: Ecology of Deepwater Rice-Fields in Bangladesh: Influence of Environmental Factors on Seasonal Changes in the Rice Plant
Source: Hydrobiologia 302 3
Keywords: nitrogen fertilisers, floodplains, deepwater rice, flooding, fertilisers, biomass production
Abstract: Measurements of the biomass of deep water rice plants at sites on the three major floodplains in Bangladesh (Ganges, Jamuna and Meghna) with and without fertiliser treatment (various combinations and rates of N, P and K) were made from shortly before the arrival of flood water (June) until it was receding (mid-October). There was usually an approximately linear increase in biomass per unit area with time until September, but subsequently there were marked differences in response, ranging from a continued steady increase to a sharp drop. Differences in the flood pattern were an important factor influencing changes in biomass and productivity. Net productivity (biomass change) measured at different stages in growth ranged from -73 to +220 kg ha-1 d-1 without fertiliser and from -141 to +430 kg ha-1 d-1 with fertiliser, with mean values of +130 kg and +160 kg ha-1 d-1, respectively. However, grain yield reflected increased biomass in only 1 of 4 experiments.
Database: CABI

Author: Karim, M. and Ahsan, A.K.M.
Date: 1989
Title: Policy Recommendations for Fisheries Development in Bangladesh
Source: Ministry of Fisheries and Livestock, Dhaka, Bangladesh
Keywords: policy recommendations, fisheries, freshwater, brackish water, shrimps, marie-culture
Abstract: The present report describes the policy recommendations for the development of all fisheries, particularly, inland openwater fisheries, freshwater aquaculture, brackish water shrimp culture fisheries and marine-culture fisheries of Bangladesh. Each section of the report is concluded with detailed recommendations. Also, the present status and problems of all fisheries are analysed. Some observations on the present status of educational and research institutions and the recommendations thereon in respect of fisheries development are also presented.
Database: LeedsBCAS

Author: Miah, M.I.
Date: 1986
Title: Prospect of Fish-Culture in Rice-Fields in Bangladesh
Source: ADB News, Dhaka, Bangladesh
Source: xiii 2
Keywords: fish-culture, rice-fields, rice/fish culture
Abstract: In this paper, the author dwells upon the problems and prospects of fish-culture in Bangladesh, more specially in the inundated rice-fields of the country, which accounts for about eight percent of the country's total animal protein supply and nine percent of its GDP. The author emphasises the need to utilise effectively the fishery resources of the country and for that matter stresses the need for adequate knowledge of scientific cultural methods and proper management practises. Finally the author describes the socio-economic and management constraints in connection with rice/fish culture, regarding a few possible measures.
Database: Leeds/BCAS

Author: Mian, M.A.M. and Dewan, S.
Date: 1982
Title: Fishes and Prawns of Chandpur Irrigation Fisheries Development Project Area
Source: Bangladesh Journal of Agricultural Science 9 2
Keywords: fishes, prawns, Chandpur, fauna, taxonomy
Abstract: In the present study, 118 species of fishes belonging to 83 genera and 7 species of prawns belonging to genus Macrobrachim were identified from the Chandpur Irrigation Fisheries Development project area. The need for a complete study of this fauna is indicated by the fact that 5 of the fish species found in the three months field wort{ were not previously known from the waters of Bangladesh. The taxonomic list of the identified fishes and prawns is given.
Database: LeedsIBCAS

Author: Mirza, M.Q. and Ericksen, N.J.
Date: 1996
Title: Impact of Water Control Projects on Fisheries Resources in Bangladesh
Source: Enviromental Management 20 4
Keywords: fisheries- environmental-impact; water- water-resources; floodingfloodlands-fish- water-management; fish-farming
Abstract: Bangladesh is a very flat delta built up by the Ganges-Brahmaputra-Meghna/Barak river systems. Because of its geographical location, floods cause huge destruction of lives and properties almost every year. Water control programs have been undertaken to enhance development through mitigating the threat of disasters. This structural approach to flood

hazard has severely affected floodplain fisheries that supply the major share of protein to rural Bangladesh, as exemplified by the Chandpur Irrigation Project. Although the regulated environment of the Chandpur project has become favourable for closed-water cultured fish farming, the natural open-water fishery loss has been substantial. Results from research show that fish yields were better under pre-project conditions. Under project conditions per capita fish consumption has dropped significantly, and the price of fish has risen beyond the means of the poor people, so that fish protein in the diet of poor people is gradually declining. Bangladesh is planning to expand water control facilities to the remaining flood-prone areas in the next 15-20 years. This will cause further loss of floodplain fisheries. If prices for closed-water fish remain beyond the buying power of the poor, alternative sources of cheap protein will be required.

Database: CABI

Author: Natprach, P.
Date: 1986
Title: Fisherwomen's Activities in Bangladesh: A Participatory Approach to Development
Source: BOBP/REP/24, Madras, Spain
Keywords: fishermen, living standards, "participatory" approach
Abstract: This paper describes and discusses a pilot project to improve the living standards of fishermen from two villages near Chittagong, Bangladesh. The project tried out the "Participatory" approach: groups of fishermen led by "link workers" took active part in the project at all stages: planning, identification of activities and implementation. The paper highlights the project methodology, achievements and failures, problems and lessons for the future.

Database: Leeds/BCAS

Author: Rahman, A.
Date: 1984
Title: Women's Economic Activity in Three Socio-economic Groups in Dhamrai
Source: Unpublished Masters Thesis, Department of Geography, Jahagirnagor University, Dhaka, Bangladesh
Keywords: women's activities, economic activity, fertility, family planning, household economy, population, socio-economics
Abstract: This study has evaluated some views of women regarding the nature and dimension of their activities. Three Socio-economic groups: a potter, brass-metal worker and parboiler of paddy have been selected to fulfil the purposes of the study. Subsequently a significant negative relationship has been established between the women's employment in economic activities

and fertility and family size but positive between women's activity and family planning.

The nature of these relationships is of importance in reassessing the contribution of women to the household economy and the approaches to population planning in the country. In fact, instead of following the clinical approaches to population control, a socio-economic approach to it may be of relevance for the country.

Database: Leeds/BCAS

Author: Shah, M.S. and Haque, A.K.M.A.
Date: 1980
Title: Quantitative and Qualitative Study of Samples of Fry and Fingerlings of Major Carps from the River Old Brahmaputra at Mymensingh
Source: Bangladesh Journal of Agricultural Science 7 2
Keywords: fry, fingerlings, major carp, numbers, floods
Abstract: A qualitative and quantitative study of samples of fry and fingerlings of major carps collected from natural spawning grounds of the river Old Brahmaputra at Mymensingh was made. Fry and fingerlings of 25 species of fish including three species of major carps (Catla catla, Labeo rohita and Cirrrhina mrigala) and two species of medium carps (Labeo calbasu and Cirrhing reba) have been obtained in the samples. The three major carps together constitutes 37%, the two medium carps 45% and out of the remaining 20 species of predatory and weed fishes, an unidentified species of the genus puntius (puntius sp.) alone constituted 48.54% of the total catch. The number of species represented in the catch is also the number of species, have been found to have some relationship with the size of the carp fry as also with the occurrence of monsoon flood, both being greater in samples immediately following floods.

Database: Leeds/BCAS

Author: Shimura, T.
Date: 1986
Title: A Remote Sensing Study of Water Bodies as Fishery Resources in Bangladesh.
Source: SPARSO/UNDP/ESCAP
Keywords: remote sensing, water bodies, ponds, fish resources
Abstract: The present paper deals with the total area of inland water bodies by different types through a remote sensing study of water bodies using satellite imagery and aerial photographs over 40 sample thanas out of 44 thanas in the whole country, conducted by SPARSO. The total ponds for the whole of Bangladesh comes out to be about 1,300,000 and the total pond area about 360,00 acres or about 145,00 (ha). The total number of

ponds by condition (cultured, cultivable and derelict) was estimated as 580,000, 390,000 and 331,000 respectively, and the total area of ponds by the three conditions was estimated as 184,00, 109,000 and 65,000 acres respectively.

