Seminar on

Bangladesh Disaster:
Issues and Perspectives

3rd September, 1991

Organised by: IHE's Bangladeshi Participants

Sponsored by: IHE, Delft, The Netherlands

Venue IHE DELFT

Invitation

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Programme

- **Opening Ceremony - 13.30**

  - Opening address by Prof.Ir. W.A. Segeren, Director of IHE
  - Address by a Dutch official
  - Address by Mr. A.K.M. Kamaluddin Choudhury, Ambassador of Bangladesh
  - Keynote address by Mr. M.H. Siddiqui Director, Bangladesh Water Development Board

- Coffee Break - 14.30

- **Technical Session - 14.40**
  Chairman: Mr. M.H. Siddiqui

  Floods and Flood Protection
  - Mr. Tanveer Ahsan, IHE
  - Prof. W. van Ellen, IHE

  Cyclone and Coastal Protection
  - Mr. Mustafizur Rahman, participant in S.E. course, IHE
  - Ir. Fred Koch, Delft Hydraulics

  Environmental Profile and Ecological Concerns
  - Mr. Reazuddin, participant in E.S.T. course, IHE
  - Prof.dr. W. van Vierssen, IHE

  Socio-Economic and Demographic Aspects
  - Mr. Gouser Reza, participant in M.Sc. programme, ISS
  - Dr. Subinay Nandi, Socio-Economic Adviser, DDP, Bangladesh

- Coffee Break - 16.00

- **Group Discussions** (simultaneous) - **16.15**

  1 Floods and Flood Protection
  Chairman: Dr. M.S. Zaman, Institutional Specialist, Bangladesh Flood Action Plan
  Co-Chairman: Prof. W. van Ellen, IHE

  2 Cyclone and Coastal Protection
  Chairman: Ir. Gerrit J. Klaassen, IHE, Delft Hydraulics
  Co-Chairman: Ir. Fred Koch, Delft Hydraulics

  3 Environmental Profile and Ecological Concerns
  Chairman: Dr. J.C.J. van Zon, Environment Division, Euroconsult
  Co-Chairman: Prof.dr. W. van Vierssen, IHE

  4 Socio-Economic and Demographic Aspects
  Chairman: Prof. H.P.A. Roosmalen, ISS
  Co-Chairman: Dr. Subinay Nandi, Economic Adviser, DDP Bangladesh

- **Plenary Session - 17.15**
  Chairman: Prof. W. van Ellen, IHE

  Discussion of the recommendations
  Adoption of the recommendations
  Words of thanks
  Closing of the seminar

- Social Drinks - 18.00

- Light Food Bangladeshi) - 18.30

- **Cultural Programme - 20.00**
  "Meet Bangladesh"

The Bangladeshi participants with the support of IHE are organizing a seminar on

Bangladesh Disaster: Issues and Perspectives

on Tuesday September 3, 1991.

The seminar will be followed by a cultural programme.

You are cordially invited to attend.

Bangladeshi Participants
at IHE.

Venue: IHE, Nieuwelaan 76, Delft.

R.s.v.p. 015 - 78 71 89
Regrets only.

IHE
DELFT

P.O. Box 3015
2601 DA Delft
The Netherlands

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Background and objective

The most devastating cyclone and storm surge of the century hit the coast of Bangladesh on the April 29th of this year. It claimed lives tens of thousands of lives and the damage to property and resources was colossal. This is not the first time that a cyclone hit Bangladesh; it is almost a regular occurrence. Such is also the case with floods; the 1987 and 1988 floods in Bangladesh were unprecedented in history.

On one side of the globe, technology has progressed rapidly and has found the ways and means to fight against the odds of nature. An example of this is the famous storm surge barrier in The Netherlands. On the other side of the world the lives of the people are still at the mercy of nature, such as in Bangladesh and the like. In other words, The Netherlands, which is a deltaic country like Bangladesh has already been able to solve the consequences of natural calamities which Bangladesh is now facing.

IHE is a well known internationally reputed institution which provides the technical know-how to deal with similar situations. The participants of Bangladesh at IHE felt this to be the just moment and the right forum to address these issues to a learned gathering. The problems can also be discussed at length, when the Government of Bangladesh is undertaking a flood action plan and measures against coastal protection with cooperation from the international community.

The objective of the seminar is therefore to explore the ways and means to face the challenge of recurrent natural calamities.

Message of the Ambassador

EMBASSY OF BANGLADESH
29-31, RUE JACQUES JORDAENS
1050 BRUSSELS
TEL. 640 55 00 - 640 56 06

I AM VERY PLEASED TO KNOW THAT A SEMINAR ON "BANGLADESH DISASTER : ISSUES AND PERSPECTIVES" IS BEING ORGANISED BY THE STUDENTS PARTICIPATING IN THE VARIOUS TRAINING PROGRAMMES AT IHE WITH THE ACTIVE SUPPORT OF IHE. IT IS FOR THE FIRST TIME THAT SUCH A SEMINAR HAS BEEN ORGANISED ABROAD BY STUDENTS ENTHUSIASM. I CONGRATULATE THE ORGANISERS OF THE SEMINAR FOR CHOOSING A THEME WHICH IS VERY SIGNIFICANT FOR US.

THE RECENT CATASTROPHIC CYCLONES AND TIDAL SURGES HAVE CAUSED IMMENSE DAMAGE TO OUR PHYSICAL AND SOCIO-ECONOMIC INFRASTRUCTURE IN THE COASTAL REGION. IT WAS A BATTLE FOR SURVIVAL BETWEEN MAN AND NATURE IN WHICH NATURE HAD THE UPPER HAND SINCE OUR METHOD AND TECHNOLOGY WAS INADEQUATE TO MEET THE CATASTROPHE. IN SUCH A CONDITION, NEW IDEAS CONCERNING THE METHODS AND TECHNOLOGY ABOUT THE PREVENTION OF SUCH DISASTERS IN THE FUTURE IS HIGHLY WELCOME. IHE IS AN INTERNATIONALLY REPUTED INSTITUTION WHICH PROVIDES THE TECHNICAL-KNOW-HOW TO DEAL WITH SIMILAR SITUATIONS AND THEREFORE, I THINK IT IS A VERY APPROPRIATE INSTITUTION FOR HOLDING SUCH A SEMINAR.