Database: Leeds/BCAS

Author: Sobahan, R. et al.888
Date: 1997
Title: Growth or Stagnation? A Review of Bangladesh's Development 1996
Source: University Press Limited (UPL), Dhaka, Bangladesh
Keywords: macro- economy, agriculture, crop sector, non-crop sector, industry, financial sector, external sector, poverty and policy, population, education and health, environment, women and development, rice
Abstract: the independent reviews of Bangladesh's development (IRBD) prepared the present volume. a panel of eminent experts, most of whom contributed to IRBD 1995, now focus their attention on the developments and changes in the economy in financial year 1995-1996 where IRBD 1996 continues this in-depth analysis of some of the major issues challenging the economy. the volume presents a wealth of information on the development process and draws attention to the immediate task which need to be address in the near future if the economy is to graduate to a sustainable growth path.

IRBD 1996 covers thirteen themes which include the macroeconomy, the financial sector, the fiscal sector, poverty, the external sector, agriculture (both crop and non-crop), gender, environment and quality of public investment. the last themes are the new to the IRBD and provide a basis for a continuing discussion of these issues in future IRBDs.

This volume will be use to the government, policy makers, experts, students who will be exposed to a challenging analysis of the current state of the economy in bangladesh, the quality of public expenditure and the long-term impact of policies in areas such as environment and the position of women in society.

Database: LeedsBCAS

Author: SPARSO
Date: 1984
Title: Report on FAO/UNDP Project in Bangladesh Contract No DP/bGD 79/015/ F 1 (Fisheries Resources Survey System).
Source: SPARSO, Dhaka, Bangladesh
Keywords: water bodies, satellite imagery, fisheries resources, bangladesh

Abstract: The present report deals with the study and survey result of the water bodies of Bangladesh using satellite imagery and areal photographs and thus makes a correct estimation of total water bodies useable for fish production in the country during the study. Water bodies were divided in to two categories such as small water bodies and large water bodies.

Database: Leeds/BOAS

Author: Sutradhar, S.C. and Hossain, S.
Date: **1984**
Title: A Study on Mosti Irrigation
Source: BARC, Dhaka, Bangladesh
Keywords: feasibility of irrigation, irrigation requirements, mosti irrigation
Abstract: The feasibility of irrigation by Mosti (a hand tube well generally of about 0. 00056 cu.m/sec. capacity) for producing high yielding variety rice and wheat crop was investigated by comparing the benefits with the costs. Irrigation requirements for crop were derived from published records. Operational costs were critically examined determining operating hours based on irrigation requirements. The main constraints to Mosti irrigation are its operation and operational costs resulting in HYV Boro rice production financially non-viable. 'Dheki pump" if a Mosti is to be profitably used for irrigation, in agriculture crops.

Database: Leeds/BCAS

Author: Townsley, P.
Date: 1996
Title: Rapid Rural Appraisal, Participatory Rural Appraisal and Aquaculture
Source: Fisheries Technical Paper 358
Keywords: aquaculture, development, planing, management, rra, pra
Abstract: This document is intended for aquaculture development specialists, aquaculture project managers, and officials and specialists involved in the planing and management of aquaculture activities. It is intended to provide an introduction to Rapid Rural Appraisal (RRA) and Participatory Rural Appraisal (PRA) for people working in these fields. The principal components of these two approaches to inform collection and planning are described along with the various tools used, with a case study to illustrate their use and some of the issues they raise. Possible applications of the approaches for those involved in aquaculture development are given and an outline provided of the sorts of planning and institutional context where they can best be applied. The problems and shortcomings of the approaches are also discussed and guidelines given for the alternative approaches to information gathering and planing.

Database: Leeds/BCAS

Author: Tsai, C. and Ali, M.Y.
Date: 1997
Title: Openwater Fisheries of Bangladesh
Source: University Press Limited (UPL), Dhaka, Bangladesh
Keywords: fish, fisheries, openwater, floodplain, fishing gear, nets, fish traps
Abstract: This book is a valuable compilation of fourteen chapters containing information on different aspects of openwater fish and fishers. The Chapters are: 1) Tropical Floodplain Fisheries, 2) Riparian Rights; The organisation of Work and Market Relations Among the Inland Fishers of Colonial Bengal, 3) Stock Improvement and Genetic Resource Conservation of the Floodplain Fishes, 4) Fish Health and Management in Bangladesh Floodplain, 5) Fish Biodiversity, Human Nutrition and Environmental Relation in Bangladesh, 6) Socio-economic and Policy Issues in the Floodplain Fisheries of Bangladesh, 7) Marketing of Fish from Selected Floodplains in Bangladesh, Limnology of some Floodplains of Bangladesh, 10) Floodplain Fishing Gears of Bangladesh, 11) Ecology of Floodplains in the Northeastern Region of Bangladesh, 12) Openwater Fisheries in the Northeastern Region Of Bangladesh, 13) Stock Enhancement in the Floodplain Fisheries of Northeastern Bangladesh, and 14) Impact of Flood Control and Drainage with or Without Irrigation Project, on Fish Resources and Fishing Community in Bangladesh.

This book has possibly for the first time in Bangladesh, brought together different aspects of inland openwater capture fisheries and is expected to provide an impetus to further work by fisheries biologists, fisheries economists, fisheries technologists, fisheries planners and others in developing sustainable use of fishery resources of the country.
Database: Leeds/BCAS

Author: Uddin, B.S., Hossain, S.M.A., Somen, D.
Date: 1996
Title: Alternate Rice-Fish System in the Baid Ecosystem, Mymensingh Region. In: Land/water Interface Production Systems, Centre for Land Use and Water Resources
Source: Department of Agricultural and Environmental, Science, University of Newcastle, UK, Department of Anthropology, University Of Durham, UK, Institute of Aquaculture, University of Stirling UK.
Keywords: farming system, rice-fish culture, livelihood systems, productivity Abstract: The present study report describes the preliminary investigation on existing farming in a particular area which characterises the whole farm system and its resource-base. This facilitated development of a conceptual model of livelihood strategies of farmers producing rice/or fish, identification of major constraints to the productivity of the system and the prospect of rice-fish culture on a long term basis. Participatory Rural Appraisal (PRA)

with Agro-Ecosystem Analysis (AEA), and questionnaire surveys were conducted in the present study.

Database: Leeds/BCAS

Author: World Bank
Date: 1996
Title: Social Indicators of Development
Source: John Hopkins University Press, London, UK
Keywords: social indicators, social and economic conditions, poverty indicators, resources and expenditures, more information
Abstract: This publication has includes all aspects of the social indicators of development country wise. data were used to show the present status of the following sectors: overview of social and economic conditions, priority poverty indicators, supplementary poverty indicators, development diamond, resources and expenditures and for more information.

Database: Leeds/BCAS

Author: Yousuf, H.A.K., Alain, M. and Mazid, M.A.
Date: 1993
Title: Experimental Study of Paddy-cum Fish/Shrimp Farming in Bangladesh. Effect of Fertiliser on Growth and Yield.
Source: Bangladesh Journal of Zoology 212
Keywords: paddy, fish/shrimp farming, fertiliser, carp, prawn
Abstract: Paddy yields from either paddy-fish or paddy-shrimp farming almost equal that obtained from paddy farming alone. Use of different doses of extra fertilisers did not help increase production of either fish/shrimp or paddy significantly. Performance of major carps in rice fish systems was not satisfactory. Giant fresh water prawn could be one of the best species for rice-shrimp integration.

Database: Leeds/BCAS

Section C: Water Resources Management and Water Sector Planning

Author: Abbas, B.M.
Date: 1989
Title: Flood Management in Bangladesh. In Ahmad, M. (ed.) Floods in Bangladesh
Source:
Keywords: floods, causes, control, 1988 flood, himalayas, rivers
Abstract: The paper deals with the causes of floods and methods of flood control. The Himalayas have a profound influence on the climate of the subcontinent. On account of their high altitude and location in the path of the monsoon, the Himalayas cause precipitation of most of the cloud moisture, either as snow or rain. There are vast reservoir of water in the form of ice, snowfields and glaciers giving rise to many large rivers, such as the Brahmaputra, Ganges and Indus and innumerable streams.

The Himalayas, contain the highest mountains, the highest passes and the deepest gorges on earth and with some of the world's largest and most violently erosive rivers, is a region liable to frequent earthquakes, landslides and floods. In heavy floods, villages are washed away, bridges and ferries carried away and low-lying crops destroyed. Man has been further endangering the environment and helping to create deserts with his own hands.

The catchments of the Brahmaputra and its tributaries receive very heavy rainfall ranging from 110 cm to 635 cm a year, mostly during the monsoon months of June to September. As a result, the region is subject to severe floods. In addition, frequent earthquakes occur in the region, causing numerous landslides in the hills and upsetting the regime of the rivers. The problems encountered are; spilling, drainage congestion and a tendency for some rivers to change their course.

Bangladesh which lies on the combined estuaries of the Ganges and the Brahmaputra, two of the world's largest rivers, occupies a very special position and has to bear the brunt of the huge quantities of water carried by the two rivers from the large catchments, only 7.5 percent of which lies within the territory of Bangladesh. Further, more than half the country is less than 7 meters above sea level and is exposed to inundation from the sea as a result of high tides or because of tidal waves generated, for example, by tropical cyclones.
Database: Leeds/BCAS

Author: Abbas, B.M.
Date: 1992
Title: Development of Water Resources in The Ganges and Brahmaputra River Basins In: David J. E. (eds.) The Ganges - Brahmaputra Basin: Water Resources Cooperation Between Nepal, India And Bangladesh
Source: Lyndon B. Johnson School of Public Affairs, University of Texas, Austin, Texas.
Keywords: himalayan rivers, potentials, water resources, development, river basins
Abstract: The paper deals with the current problems and future potential of the countries of the Ganges, Brahmaputra, and Meghna Basins. Co-riparian cooperation is necessary for a lasting solution of the problem and optimum development of the water resources of river basins. Bilateral discussion between Bangladesh and other co-basin statistics of the Ganges and Brahmaputra river basins are now in progress about the flood problem. It is hoped that the bilateral actions will lead to broader regional cooperation. The initial step in this direction may be the formation of a joint body of the co-basin states to plan and execute river basin development.
Database: Leeds/BCAS

Author: Adnan, S.
Date: 1994
Title: Flood, People and Environment : Reflections on the Recent Flood Protection Measures in Bangladesh.In: Rahman, A. et al. (eds.) Environment and Development in Bangladesh, Volume II
Source: University Press Limited (UPL), Dhaka, Bangladesh
Keywords: complexities of flood in bangladesh, genesis of fap, flood control programmes, social, economic and demographic consequences, impacts on women, environmental consequences, policy implications
Abstract: The article looked at the existing flood protection programmes in the country including FAP and moved towards an analytical treatment of certain critical issues. It focused mainly up on assessment of short run trends in flooding during 1990 and various institutions which were charged to cope with flood related problems. The article also assessed the effect of flooding as well as the actual performance of existing flood control and drainage structure. The discussion also subsumed social, economic, demographic and environmental consequences. The analysis then moved towards identifying the causal factors underlying the outcomes.
Database: LeedsBCAS

Author: Ahmad, Q.K.
Date: 1994
Title: Integrated River Basins Management for Socio-economic Development of a Region
Source: In Management of International River Basins and Environmental Changes, Academic Publishers, Dhaka, Bangladesh.
Keywords: the g b in region, physical characteristics, socio-economic characteristics, environment, water resource, integrated development.
Abstract: This paper focuses on the socio-economic development of the Ganges, Brahmaputra and Meghna basins through integrated river basins management. The various dimension of an integrated management and development of the GBM river have been outlined in this paper. Th integrated approach is surely water sharing arrangement among the co-riparian countries. In this context, a long-term agreement for the sharing of the Ganges water between Bangladesh and India at Farakka is an important element. similarly, there are nagging water related problems between India and Nepal which call for urgent resolution. Other collaborative activities will have to be developed overtime through negotiations once the initial hurdle has been crossed. In this whole process of inter-country integration, there is a crucial generating positive approaches and transparency in the negotiations for moving forward together towards a better future, discarding the hitherto pursued path of exclusion and hence privation and self-abnegation.

The other dimensions of integration will need to be developed simultaneously in order to pursue socio-economic development vigorously as opportunities are created by inter-country cooperation on water issues. Generation of sustained productive employment through basic education, trade training and organisation is identified to be the focal process for socio-economic development of the GBM region.
Database: Leeds/BCAS

Author: Ahmed, K.
Date: 1991
Title: Institutional Aspect of Sustainable Development: A Case Study on Water Resource Management.
Source: IUCN/NORAD
Keywords: water management, popular attempts, history of water management
Abstract: This paper digs into history to present materials which would contribute to this issue. it has contains on the History of water management in Bangladesh such as, Ancient period, Medieval period, colonial period and post colonial of Bangladesh. Popular attempts of water management and a national model of water management also includes in this document.
Database: Leeds/BCAS

Author: Ahsan, A.
Date: 1994
Title: The Prospects of Regional Co-operation for the Development of the Water Resources of the Eastern Rivers of South Asia
Source: In Management of International River Basins and Environmental Challenges, Academic 888Publishers, Dhaka, Bangladesh.
Keywords: regional cooperation, the GBM
Abstract: The paper examines in a very preliminary way the question of co-operation among Bangladesh, Bhutan, India and Nepal, The riparian States of the Ganges, the Brahmaputra and the MeghnaBarak (GBM region or so-called Eastern rivers) for the development of the water resources of the area. He said the water is a critical resource for the 21 st century. The area is rich in water resources but there is no regional approach to their development.

The author given some of ideal how to improve the situation regarding the cooperation in the region. he said there is a need to promote cooperation to generate public awareness about the benefits and programmes which can create visible benefits to the people inn all the countries, sharing of information about one another's future plans and programmes exchanges of data and analysis, agreements for forecasting and early warning system etc..
Database: LeedsBCAS

Author: Ali, M.Y.
Date: 1989
Title: Environment, Conservation and Fishery Resources in Bangladesh. In: Aguerio, M. and Huq, S. (eds.) Inland Fisheries Management in Bangladesh
Source: DOFBCAS, Dhaka, Bangladesh and ICLARM, Manila, Philippines
Keywords: inland fisheries, production systems, fisheries, conservation, water withdrawal, pollution, pesticides
Abstract: The article highlights the importance of the floodplains during the monsoon season in the continuation and sustenance of the stocks of a large variety of fish species as the inland fishery production system, consisting of rivers, floodplains, beels and estuaries, is a single integrated system. It discusses the impacts of some flood control, drainage and irrigation (FCDI) projects of the fish production system. The impacts of sustainable embankments on the aquatic production system and species diversity in haor areas are described. It also discusses the withdrawal of irrigation water from large water bodies such as the oxbow lakes of the Jessore area
and perennial beels. The effects of this on the fishery production system are indicated.

The impacts on fish and prawn resources by the possible industrial and chemical pollution on, particularly those caused by agricultural pesticides is considered. It also discusses conservation measures to sustain the populations and stocks of various fish species, as well as the environment of those measures.

Database: LeedsBCAS

Author: ANON
Date:
Title: First Draft of National Water Policy
Source:
Keywords: water policy, elements, development of resources, water allocation, development strategies, conservation, drought management, institutional development, peoples participation, legal framework, region
Abstract: the draft national water policy formulated by the ministry of water resources has six chapter including introduction, development of water resources, potential for sectoral allocation, development strategies, institutional development and regional and international cooperation in water sharing. setting the goals of water policy, it has also described elements of national water policy which include physical environment, water resources potentials, the institutional and legal framework. under the institutional issue, the draft policy also addressed the long felt need of people's participation in water sector. it also emphasised on cost recovery and technology transfer.

Database: Leeds/BCAS

Author: APO
Date: 1986
Title: Farm-Level Water Management in Selected Asian Countries
Source: Asian Productivity Organisation, Tokyo, Japan
Keywords: water management, farm-level, irrigation system, human organisation, water resources, water conservation, impact of irrigation, drainage, flood control, financing
Abstract: The report describes on Farm-level Water Management in selected countries produced by a team of multi-country study mission. The report deals with the history of irrigation development, examining existing irrigation systems, harnessing water resources, establishing stable human organisation, water conservation and distribution. It investigates on-farm development, land reclamation flood and salinity control, considering financing of the project and water management by cooperative efforts. The project also includes rational irrigation method, organisation chart of irrigation association in different classes, impact of irrigation, drainage and water management. It documents problems at farm-level and training in

On-Farm water Management, finally giving major objectives to better water management.