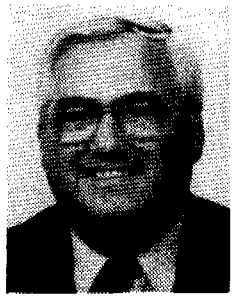
THE GOVERNMENT OF BANGLADESH RECENTLY HAS BEEN WORKING ON A FLOOD ACTION PLAN FOR THE PREVENTION OF SUCH NATURAL DISASTER AND I HOPE THAT THE DELIBERATIONS OF THIS SEMINAR WILL OPEN NEW HORIZONS IN THIS FIELD AND GIVE US NEW INSIGHTS INTO THE COMPLICATED PROBLEM OF TACKLING NATURAL DISASTERS. I ALSO HOPE THAT THE FLOOD ACTION PLAN OF THE GOVERNMENT OF BANGLADESH WILL BE BENEFITTED BY THE PROCEEDINGS OF THE SEMINAR.

I SINCERELY THANK IHE FOR SUPPORTING THE ENDEAVOURS OF BANGLADESHI PARTICIPANTS FOR HOLDING THIS SEMINAR.

I WISH THE SEMINAR WHICH IS RELEVANT TO OUR DEVELOPMENT PROCESS ALL THE SUCCESS.

A.K.M. KAMALUDDIN CHOUDHURY
AMBASSADOR OF THE PEOPLE'S REPUBLIC OF BANGALDESH
TO BENELUX

Words of support



Again Bangladesh has had to face the consequences of natural disaster. Unfortunately, countries in that part of the world do not yet have the economic means and infrastructure to realize adequate protection against the immense powers of nature.

However, as early as the fifties, Bangladesh (then still called East Pakistan), realized that a vital step in trying to conquer its flood problems, was to develop its human resources.
In 1955 just after the 1953 flood in the south of The Netherlands, leading to the well known Delta Plan, the Begum Liadquat Ali Khan of Pakistan, who was ambassador to the Netherlands at the time, motivated The Netherlands University Foundation for International Cooperation (Nuffic) and Delft University of Technology to organise a Hydraulic Engineering course in English to train the civil engineers of Bangladesh in hydraulic engineering and flood protection.
This request, was in fact the beginning of IHE. In 1957 IHE started its first course not only for Bangladeshi but also for civil engineers from the rest of the world. Since then 210 Bangladeshi have participated in the various courses at IHE.

I am proud and pleased to learn that initiative and broad humanitarian and scientific interest are still one of the enourmous assets of the people from Bangladesh.
It is my opinion that education and development of human resources is the first and most important step towards solving problems, caused by nature and otherwise, in developing countries.
Also I consider it of great value that people from the western world share the problems of the developing countries, not only through their own judgement but especially by listening to the people from those countries.
It is therefore, that I heartily welcomed the initiative of the Bangladeshi participants at IHE during the current academic year to organize a seminar on "Bangladesh Disaster: Issues and Perspectives".
I also appreciate the support our Bangladeshi participants received from the Bangladesh authorities and from the Ambassador of the Peoples Republic of Bangladesh to Benelux.

I wish you all an inspiring and fruitful seminar and hope this intiative will contribute to a more permanent solution of the problems in Bangladesh.

Prof.ir. W.A. Segeren
Director IHE

Programme

13.30 **Opening Ceremony**

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14.30 Coffee Break

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16.00 Coffee Break

16.15	**Group Discussions** (simultaneous)
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	Discussion on the recommendations Adoption of the recommendations Words of thanks Closing of the seminar
18.00	Social Drinks
18.30	Light Food (Bangladeshi)
20.00	**Cultural Programme** **"Meet Bangladesh"**

Committees

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Prof.ir. W.A. Segeren (Chairman), IHE
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Senior Desk Officer Dept. of International Co-operation.
Ministry of Foreign Affairs. The Netherlands.

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Bangladesh Disaster
Issues and Perspectives

M.H. Siddiqi

Bangladesh Water Development Board

BANGLADESH DISASTER
Issues and Perspectives

by

M.H. Siddiqi

PREAMBLE

Natural disasters in Bangladesh may be classified into two broad categories based on temporal considerations:

- flood, a recurrent phenomenon; and
- cyclone, an occasional event.

Other natural and man-made disasters like drought and saline intrusion from the Bay, though not as pronounced, affect the country none the less.

In the absence of any other resource of significant value, the economy of Bangladesh is essentially dominated by agriculture which, in turn, is critically dependent on water. But apart from agriculture, water is also vital for:

- domestic and industrial usage;
- fisheries;
- inland navigation.

As such the annual cycle of water from over-abundance to scarcity has been the predominant factor shaping the life in this riverine delta over the ages.

Therefore, cyclone may again be separated from water-related disasters like floods, drought and salinity intrusion although the former may ultimately have water-related impacts at least for a while.

FLOOD

In rural Bangladesh which covers about 80 percent of the country, children go to school or works, farmers to the field by country-boats for about 5 months (mid-May to mid-October) of the year because the village tracks are not negotiable and the countryside is covered under a sheet of water (Fig. 1). This is a common annual event to which life has been adapted and there is no complaint about such inundation. Only when the inundation is so deep as to drown men and cattle and to damage the standing crops totally, the farmer curses his fate, looks at the sky for God's mercy and terms it as a flood.

A glance at the basin map (Fig. 2) would help the understanding of the situation better. Bangladesh through its intricate network of rivers drains an area of about 2.0 M sq.km. into the Bay, of which only about 7 percent lies within the country.
The huge cross-boundary flow along with local precipitation does not drain out easily due to flat topography, high tide and further swelling of the Bay caused by southern monsoon winds. Hence the annual flooding!