Database: LeedsBCAS

Author: Asaduzzaman, M.
Date: 1994
Title: The Flood Action Plan in Bangladesh: Some Lessons of Past Investments
Source: Centre for Udviklingsforskning (Centre for Development Research) (CDR) Copenhagen, Denmark
Keywords: flood control, projects, water management, rural development
Abstract: Because of the country's unique geographical features, the flood in Bangladesh is a regular phenomenon. Much of Bangladesh is a deltaic plain formed by the sediments carried by three of the mightiest river systems in the world, the Ganges-Padma, the Brahmaputra-Jamuna and the Meghna-Barak. As a result, the country is gently sloping towards the sea. The sediment load carried by the river systems in Bangladesh is enormous, estimated at 1500-2500Mt per year. A flood is experienced every year. With international help the government initiated a Flood Action Plan (FAP) in 1990. This study discusses some of the lessons that have emerged from the experiences for water resource development in the country and investigates future flood protection measures that can be taken. The main sections of the report cover: flood frequency and flood damage; interactions among floods, the environment and the economy; public responses to floods; the Flood Action Plan; the impact of flood and flood control measures; and the prospects for the future. Despite various problems related to the planning, designing, implementation and operation and maintenance, the gains in many projects in terms of agricultural output have been impressive. Some problems on the fisheries have lowered the total benefit to the extent that no more than half of the projects can be said to be viable. People will always demand some form of protection from floods, although what measures they are and whether they are structural or non-structural, depends on the design of the project.

Database: CABI

Author: Bari, F.M. and Shajahan, M.
Date: 1989
Title: Water Resources Development Activities in Bangladesh: Survey and Appraisal. In: Ahmad, M. (ed.) Floods in Bangladesh
Source: Community Development Library, Dhaka, Bangladesh
Keywords: role of water sector, history of water resources, resources development, resources planning, development potential
Abstract: The paper discusses the role of water sector in the national development program and recapitulates the extent and limit of water sector and its

relative position in national life and economy as well. This is followed by a review of the historical pattern of water resources development in Bangladesh along with past targets and achievements, as well as potential for future development. Also discussed is the motivation for a comprehensive and multisectoral national water resources development plan to ensure that good investment decisions are made to harmonise different needs and avoid costly conflicts and to attract need financing. The proposed National Water Plan (NWP), which recommends water resources development programs and priorities in term of each sub-sector of water use over a period of 20 years (1985-2005), are summarised.

Database: Leeds/BCAS

Author: BCAS
Date: 1997
Title: Impacts of Flood Control and Drainage with or Without Irrigation Projects (FCDI) on Fish Resources and Fingerling Community in Bangladesh. In: C. Tsai and M.Y. Ali, Openwater Fisheries of Bangladesh
Source: University Press Limited (UPL), Dhaka, Bangladesh
Keywords: flood action plan, socio-economics, fisheries studies, flood control, drainage, irrigation
Abstract: The present paper is the Executive summary of the Final Report of Flood Action Plan (FAP) FAP-17. The fisheries studies and pilot project, was one of the activities of 26 FAP activities supported by the ODA of the UK. It undertook investigation solely on biological and socio-economic aspects of inland openwater fisheries and impacts thereon by Flood Control, Drainage and Irrigation (FCDI) projects. The study started in August 1992 and ended in February 1994, providing 13 to 19 methods of sampling depending on region. The findings and recommendations were presented in the final report submitted in July 1995.
Database: Leeds/BCAS

Author: BCAS
Date: 1991
Title: Floodplain Production Monitoring Initial Study Report
Source: Directorate of Fisheries, Dhaka, Bangladesh
Keywords: floodplain, production monitoring, fisheries
Abstract: The report deals with the methods and techniques of monitoring floodplain capture fisheries. The methods cover both the households and gear dependant monitoring systems for estimating production. The Socio-economic survey method for fishing households is also described.
Database: Leeds/BCAS

Author: Custers, P.
Date: 1993
Title: Bangladesh's Flood Action Plan: A Critique
Source: Economic and Political Weekly 28
Keywords: flood control, projects, world bank, water management, rural development
Abstract: This paper reviews Bangladesh's flood action plan of 1990, which is cited as a good example of the unrealistic and expensive schemes that agencies like the World Bank have forced many developing countries to undertake, without a realistic appraisal of experiences within the country. After excessive floods in 1987 and 1988, Bangladesh called other international organisations for help. Under the coordination of the World Bank, other international goverrunents held a conference and subsequently drafted the 'Flood Action Plan' (FAP). This consisted of numerous studies and pilot schemes. Implementation of these projects has not proceeded far, with conflicts of interest appearing within the Bangladesh bureaucracy and delays by other members. The plan's ultimate aim is to construct tall embankments along both sides of Bangladesh's three main rivers; the Ganges, Bralunaputra and Meghna. Criticisms have come from many sources, objecting to the FAP for environmental and cost reasons as well as the inappropriateness of the plan for the river system has not been sufficiently examined. The costs, even if spread over two years, would apparently present the peasantry with all added tax burden, in a country where millions are threatened daily with famine and starvation.
Database: CABI

Author: Dempster, J.I.M. and Brammer, H.
Date: 1992
Title: Flood Action Plan - Bangladesh
Source: Outlook on Agriculture 214
Keywords: water management, flood control, planning
Abstract: The development of the Flood Action Plan in Bangladesh, stimulated by the 1987 and 1988 floods, is described. The objectives of the first five-year phase were to establish the principles and criteria for sustainable flood mitigation, to undertake comprehensive planning studies and to begin the implementation of high priority projects. A main principle of the plan was that main flood control and drainage works should be integrated with the development of protected areas. The first phase should be completed by the end of 1995. Project preparation and implementation would then proceed on a project-by-project basis. Controlled flooding would still be used. Public participation in project planning, design and operation is being assessed. The implications of the growing poputation in Bangladesh for the Flood Action Plan are discussed.
Database: CABI

Author: Dutta, S.C.
Date: 1991
Title: On-farm Water Management of Diversified Crops
Source: Workshop on Irrigation Management for Crop Diversification, Held 5-6 March, Bangladesh Agricultural University, Mymensingh, Bangladesh
Keywords: on-farm water management, crop diversification, crop irrigation, water management practises, efficiency
Abstract: This paper describes On-farm water Management of Diversified Crops in Bangladesh. Attempts were made to understand the status of actual crop-wise irrigation practice compared to their water demands empirically determined from the key determinants such as soil, crop, altimeter, and irrigation plan. The investigation was carried out following a sampling framework prepared for technical study and secondary data and published documents were used for reference crop co-efficients and other location specific soil and climatic information. According to the study result, overall irrigation anal system efficiency is relatively low compared to recommended efficiencies which usually very from 70-75%. As a consequence, a considerable amount of pump water is lost resulting in either low irrigation coverage or under irrigation to the crops.