Figure 1

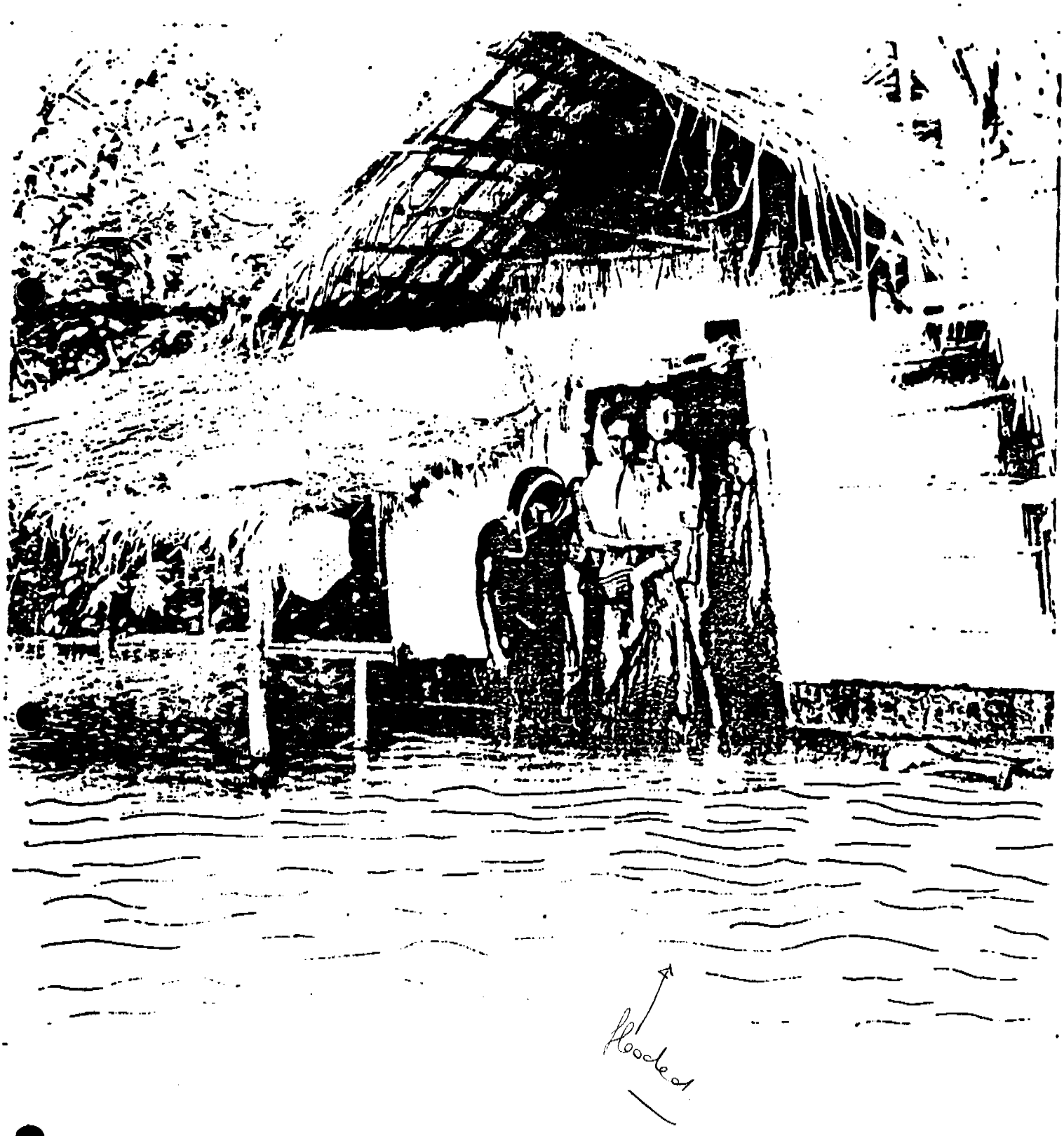
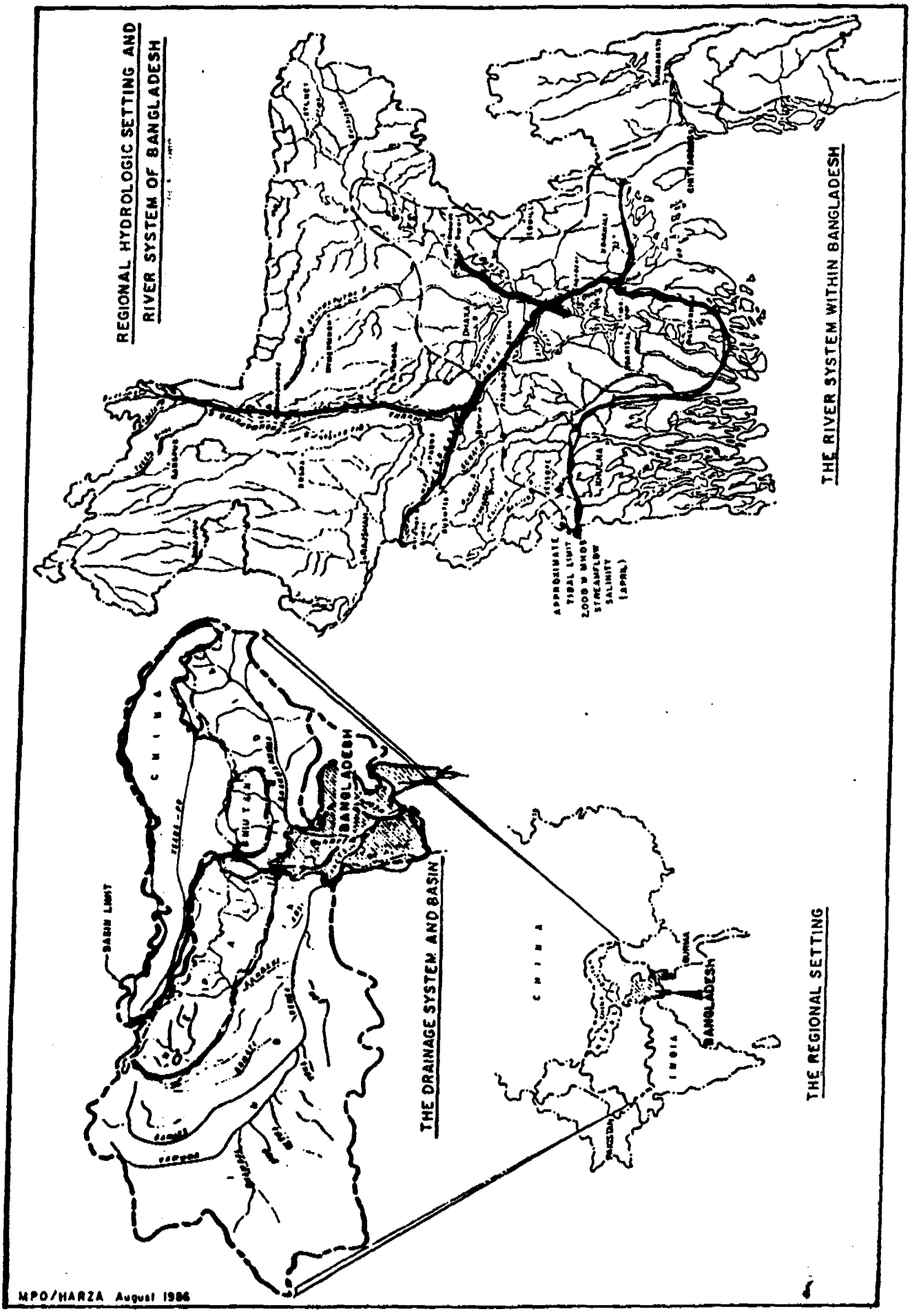


Figure 2


REGIONAL HYDROLOGIC SETTING AND
RIVER SYSTEM OF BANGLADESH
THE RIVER SYSTEM WITHIN BANGLADESH
THE DRAINAGE SYSTEM AND BASIN
THE REGIONAL SETTING
BANGLADESH
CHINA
INDIA
BASIN LIMIT
MPO/HARZA August 1986

Floods have widespread impacts some of which are direct and quantifiable while some are indirect and non-quantifiable. The most significant of impacts in an agrarian economy is that flood severely restricts farmer's choice of crops to low yielding varieties that may survive in water. Damage caused to crops and infrastructure are generally considered direct impacts while indirect impacts include, inter alia:

- a depressed environment;
- health hazards, water-borne diseases;
- shortage of firewood etc.

In a catastrophic event it is possible to quantify many damages caused to the economy e.g. losses incurred by disruption of trade and commerce or by closure of industry, but loss in education due to closure of schools can hardly be expressed in monetary units.

There are several ways of assessing the magnitude of flooding. Assuming that damage is directly proportional to the extent, depth and duration of flood, the most common practice is to express the severity of flood in terms of quantified damage. This criterion, however, has a distorting effect because it tends to give an impression that severity increases with time.

Whatever way a flood is assessed that fact remains that in a flood-prone area the farmer's philosophy is one of risk-aversion rather than profit-maximization. Similarly, with growth and development more and more assets placed at stake, a feeling which itself retards the pace. Obviously, the perpetual threat of floods puts the development potential in a low key.

Work on a Flood Action Plan comprising 26 components of both structural and non-structural measures is underway. It would be discussed elaborately in the Technical Session.

DROUGHT

As stated earlier the geographic location has deprived Bangladesh of any control over the massive inflow that floods the land in one season and becomes too scarce in the other. The combined minima is about one-twentieth of the peak discharge during monsoon (about 0.15 m^3/s) near the Bay.

From mid-October effective drainage occurs which may be earlier in a dry year. Local variety of rice transplanted on flood-free lands would suffer from moisture stress if a droughtic spell persists for a fortnight resulting in yield loss.

After October cold wind sets in and sweeps over Bangladesh from the north which causes a lowering of the Bay accelerating drainage leading to lower stages in all rivers. By January almost all arable lands excepting those in the Meghna and the Atrai basins suffer from moisture deficit. After first spring shower of the nor'wester in March/April land preparation is done and Aus rice is sown which may be delayed if it does not rain early.
Late sowing would also cause yield reduction. Research in this regard reveals that local varieties of rice suffer a yield reduction of about 20 percent due to drought. And this loss is not recognized by farmers as irrigation is not provided to local rice.

Experiments also show that yield reduction due to drought would be much higher in HYV, but fortunately HYV is practised only in those areas where irrigation is assured. Beside rice, Jute, another important cash crop suffers heavy loss from drought due to retting problems.

In the Flood Action Plan it has been envisaged to develop flood-protected lands simultaneously which would include provisions for supplemental irrigation.

SALINITY INTRUSION

In addition to the reduction of flow in the lean period, there has been substantial reduction in the Ganges flow due to upstream withdrawal in India. Reduction in upland flow has led to the inland intrusion of the saline front considerably in the Southwest region of Bangladesh. It has affected the industrial belt around Khulna, where cooling water for installations is imported by barges from upstream. The effect of salinity on the total environment is surfacing gradually. This may be termed a man-made disaster.

Negotiation with india for sharing of the international rivers is underway.

CYLONE

Situated at the northern narrow end of the Bay of Bengal, Bangladesh is directly in the path of the pre- and post-monsoon cyclones that are generated in tropical atmospheric conditions out in the sea. The country's vulnerability to these storms is aggravated by the nature of its low-lying coast line, which forms the mouth of the world's largest river delta draining the Ganges, the Brahmaputra and the Meghna. With its numerous offshore islands that are continuously in the process of formation and barely stand above sea-level, separated by sea-arms, tidal inlets and creeks , and with extensive mud flats, the entire coastal area is open to the fury of cyclones. As the Bay is narrowest here, cyclones are usually accompanied by tidal surges that exacerbate the destructive power of cyclones.

The last event of April 1991 was, however, a disaster of exceptional intensity. Although the entire coastal belt was affected the northeastern part suffered the most. Winds gusting at upto 240 kph, torrential rains and a tidal surge between 7 and 8 m high in places lashed an area about 160 km stretching from sandwip down to Cox's Bazaar in the south.