The author mentioned in the section of under intervention that water management largely depends on adequate and regular water supply to the crop fields. Proper water management for crops is necessary to increase crop yields. Efforts should be made to introduce low-water consuming and high value crops in high and medium high lands and irrigable soils.
Database: Leeds/BCAS

Author: FAO
Date: 1976
Title: Water Management and Control at Farm Level
Source: Food and Agricultural Organisation, Bangkok
Keywords: water management, irrigation, small scale irrigation, farm level water management
Abstract: This is an outcome of a seminar arranged by the Flood Control and Water Resources Division of Planning Commission of GOB. Eighteen papers presented by FAO experts have been put together in the summary proceedings of the seminar. The papers found water management at farm level and regional and national levels. The major papers include water management in GK project, irrigation and water management in Bangladesh, optimum water application at farm level for rice, economic analysis of small scale irrigation in Bangladesh. The proceedings will be very useful for the study.
Database: LeedsBCAS

Author: FAO/Euroconsult
Date: 1986
Title: Bangladesh Floodplain Fisheries Development Project
Source: FAO/Euroconsult
Keywords: Foodplain fisheries, fisheries development, production unites, economic feasibility, sensitivity
Abstract: Present report consist of five Annexes and a Main Report. After a description of the missions terms of references and the project background, the adopted fisheries development concepts for implementation in the two selected project areas, greater Sylhet and Rajshahi is briefly described. The outcome of the financial appraisal of various proposed production unites and the economic feasibility of the entire project is subsequently presented, including the outcome of sensitivity tests.
Database: LeedsBCAS

Author: Faruqee, R. and Choudhry, Y.A.
Date: 1996
Title: Improving Water Resource Management in Bangladesh
Source: The World Bank, New York, USA
Source: Policy Research Working Paper 1569
Keywords: warpo, water pricing, cost recovery
Abstract: In Bangladesh, water can no longer be considered a totally free resource, and plans must be developed for its efficient use through better management and rules that preserve everybody's access to it and interest in its development: the discussion focuses on some of these management issues. Because it is a common resource, its development and management should involve all beneficiaries. The government's role in this process is to establish the ground rules for water use and conservation through a policy and legal framework and a monitoring system that ensure its continued safety of supply to, and responsible use of water by, every sector and user in the economy. National water policy must set the ground rules for allocation to different users, water rights, pricing, and environmental safety. Bangladesh's water strategy should start with a national water policy that spells out key objectives such as priority of use by critical economic sectors, approaches to water pricing and cost recovery for development, and shared public- and private-sector water management. An apex public planning organisation is needed to perform overall planning for water resources and to advise the National Water Counsel on policy and legislation. Also needed are agencies to implement public water plans for the development of infrastructure, the monitoring of water regimes, and the enforcement of regulations.
Database: CABI

Author: FPCO
Date: 1995
Title: Bangladesh Water and Flood Management Strategy
Source: Flood Plan Coordination Organisation (FPCO), Dhaka, Bangladesh
Keywords: water, flood, management strategies, resources planning, flood action plan,
Abstract: this report presents a framework for the development and implementation of a strategic national water management plan for bangladesh. the report is divided into four chapters. Chapter 1 presents an overview of water resource planning in bangladesh, summarises the work undertaken under the two phases of the national water plan (nwp) and details the evolution of the flood action plan (fap) and the accomplishments of its 26 planning and supporting studies. chapter 2 discusses the key issues and options for development and management of water resources in bangladesh and focuses on key issues (e.g., people's participation; social and environmental assessment) and options that need to be taken into account in water sector planning. chapter 3 presents short-and long-term strategies for water resource and flood management, and chapter 4 presents a development programme for the next five years (1995-2000), within the context of likely longer-term activities in the sector.
Database: Leeds/BCAS

Author: Ghani, A.
Date: 1987
Title: Improved Water Management for Rice Irrigation System in Bangladesh
Source: D.Phil. Thesis, Agricultural and Irrigation Engineering, Utah State University, Logan, Utah, USA
Keywords: water management, irrigation, seasonal data, daily data, system education, paddies, production models, model verification, growing seasons, pump operation, crop calendar, rotation schedule
Abstract: This study was conducted on the Ganges-Kobadac irrigation system in Bangladesh which has-total irrigable area of 141,700 (ha) and pumping capacity of 153 CMS. Three secondaries , three tertiaries and fifty observation paddies were selected to represent the head , middle and tail reaches of a main, secondary and tertiary canals respectively. Seasonal data on water production status, use of inputs and rice varieties; daily data on rainfall, evaporation, seepage and percolation and water flow were recorded at each of the nine tertiaries during 1981-1985.

Rice production models For two growing seasons (Aus and Amon) and irrigated area models (IRRARM) were developed. Irrigation model estimated irrigated areas were in close agreement with actual values for

both Aus and Amon season. However, the goodness of fit was better for Aus season than for Amon season.

Adaptation of proposed pump operation schedule and crop calendar, improvement in implementation of rotation schedule and water distribution were major recommendations.

Database: Leeds/BCAS

Author: Haque, M.I., Howsam, P. (ed.) and Carter, R.C.
Date: 1996
Title: Water Policy Formulation and Implementation in Bangladesh
Source: Proceedings of international conference on Water policy: allocation and management in practice, Cranfield University, UK, 23-24 September, 1996, E & F N Spon Ltd, London, UK
Keywords: environmental impact, social impact, water resources, policy
Abstract: The paper describes Bangladesh's water policy and its water resources potential. Local people have traditionally lived on the banks of its large rivers and have drawn their living from an irrigated-based economy. However, this water has become very scarce in certain parts of this country because of cross-boundary diversions. This has devastated the environment and changed completely the traditional water-use pattern.

Database: Leeds/BCAS

Author: Hossain, S. and Sutradhar, S.C.
Date: 1984
Title: Shallow Tubewell Irrigation in Bangladesh (Screen in use and Length)
Source: Bangladesh Journal of Agriculture 9 1
Keywords: shallow tubewells, stw, screen type, screen length, aquifers
Abstract: This study reviews the type of screen and its length now in use for shallow tubewells (STW) in the country by different agencies. A critical study was made on the screen and a relationship has been shown graphically between entrance velocity, discharge and the length. The study also indicates that the general practice of 12.19m STW now in use should not be the criteria everywhere, rather it should be fixed on the availability of aquifers at different depth and their hydraulic properties.

Database: Leeds/BCAS

Author: Hughes, R., Adnan, S. and Dalal-Clayton, B.
Date: 1994
Title: Floodplains or Flood Plans? A Review of Approaches to Water Management in Bangladesh
Source: International Institute for Environment and Development, London
Keywords: floodplains, water management, water resources, people, flood plan
Abstract: This book deals with an overview and reinterpretation of some of those vital interrelationships between natural and socio-economic systems which characterise the relationship between people and water resources in Bangladesh. Their implication for some key and strategic issues, which currently are the focus of the debate on water management in Bangladesh are also outlined. The book is based primarily on a critical assessment of secondary data sources but also draws upon the fieldwork experience of the authors in Bangladesh.
Database: Leeds/BCAS

Author: Islam, M. (ed.)
Date: 1997
Title: Gangar Pani Bantan Chukti O Antarjatik Prekkhit
Source: Dibya Prokas, Banglabazar, Dhaka, Bangladesh
Keywords: water-sharing, farakka barrage, agreement signed, international river water distribution, water sharing treaty, impacts on morphological aspects, bangladesh, india, nepal
Abstract: This publication highlights the history of water sharing along the Ganges: the history of the Farakka Barrage, agreements signed between the Government of Bangladesh and the Government of India, pre-agreement and post-agreement reports, and international river water sharing treaties in other countries.
Database: Leeds/BCAS

Author: Islam, M.Z., Haq, K.A. and Bhuiyan, L.R.
Date: 1986
Title: Effect of Different Water Management Practices on Grain Yield, Weed Population and Recovery of Applied Nitrogen in Rice Cultivation
Source: Bangladesh Journal of Agriculture 113
Keywords: water management, weed population, yield, nitrogen, irrigation, fertiliser
Abstract: This experiment was conducted at the Bangladesh Rice Research Institute (BRRI) farm, Gazipur in 1981 and 1982 to evaluate the effect of different water management practises on applied nitrogen, grain yield and weed population. Among the three water treatments: continuous standing water, starting condition and intermittent irrigation, higher grain yields and applied nitrogen were observed under continuous standing water treatment in each growing season. Significant yield differences were observed

between fertilised and unfertilised plots under each treatment option. Maximum weed infestation was record under saturated conditions. Apparent recovery of applied nitrogen was lowest during intermittent irrigation.

Database: Leeds/BCAS

Author: Islam, N.
Date: 1980
Title: An Economic Evaluation of the Deep Tubewell Rehabilitation Programme at Dhamrai, Bangladesh
Source: Masters Thesis, Agricultural Economics, University of the Philippines, Banos
Keywords: rehabilitated tubewells, non-rehabilitated tubewells, command area, ground water project, traditional methods, socio-economic comparison, productivity, resources, employment, cost analysis
Abstract: The objective of the study was: (a) to identify the factors behind the differences in performance, measured in terms of command area, between rehabilitated deep tubewells and non-rehabilitated deep tubewells and (b) to evaluate the rehabilitation project in terms of private and social benefits in Dhamrai, Dhaka, Bangladesh. The study was conducted in three parts. The first part showed that the organisation and management issues are the main causes for the differences in command areas, the second part showed that there is no change in productivity and resource use on per hector basis, but there is higher total production resources use and employment opportunities on per tubewell basis, finally it is shown that the DICP project is judged to be highly beneficial to Bangladesh as a whole as well as to the private sector in terms of benefit-cost rotation and net present worth.