It is estimated that about 12 million people in 16 districts homes, 5,200 primary schools and 1,700 secondary schools were damaged or destroyed. Standing crops on an area of 110,000 ha were damaged, and fish and shrimp hatcheries sustained heavy losses. About 7,000 to 8,000 vessels reported lost or missing. Hundreds of kilometers of roads and embankments were washed away or needed major repairs. Worst hit of all were the major industrial units, communication facilities and basic utilities concentrated in the coastal belt many of which went out of commission.
Chittagong Port, the only deep water harbour was battered with 22 sunken vessels and wrecked equipment choking port operations.

While relief operations continued in full swing, assessment of damage and rehabilitation requirement had been prepared by the Government covering all sectors of the economy. The rehabilitation programme has been categorized into urgent, mid-term and long-term according to order of priority.

Engineering solution like high seadyke or seawall is not difficult to design but may be cost prohibitive. Therefore, the Government programme has been based on lessons from the recent event.

The absence of an adequate coastal forest cover has been amply felt. An integrated coastal area development programme based on local farming and fishing practices, should be undertaken as an important medium to long-term measure. Resources, if effectively coordinated can help build greater resistance to natural disasters. Land management, afforestation including homestead forestry and human settlement programmes have been assigned early priority.

Coastal defence against cyclones may be improved. Cyclone warning measures were adequate and effective but shelters are inadequate. A vigorous shelter construction programme is under examination. Benefits can be enhanced if such structures are multi-purpose.

Disaster preparedness and human settlement are included in the inventory of Flood Action Plan.

Finally, local response to the disaster was instrumental in reducing casualties and accelerating relief operations. This local capability was particularly important as the affected area was cut-off from rest of the country during the most critical period immediately after the catastrophe. The roles of Red Crescent Society, NGOs and local group deserve special mention.

Seminar on

Bangladesh Disaster: Issues and Perspectives

Floods and its Consequences in Bangladesh

Ir. Tanveer Ahsan

IHE

3rd September, 1991

Seminar on
Bangladesh Disasters: Issues and Perspectives
September 3, 1991

FLOODS AND ITS CONSEQUENCES IN BANGLADESH

Ir Tanveer Ahsan, IHE, Delft

Background

Flood is a recurring feature in Bangladesh (144 836 km^2). The country experiences flood almost every year because of its flat topography and geographical location. Bangladesh forms part of the world's largest delta situated at the confluence of the three great rivers; the Ganges, Brahmaputra and Meghna. The flood plain of these three rivers and other smaller rivers occupy 80% of the country. The hills occupy 12% and uplifted fault blocks (so-called terraces) 8%.

The source of all the rivers lies outside the country. The total catchment area of the three rivers is about 1.5 million square kilometre of which only 8% lies within Bangladesh. Of the rest, 62% lies in India, 18% in China, 8% in Nepal and 4% in Bhutan.

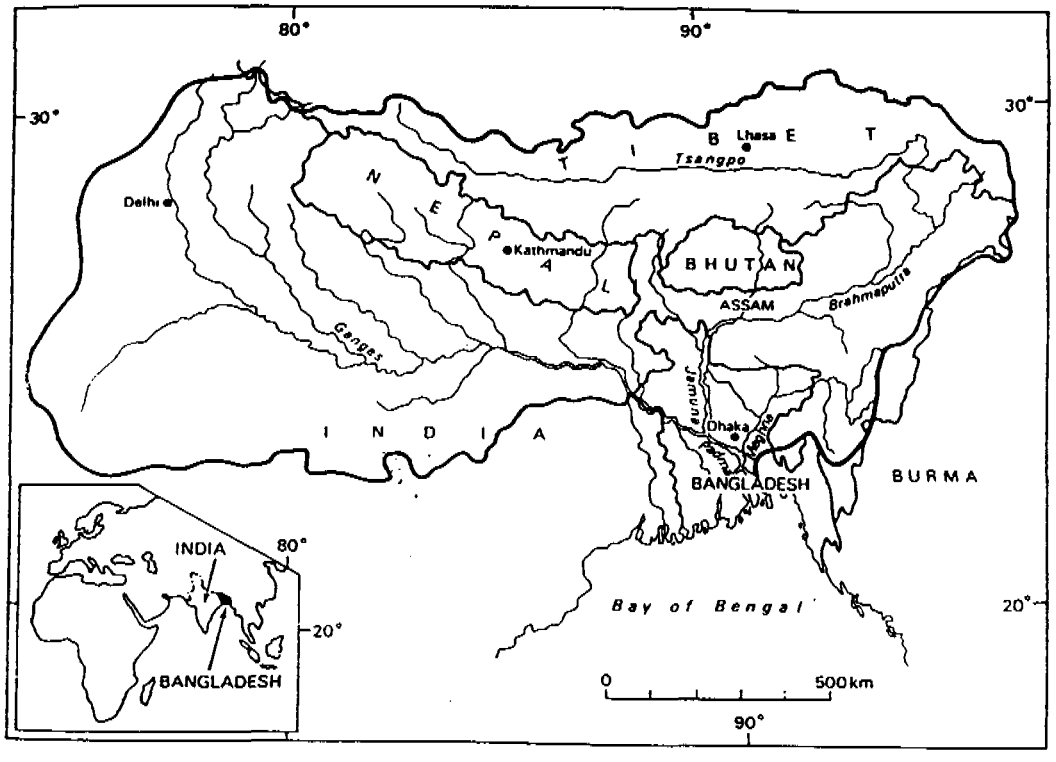


Figure 1. Catchment area of the Ganges, Brahmaputra and Meghma rivers

About 1200 cubic meters of water flows through the Ganges-Brahmaputra-Meghna system every year and 85% of the total inflow comes during the monsoon season (June-September). The combined flow from the three rivers passes through a single outlet, the lower Meghna, and then to the Bay of Bengal.

Together with this tremendous flow about 2 billion tons of sediments are carried through these rivers every year. Accumulation of sediments over thousand of years is believed to have contributed to the creation of land mass in the Bay of Bengal.

History

A long time ago people from different parts of Asia migrated to this deltaic region now called Bangladesh. The fertile land, abundance of fresh water and fishes, favourable climate, good river transport and easy way of living attracted people to settle along the rivers. Floods at that time was a blessing to them. It left the land with fertile alluvial deposits and enough moisture for subsequent easy cropping. But as time passed human settlement and their activities increased in the plains. The first remarkable change was observed when the British began to construct the railway lines to exploit the tea production from the western part of Bangladesh. The consequences of these construction could perhaps not be foreseen at that time. The railway lines were constructed East to West whereas the water flows from North to South. These obstructed the natural water flow and caused localized flooding. Subsequently, the major highways were constructed parallel to the railways which aggravated the situation. This was the starting point when people realized the adverse effect of floods.