Database: LeedsBCAS

Author: Jaim, W.M.H.
Date: 1993
Title: Can Potential Capacity of Deep Tubewells be Utilised?
Source: Windrock International, Dhaka, Bangladesh
Keywords: irrigation management, distribution channels, compacted earth channel, dtw projects, water distribution, policy implications
Abstract: This book is the result of Post-Doctoral Research on irrigation management conducted at the Rural Development Academy (RAD), Bogra, Bangladesh. The book presents an overview of irrigation development, concepts of irrigation management and its importance in Bangladesh. It examines the performance of DTW irrigation, factors affection under utilisation, and the importance of compacted earth
chamiels compared to other types of distribution channels. The

methodology examines salient characteristics of the Bogra region, investigating the nature and extent of DTW utilisation, searching the causes for non operation of DTW, includes financial analysis, and costs and benefits of compacted and uncompacted earth channels of DTW projects. It explores the socio-economic constraints for improving capacity utilisation of DTWs, problems of command area development in general, adopting compacted earth channels for improved water distribution throughout the year, and policy implications for future action.

Database: Leeds/BOAS

Author: James, L.D.
Date: 1994
Title: Flood Action: An Opportunity for Bangladesh
Source: Water International 19 2
Keywords: food production, flood control, economic development, industry, floods, economic impact, food supply, hydrology, economics, rural development
Abstract: The farmers of Bangladesh successfully accommodate seasonal flooding and are able to feed the country's dense population. However, most of the country is periodically inundated, and a large portion of the population lives on the edge of poverty. This article presents a dynamic programme of flood proofing to foster economic growth through industrial development in which the government and the people would work together on hydrological, engineering, economic, financial, social, cultural, and environmental issues. Within Bangladesh, the problems are exacerbated by 'top down' management that neglects the poor. Internationally, they are exacerbated by non productive debate between engineers who favour embankments and environmentalists who prefer natural conditions. Such confrontations just add obstacles to getting the best experts to work together. This paper seeks to solve institutional blockages by presenting a strategy to define hydrological risk, design a flood action programme to reduce losses, invest the savings to form capital that will reduce flood disruptions and make more savings possible, and foster a functioning industrial economy in the midst of flooding. The concepts are drawn from Western literature on flood management and experience with flood action planning in Bangladesh.

Database: CABI

Author: Kalam, A.K.M.
Date: 1994
Title: Peoples Participation Deciding Programmes for Development at Local/Rural Levels
Source: Jahangirnagor University, Dhaka, Bangladesh
Keywords: people's participation, local planning, development process
Abstract: The present study oversees the decision of programme development at local/rural levels. Public participation is rarely seen in this process at a local level, as for a variety of reasons their demands are bypassed.

Confusion surrounding the status of local institutions, job descriptions and accountability of the respective for such weak performance of the local government in local level administration, is clearly mentioned in the countries constitution. The country, however, is yet to achieve a high status in local institutions.
Database: Leeds/BCAS

Author: Khan, A.H.
Date: 1994
Title: Development and Management of International River Basins: The Ganges Issue
Source: In Management of International River Basins and Environmental Challenges, Academic 888Publishers, Dhaka, Bangladesh.
Keywords: hydro-meteorological setting, ganges basin, brahmaputra basin, meghna basin, floods, the river systems, ganges issue
Abstract: The paper considers, "Development and Management of Integrated River Basins: the Ganges Issue." Development of International River Basins, 3 mighty rivers (GBM) basins, foods in India, Nepal and Bangladesh, the river systems, the Ganges issue, the present situation in Bangladesh, an approach for sustainable development and management, management of the Ganges Basin, and finally there are recommendations for pragmatic solution. The author believes that the Ganges basin development should be a prior concern for Nepal, india and Bangladesh. Political cooperation
amongst the three countries in needed. Greater transparency, understanding and shared sacrifices are prerequisites for building trust and confidence amongst the people of the basin.
Database: LeedsBCAS

Author: Latif, M.A.
Date: 1983
Title: Bangladesh District Gazetters, Tangail
Source: Government of Bangladesh, Dhaka, Bangladesh
Keywords: physical aspects, geography, topography, history, people, society, culture, agriculture, livestock, economics, commerce, health, education, local government
Abstract: Geographical, topographical, historical, socio-economics and cultural details and statistics come down to the author as a tradition from Ain-i-Akbari, a source document of information of Mughal administration and from other documents. The Gazetteers describes Physical Aspects, History, People, Society and Culture, Agriculture and Livestock, Forest, Economic condition, Communication, Industries, Trade and Commerce, Public Health, Education and Information, Language and Literature, Land Revenue Administration, General Administration, Local Government and Places of Interest. This document has also a Bibliography, Index, Plates and Map.
Database: Leeds/BCAS

Author: Matin, M.A. and Hussain, A.
Date: 1989
Title: Hydrological Aspects of 1989 Flood. In: Ahmad, M. (ed.) Floods in Bangladesh
Source: Community Development, Dhaka, Bangladesh
Keywords: sequence of floods, hydrological parameters, causes of flood
Abstract: The document deals with the Hydrological aspects of 1988 flood in Bangladesh. The flood has been assessed as the largest as the flood on the record. The author describes the causes of flood, sequence of flood, extent of inundation, and level of flood. Rainfall data, water level data of several water gauge stations and water flow date of major stations are presented to make comparison of synchronisation of major river floods in the country for different years.
Database: Leeds/BCAS

Author: Minkin, S.F., Rahman, R. and Islam, M.A.
Date: 1996
Title: Flood Control Embankments and Epidemic Kala-Azar in Bangladesh
Source: Centre for International and Comparative Studies of Lowa City, Lowa Dhenmondi, Dhaka, Bangladesh And Centre For Natural Resource Studies, Dhaka, Bangladesh, Bangladesh.
Keywords: kala-azar, health, tuberculoses, embankments, risk, exposure
Abstract: The present paper deals with the distribution of Kala-azar cases. Health centre inpatients and tuberculoses patients were plotted on maps showing

the location of embankments, roads, and rivers. Kala-azar cases were largely clustered within flood protected areas in contrast to the other patients, who came from villages outside the embankments. An analysis showed that most of the epidemic occurred within newly constructed flood control embankments. The author mentioned that the risk increased according to exposure level. When compared with non-flood protected villages, residing in villages located both inside and outside embankments increased risk moderately. Living completely within the embankments substantially increased risk. People living inside embankments were found to have a risk of developing Kala-azar that was 17.69 times higher than among those living outside the embankment. A high proportion of Kalaazar morbidity was explained by living within the embankments. In this fraction the attributable risk among the exposed was 88% and the population attributable fraction was 73.8%..

Database: LeedsBCAS

Author: Mortuza, M.G., Parween, S. and Hossain, M.A.
Date: 1995
Title: Impact of Flood Control and Drainage (FCD) Project of Fishes in the River Barnai
Source: Bangladesh Journal of Zoology 23 2
Keywords: flood control, fisheries, catch, soil nutrients
Abstract: A study of the flood plain fisheries on the Barnai river and the effect of FCD (Flood control and drainage) project (gross area 56,580 ha and net area 43,10 ha) undertaken from June 1990 to June 1991 showed that the total catch of fishes decreased to 67%. The average size of carps decreased to 6 fishes/kg and that of Wallago attu to I or more fish/kg. The same fate was found in other available fishes. However, Tenualosa ilisha (Regan), Pangasius pangasius (valenciennes), Nandus nandus (cuvier), setipinna phasa (Hamilton), Labeo nandina (Hamilton), Chana punctatus (Bloch), Silonoa silonia (hamilton), and Trygon (Hamilton) have now reached critical levels. The nutrients in submerged soil also decreased to a minimum level.

Database: LeedsBCAS

Author: MPO
Date: 1984
Title: National Water Plan Project
Source: Master Plan Organisation and HARZA Engineering Company Internationals, Dhaka, Bangladesh
Keywords: water plan, fisheries, flood control, drainage, competitive use
Abstract: The current report deals with the present status of fisheries in Bangladesh, its development potential and policy, interaction between fisheries, flood

control, drainage and competitive use and finally interim recommendations, approaches and work plan for increasing the production of fisheries resources.

Database: Leeds/BOAS

Author: Nishat, A.
Date: 1990
Title: Background Paper on Water Resources and Flood Control
Source: Department of Water Resources Engineering, Bangladesh University of Engineering and Technology, Dhaka, Bangladesh
Keywords: water management, economics, water sector development, national water plan, flood action plan, flood control, drainage project, minor irrigation, environmental impacts
Abstract: The present paper describes different aspects of water resources related issues. It is mainly a review report of water resources and flood control in Bangladesh. The seven chapters deal with: 1) introduction , 2) Economic Importance, 3) Trends in resource use, 4) Evaluation of current use pattern, S) cause is and effects of degradation, 6) Recommendations for sustainable development, 7) Recommendation for an Action Plan, there is also a summary and a list of reference. There are no tables, graphs or figures in this paper.
Database: Leeds/BCAS

Author: Nuruzzaman, A.K.M., Petr, T., (ed.) and Morris, M.
Date: 1994
Title: Some Critical Issues for Sustainable Floodplain Fisheries Development in Bangladesh
Source:
Keywords: conservation, floodplains, environmental degradation, fisheries, resource management, sustainability
Abstract: More than 130 native and eight exotic species of fish are found in the inland waters of Northeast Bangladesh and almost all have some commercial significance. At the start of the flood season fish migrate on to the floodplains to spawn. Later, as the water recedes, they retreat to deep water refuges in the rivers and depressions where they are very vulnerable to overfishing. This seasonal cycle is severely hampered, and thus fish production reduced, by structures designed to control or prevent flooding. Fish production is further reduced by industrial pollution, conversion of floodpiain depressions into paddy fields, clearance of wetland forest in which fish congregate during the flood, and siltation. All these problems are exacerbated by a traditional leasing system which encourages overfishing. Various simple structural mitigation measures are suggested but, even if they were implemented, although the New Fisheries

Management Policy should improve the socio-economic structure of the leasing system, it cannot while government views it primarily as a source of revenue. In these circumstances conservation of fish stocks urgently requires the designation of (i) 'mother fishery' areas in which intense fishing pressure on overwintering broodstocks is regulated and reduced,
(ii) reserve fishery areas which are only fished once every 5-7 years and
(iii) sanctuary areas in which fishing is prohibited. This approach could be more effectively implemented if community based management were to replace the present centralised approach and is more likely to have long term success than the stocking of floodplains with selected native and exotic carp on which large amounts of development money are presently being spent. Neither money nor manpower are lacking, only political will.

Database: CABI

Author: Parihar, S.S., Khepar, S.D., Singh, R., Grewal, S.S. and Sondhi, S.K.
Date: 1993
Title: Water Resources of Punjab
Source: Punjab Agricultural University, Ludiana, India
Keywords: cropping intensity, cropping pattern water resources, irrigation zones, supply of water, requirement of water. future research, policy implementation, agenda for action
Abstract: The study report deals significantly with two accounts i.e., critical question of the study of Punjab's water resources vis-a-vis the intensive scale of its agriculture production pattern and seeks to demonstrate that a multidisciplinary team efforts and serve as a useful reservoir to pool varying types and levels of knowledge and skills to investigate a phenomenon which is complex and has may dimensions.

It is the second edition which containing the follow up the previous study and re-assess the water balance situation using 1988-89 cropping pattern data. This Edition has eight chapters: 1) A Synoptic View of the Growth of Punjab Agriculture, 2)The Concern About State's Water Resources Genesis and Objectives of the Study, 3) Agro-climatic Irrigation Zones concept, Approach and Delineation, 4) Available Supply of Water Present and Proposed Methodology and Assessed Status, 5) Requirement of Water-Methodology and Assess Status, 6) Available Supply and Requirement of Water-The Emerging situation, 7) Knowledge Gaps for Future Research, 8) Policy Implications and Agenda for Action.

Database: Leeds/BOAS

Author: Paul, B.K.
Date: 1995
Title: Farmers' Responses to the Flood Action Plan (FAP) of Bangladesh: An empirical Study
Source: The World Bank, New York, USA
Keywords: environmental impact, hydraulic structures, flood control, farmers' attitudes, world bank, rural development
Abstract: The World Bank has recently prepared a Flood Action Plan (FAP) to solve the flood problems of Bangladesh, which proposed construction of embankments on both sides of all major rivers. There is, however, strong opposition in the country to the 'structural solution' to its flood problems. The objectives of this paper are to study the farmers' level of awareness of, responses to, and the possible positive and negative impacts of the proposed embankment projects as outlined in the FAP. The data for this study were derived from field surveys conducted in two rural areas of Bangladesh: three adjacent villages of the Sibalay thana in the Manikganj district and another three villages from the Ghatail thana of the Tangail district. The survey data showed that slightly less than half of the total respondents had heard about the proposed construction of the embankment, and that the respondents overwhelmingly supported the embankment projects of the FAP. They were also aware of both positive and negative impacts of embankment construction. The results of the field survey provide support for the structural solution to the flood problem of Bangladesh. This suggests that the government would receive full cooperation from the farmers in implementing its plans to prevent flooding. The number of adverse impacts was fewer than the perceived positive impacts of the construction of the embankment. The execution of the major flood works proposed in the FAP will proceed in stages. They thus still have time to provide information to the farmers about the environmental and other impacts of the embankment projects. An attempt may be needed to change villagers' attitudes towards the structural solutions of the flood problem.
Database: CABI

Author: Rahman, M., Hussain, M.Z., Solaiman, M. and Kamal, U.A.
Date: 1987
Title: Chronological Changes in Irrigation System in Comilla
Source: Bangladesh Academy for Rural Development Comilla and Bangladesh Agricultural Research Council, Dhaka, Bangladesh
Keywords: irrigation, ground water, sources, status, exploration, irrigation, cropping pattern, irrigated crops, institutional arrangement
Abstract: This document is the outcome of the Irrigation and Water Management, the sub-projects Being: "Social and Economic Aspects of Irrigation. Basically this is a study of the History of Irrigation in Comilla. The team

reviewed a number of relevant documents to evaluate the changes and impact of irrigation, described history of irrigated agriculture and conducted an experimental model of small scale irrigation. They also investigated sources of surface water, age of tubewells and cost of irrigation, they estimated the total annual ground water available in Comilla Thana and utilised census & location mapping analysis, all of which are described in this book.

Database: LeedsBCAS

Author: Rogers, P., Lydon, P., Seckler, D. and Pitman, G.K.
Date: 1994
Title: Water and Development in Bangladesh : A Retrospective on the Flood Action Plan
Source: ISPAN, Arlington, Virginia, USA
Keywords: water management, flood control, water policy, project assessment
Abstract: The report is to review selected aspects of the process and the outcomes of the FAP and examines and the water policy in Bangladesh as it affects the country's development needs and opportunities, both agricultural and urban. The report expresses the independent views of these four authors. It should be reed as a broad-brush clarification of a complex policy situation, not as a detailed discussion of the subject's many subtopics, special angles, and variations. It does urge that all project proposals, including those for irrigation, should be subject to multi-criteria evaluation, including comparison with alternative investments from other sectors, an environmental impact assessment and serious consultation with those who will be affected. Any surface water management, flood control or drainage project that services this scrutiny should be acceptable.

Database: Leeds/BCAS

Author: Salim, R.
Date: 1997
Title: Lessons from the History of Water Management Studies in Bangladesh
Source: Paper Presented at the Seminar Organised by the Centre for Development Research Bangladesh
Keywords: water management, flood control, small scale programmes, foreign intervention
Abstract: This paper reviews the literature on management of water resources in Bangladesh with special reference to 1972. The most striking finding is an Evaluation Report of EPWAPDA (1964) that appears to be hitherto unknown. This document not only criticises the dominance of foreign experts and concomitant expenditures, but also provides a guide to many future developments, such as the importance of small scale programmes. Advice given to Bangladesh by US experts is compared with debates on

flood control simultaneously taking place in the USA and the complete focus on flood self-sufficiency as the primary goal of water management in Bangladesh is questioned.