Intensity and types of floods

Floods may be characterized according to their intensity, extent of inundation and severity in the following four groups.

i) **Normal flood:** The inundated area is about 18% of the total area of the country in low areas where cropping pattern is adjusted to inundation. Flooding is accepted as a part of normal hydrological behaviour.

ii) **High flood:** During high flood up to 25% of the country is inundated. Damage is limited mostly to crops.

iii) **Severe flood:** The inundated area is about 36%. Extensive damage is done in crops and infrastructure.

iv) **Catastrophic flood:** The inundated area is 60-70% and nearly 80% of the cropping area. There is large scale damage in life and property in both rural and urban areas.

Bangladesh is not unfamiliar with flood, every year it encounters flood of different magnitude. Normal flooding is expected every year. The occurrence of serious floods in the last decade is shown in Table 1.

Table 1. Recurrence interval of floods

Flood type	Recurrence interval (years)	
	1870-1922	1954-1988
Moderate to severe	4	5
Severe	7	5
Catastrophic	33-50	12

Floods both normal and damaging, can also be classified into three types:

1. **Flash flood** is caused by exceptionally heavy rainfall occurring over neighbouring hills and mountains. Eastern and Northern rivers are characterised by sharp rise in water level and followed by rapid recession, usually within few hours or days. Flash flood often deposits large amount of sediments on the land and within the river channels. This kind of flood does not necessarily damage crops or property. Where and when damage occurs, it is mainly due to rapid flowing water or submergence of crops in depression sites for more than a few days.

2. **River flood** is caused by the melting snow in the high Himalayas plus heavy monsoon rainfall over the Himalayas, the Assam and Tripura Hills, the adjoining flood plains and the northern part of central Indian plateau. Most extensive damage from river water happens when the Ganges, Brahmaputra and Meghna rise simultaneously. Crops may be uprooted or lodged by rapid water flow, fields buried with thick alluvial deposits and the river bank erodes. High floods may also damage roads, houses and urban properties.

3. **Rain flood** is caused by heavy rainfall within Bangladesh. Intensive rainfall of 3 to 10 days duration is much in excess of the local drainage capacity and causes localized floods.

Reasons of flood

Various geographic, climatic and hydrological factors, as well as human interferences has been identified as the causes of flood in Bangladesh. A single or combination of the factors that may cause floods are:

- low general topography;
- snow melt runoff from the Himalayas;
- excessive rainfall within the country;
- synchronization of major river peaks;
- increase in ambient temperature and possible greenhouse effect;

- reduction in drainage capacity of the rivers due to sedimentation; and
- human interference such as deforestation, soil erosion in upstream catchment areas, flood plain development and water development activities e.g. Farakka barrage, etc.

To illustrate the effect of human activities in and around the region Table 2 shows the amount of deforestation in the regional countries. Another example is the construction of Farakka Barrage in India at a distance of only 18 km from Bangladesh border has changed the regime of Ganges. An increasing trend in the annual high water level (5 to 6.5 cm per year) is observed in different rivers within Bangladesh (Figure 2).

Table 2. Deforestation in South Asia

Country	Average annual area deforested (1976-85, in thousand ha)
Bangladesh	8
Bhutan	2
India	147
Nepal	84

It is apprehended that the change in global climate due to greenhouse effect will increase the snow melt runoff from the Himalayas. On the other hand the drainage capacity will further decrease for the rise in the mean sea level. Deforestation and other human activities in the upstream will make the situation worse. Therefore, it is predicted that the magnitude and the affects of floods in Bangladesh may increase if the present trend of regional and global activities continue.

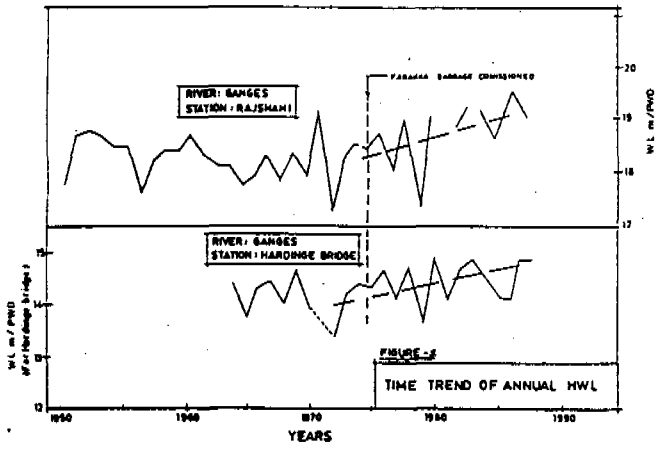


Figure 2. Rise in river water level due to Farakka barrage

Consequences of flood

The immediate effect of flood is the loss of human life and livestock; damage to standing crops and properties. Other consequent effects are contamination of food and water and resultant outbreak of diseases; disruption in socio-economic activities, etc. After devastating floods the development of the country comes to a stand still. The national economy is constantly undermined by periodic, large scale losses in agricultural production and diversion of development funds to provide ad hoc relief and rehabilitation measures and to purchase food from abroad to compensate the lost national production. For example, the Bangladesh development budget was cut by 45 % in 1988-89 to pay for such measures. The losses and damages in the devastating floods of 1987 and 1988 is shown in Table 3.

Table 3 Estimates of losses and damage by floods in 1987 and 1988

	Losses/damage	
Items	1987	1988
Area flooded	57 000 km^2	82 000 km^2
Houses totally/partially damaged	2.5 M	7.2 M
Human lives lost	1657	2379
Livestock lost		
cattle, goats,etc.	64 700	172 000
poultry	206 000	410 000
Rice production lost	3.5 M tons	2 M tons
Roads trunk	1523 km	3000 km
rural	15 107 km	10 000 km
bridges,culverts	1102	898
Railways embankments	n/a	1300 km
bridges	n/a	270
Flood embankments	1279 km	1990 km
Irrigation/drainage canals	222 km	283 km
Irrigation/drainage structures	541	1465
Electric power substations flooded	n/a	18
11 KV power lines de-energized	n/a	2000 km
Industrial units flooded	n/a	>1000
Hospitals flooded	n/a	45
Health canters flooded	n/a	1400
Schools flooded	n/a	19 000
Rural Hand tubewells flooded	n/a	240 000

Floods have also considerable impact on the socio-economic and other intangible conditions of the society which in turn has adverse affect on the development efforts of the country. The major effects are summarized as follows:

- o Floods seem to accelerate the process of social differences. People find it difficult to improve their lot. The vast majority becomes poorer.

- o Floods increase hardships, cause long periods of starvation or near starvation, but in isolation from other calamities are rarely found to be responsible for complete starvation or death.

- o The flood affected regions remain perpetually depressed. People with means do not feel encouraged to invest their surplus in these regions for fear of losing their assets in floods or of facing setbacks in production activities due to uncertain situation caused by flood.

- o The traditional agricultural practice do not undergo any fundamental change because of flood. The farmers try to adhere to the same cropping pattern and reap the benefits as much as possible, of increased fertility due to alluvium siltation of the soils. They, however, rarely use more costly inputs which would otherwise yield higher production. The risks of loss in subsequent floods are always a deterrent.

- o The flood effected people appear to have accepted to live at a low standard of living through the calamities of floods. They do not seem to loose their spirits and are still left with enough courage to face future challenges.

Conclusion

Specially after the 1987 and 1988 floods national priority was focused to this aspect and the Government of Bangladesh is taking various remedial measures within the country. These programmes, their merits and demerits will be discussed in detail by our next speaker. What is important to note is that the effect of many factors that occur across the borders and globally are also responsible for floods in Bangladesh. Therefore, these problems have to be addressed in regional and global aspects.

Seminar on
Bangladesh Disaster: Issues and Perspectives

Floods and Floodprotection

Prof. W.F.T. van Ellen

IHE

3rd September, 1991

SEMINAR BANGLADESH DISASTER - 3 SEPTEMBER 1991

F L O O D S A N D F L O O D P R O T E C T I O N

Prof. W.F.T. van Ellen.

Summary

The disastrous floods that struck Bangladesh in 1987 and 1988 attracted worldwide attention and a concerted international effort started to find a long term solution to the persisting flood problem in that country. As a result the Flood Action Plan (FAP) was initiated in 1989. Coordinated by the World Bank, FAP acquired the support of all major donors. It consists of a programme of structural and non-structural measures, which should set the scene for a systematic approach to the confinement of all major rivers of the country between embankments on both sides. The plan gives due attention to the simultaneous development of the protected areas, notably by the improvement of the internal watermanagement; some new concepts, viz. controlled flooding and compartmentalisation, were introduced, which are aimed to enlist the support and participation of the population within the protected areas.
However, a critical issue for FAP is the sustainability of the works that make up the plan, without which it would be an ineffective waste of efforts and resources. Sustainability is not yet a generally recognised notion in Bangladesh. Full sustainability rests on a number of pillars, the realisation of which will require the support of the donor-community, but which is ultimately a matter of national awareness and of effectivity in the mobilisation of talents and resources available in the country.

1. Bangladesh

Bangladesh measures about 144,800 km^2 and it has about 110 million inhabitants; see Figure 1. The population has doubled since 1961 and it is estimated to double again by the year 2020.

Agriculture is the main occupation; around 80% of the population are rural, living mainly of agriculture. Rice occupies about 80% of the cropped area and is grown in three seasons: two (aus, aman) in the wet season, the other (boro) mainly with irrigation in the dry season.