Database: Leeds/BCAS

Author: Sattar, A.
Date: 1992
Title: Water Management and Technology Adaptation for Direct Seeded Rice in an Irrigation System
Source: D.Phil. Thesis, Institute of Graduate Studies, Central Luzon State University, Munoz, Nueva Ecija, Philippines.
Keywords: water management, rice, seeded, transplanted, adoption, yield, economic benefit
Abstract: The study was conducted with the objective of: a) documenting comparative water use and management practises between direct seed and transplanted turnout areas, b) determining the differential growth stages, on yields of direct seeded and transplanted rice, c) identifying and analysing water-related biophysical, socio-economical and institutional factors/constraints that influence farmers adoption/non-adoption of direct seeded rice technology in both dry and wet seasons in the irrigation system.

The experimental findings showed that yields obtained from direct seed rice were significantly higher than the transplanted rice. Lesser amount of water can produce similar production, therefore adaptation of directs seeded rice can increase overall water use efficiency in the irrigation system and give economic benefits.

Database: Leeds/BCAS

Author: Sen, H.S. and Oosterbaan, R.J.
Date: 1992
Title: Research on Water Management and Control in the Sunderbans, India
Source: (unknown)
Keywords: mangroves, land development, reclaimed soils, delta soils, soil types, saline soils, water management, coastal areas
Abstract: The Sunderbans, to the south and south-east of Calcutta, is a deltaic coastal region shared by Bangladesh and India. It consists of a natural system of numerous islands formed by the sedimentation of silts carried by branches of the Ganges and Brahmaputra rivers flowing to the Bay of Bengal. It has the largest remaining mangrove forest in the world. The major part of the Sunderbans is in agricultural use for its dense and fast-growing population. The mangrove constitute an important coastal defence zone, sheltering the reclaimed areas against the extreme oceanic storm surges. This paper

discusses the environmental conditions of the area, the constraints to agriculture and the possible developments.

Database: CABI

Author: Serageldin, I.
Date: 1995
Title: Toward Sustainable Management of Water Resources
Source: International Bank for Reconstruction and Development, New York, USA
Keywords: water resources development, sustainable development, water management, world bank, developing countries, incentives, environmental health
Abstract: The author presents the Direction of Development "Toward Sustainable Water Management of Water Resources" to the World Bank, to its affiliated organisations or to members of its Board of Executive Directors or the countries they represent. There is good description of the following: a) A New Appreciation for Water, b) Future of Current Policies, c) Four Principal Failures, d) New Stress Require a New Approach, e) Appropriate Incentives, f) A Framework for Improving the Management of Water Resources, g) A Comprehensive, Cross-sectoral Approach, h) Environmental and Health, i) Conclusion and a number of Water Management Experiences of different countries is also presented. The findings, interpretations, and conclusions are expressed in this study document, which also includes bibliographical references.

Database: Leeds/BCAS

Author: Shajahan, M.
Date: 1989
Title: The Devastating Flood of 1988. In: Ahmad, M. (ed.) Floods in Bangladesh
Source: Community Development Library, Dhaka, Bangladesh
Keywords: flood pattern, flood, water use, irrigation, water resources development
Abstract: Water is a vital resource of Bangladesh. Besides various uses of water, the largest use of water is made for irrigating lands. Proper development of our vast water resources is necessary for national development and prosperity. The importance of comprehensive water development and management was recognised after the havoc of 1954 and 1955.

Water resources development was accelerated during the decade of the 1960s. This received tremendous impetus after independence of our country. Many multipurpose projects were planned and implemented. These projects are playing great role towards attaining self-sufficient in foodgrain production and overall prosperity of the country.

This paper first discuss the role of water sector in the national development programme and recapitulates the extent and limit water sector and its relative position in national life and economy as well. This is followed by a review of the historical pattern of water resources development in Bangladesh along with past targets and achievements, as well as potential for future development. Also discussed is the motivation for a comprehensive and multisectoral national water resources development plan to ensure that good investment decisions are made and to harmonise different needs and avoid costly conflicts and to attract needed financing.

Database: Leeds/BCAS

Author: Solomon, S.
Date: 1992
Title: Floods in Bangladesh: Is there a Solution?
Source: Ecodecision 6
Keywords: hydrology, floods, flood prevention, dykes
Abstract: Despite enormous preventive efforts and massive foreign aid, disastrous flooding remains a recurrent problem in Bangladesh. In the past the beneficial effects of flooding in Bangladesh outweighed the disadvantages, but in recent years the balance has tipped tragically in the other direction. The principal cause of this change is overpopulation, compounded by deforestation, reservoir construction, road construction and, ironically, even the construction of anti-flood dykes and polders. New and rationally conceived flood-preparedness measures could significantly alleviate the deleterious effects and enhance the beneficial effects of flooding. These would combine studies to determine a long-term solution, with interim measures based on the creation of priority areas for preventive activities.
Database: CABI

Author: Soussan, T.G. and Koudstall, R.
Date: 1995
Title: Fap-24: Reformation Report
Source: Flood Plan Coordination Organisation, Government of Bangladesh, Dhaka, Bangladesh.
Keywords: flood control, water management, cpp, institutional development and peoples participation, water user groups, flood management model
Abstract: the report prepared by the reformulation mission tried to understand the progress made and the problem, encountered by the CPP four years into it's implementation and from this understanding, identified and set out a modified set of project objectives, activities and outputs. the mission tried to strike a balance in the formulation which would address the legitimate concerns of all actors.
Database: LeedsIBCAS

Author: Timm, R.W.
Date: 1989
Title: Causes of Heavy Flooding in Bangladesh. In: Ahmad, M. (ed.) Floods in Bangladesh
Source: Community Development Library, Dhaka, Bangladesh
Keywords: causes of flood
Abstract: The has critically reviewed the causes of flood in Bangladesh. He said in gradual erosion of hillsides in the upper reaches of the ganges and Brahmaputra rivers were the cause of the overwhelming floods in 1987 and 1988. The main causation of the recent floods as being due to massive soil erosion seems to be ruled out. He gives another main theory is that denudation of the hillside forest has resulted in much greater runoff of rain water snow melt, thus causing floods in the lower reaches of the rivers.

He agreed that the floods of Bangladesh should be the major concern and responsibility of the countries from where the flood waters originate and which are privy to policies which aggravated them. A concerted effort has to be made, mostly through international pressure in the United Nations, for all the countries involved in this problem to discuss and solve it together.
Database: Leeds/BCAS

Author: The World Bank
Date: 1993
Title: Water Resources Management
Source: International Bank for Reconstruction and Development /The World Bank, New York, USA, USA
Keywords: water management, problem, approach, bank policy, irrigated water, supplying water, lessons, privatisation, user participation
Abstract: This is a policy paper containing a Glossary, Executive Summary, and four main sections such as Introduction, Conditions and Challenges in Managing Water Resources, Improving Water Resources Management and The Role of the World Bank and has five appendices; (a) Market Failure and Public Policy in Water, (b) Water, People and the User Participation in Water Resources Management (c) Summary of World Bank Operational Directives and Other Guidelines Related to Water Resources, and (d) The World Bank Experience with investments in Water Resources. The paper also includes a comprehensive bibliography and some tables showing necessary information.
Database:

Author: Zuberi, M., Rahman, F., Hossain, E. and Said, A.
Date: 1996
Title: Natural Water Bodies, Mohonpur Beel, Raj shahi
Source: Centre for Land Use Water Resources Research, Department of Agriculture and Environment Science, University Of Newcastle U K . Department Of Anthropology, University Of Durham, U K., Institute Of Aquaculture, University Of Stirling, U K.
Keywords: beels, floodplain production, sustainable utilisation, natural resources, conflicts/constraints
Abstract: This study report describes the understanding of floodplain production systems in Bangladesh in order to promote improved management and sustainable utilisation of natural resources. The main features of the whole farm system of the Beel were analysed and are reported. Conflicts/constraints arising from resource utilisation were investigated and strategies for integrated sustainable management of the system were considered with the participation of the farmers and villagers.
Database: Leeds/BCAS