The avarage farmsize is about 0.9 ha, subdivided into an average

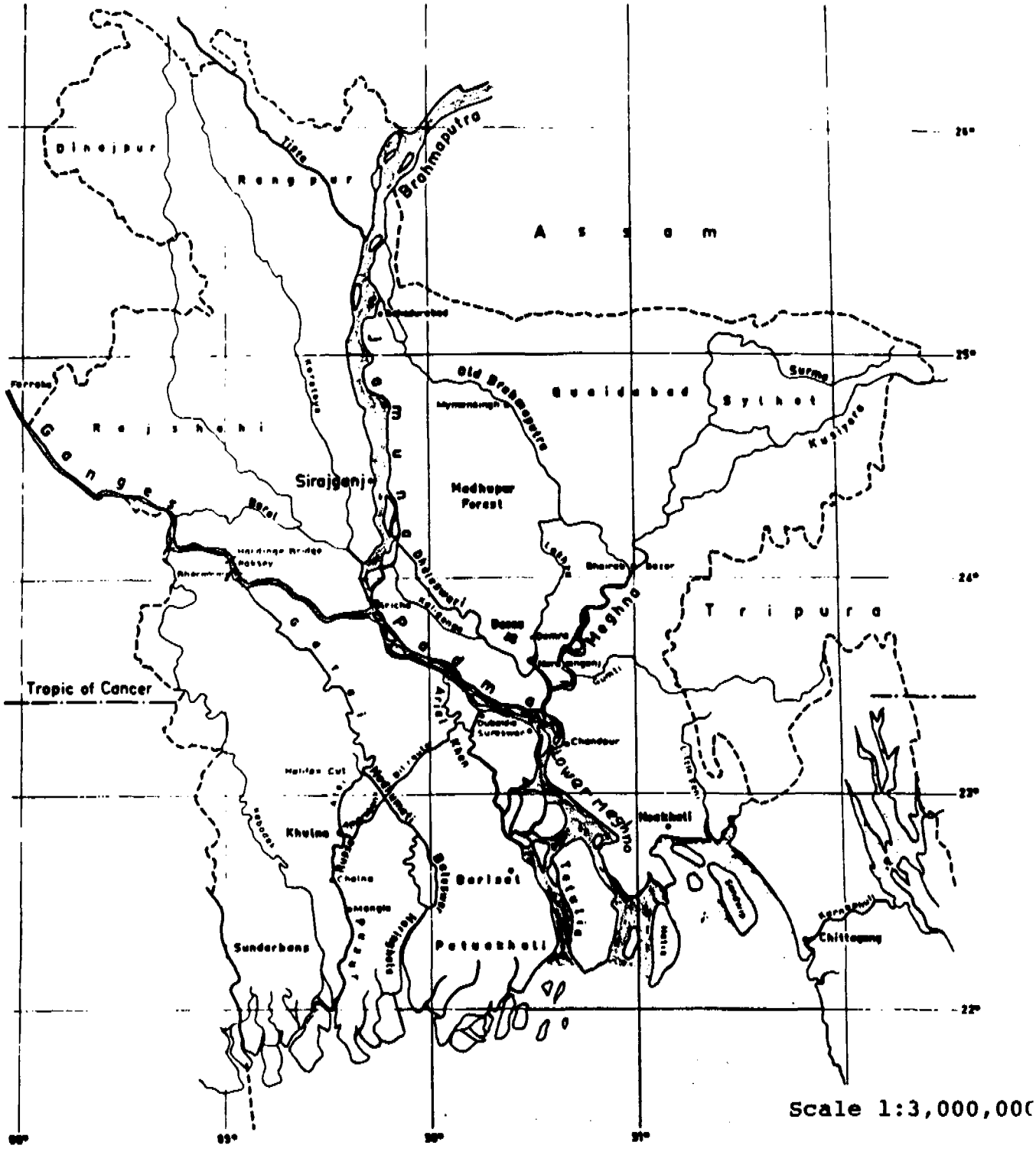


Figure 1: Map of Bangladesh

of about 10 fragments. Landownership is highly skewed: about5% of the households with more than 3 hectares operate about 26% of the land, whereas about 40%, holding 0.4 ha or less, operated about 8%. Growing population pressure has increased the number of landless families to about 40% of the rural households; it increased the rural - urban migration , forcing increased numbers of people to seek living space and subsistence on disaster-prone land within and alongside major rivers.

The country is poor, with an average GNP of around $160 per capita. It is heavily dependent on international donor assistance, providing about 80% of the of the development budget. It needs to import about 10% of its annual foodgrains requirement, mainly with donor assistance.

Bangladesh has a predominantly tropical monsoon climate. Most of the annual precipitation occurs between May and September. The mean annual rainfall ranges from 1250 mm in the centre-west to over 5000mm in the extreme north-east. The mean monthly temperatures are around 28°C for most of the year, but are 18-21°C in December.

Two of the major rivers in the world flow through Bangladesh and join together there: the Ganges and the Brahmaputra (in its lower course also called the Jamuna). Later they are joined by the Meghna. Table 1 shows the mean monthly discharge of these rivers. Table 2 gives some information about peak discharges on the major rivers.

	Jan.	Feb.	Mar.	Apr.	May	June	July	Aug.	Sept.	Oct.	Nov.	Dec.
Ganges	8.4	6.7	6.3	5.2	5.7	10.9	46.1	105.3	92.0	45.6	18.1	10.9
Brahmaputra	13.8	10.5	12.5	18.4	44.4	83.5	107.0	118.0	91.2	58.0	27.4	17.8
Meghna	1.6	1.2	1.7	2.3	5.1	10.7	19.5	20.7	20.1	17.9	7.4	2.8

Table 1 Mean value of the discharge of the main rivers of Bangladesh (in 10^9 m^3 per month)

Return Period Years	Brahmaputra	Ganges	Meghna
	Flood peaks in 10^3 m^3/s		
5	73.1	58.2	15.9
10	79.3	63.7	17.5
50	93.0	76.0	20.9
100	98.8	81.1	22.3
200	104.6	86.3	23.8

Table 2 Flood flow frequencies

About 92.5% of the catchment of the Ganges ($1x10^6$ km^2) and the Brahmaputra ($1.6x10^6$ km^2) lies outside the boundaries of Bangladesh. Figure 2 shows the extent of the catchments of the main rivers. Within these catchments and especially that of the Brahmaputra, rainfall is locally considerably higher than that in Bangladesh: up to 11,615 mm at Cherrapunji, just across the

border of north-east Bangladesh.

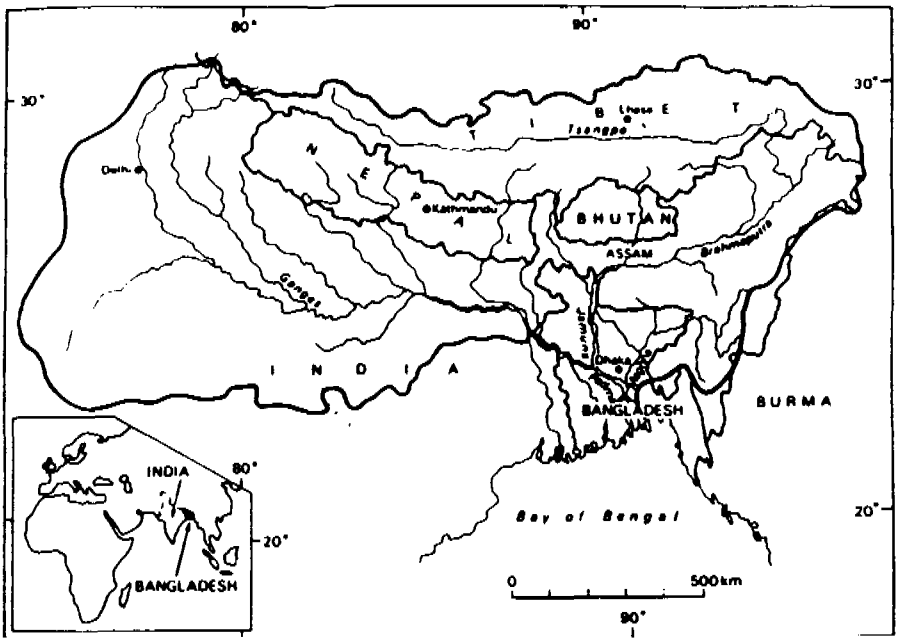


Figure 2: Catchments of the Ganges, Brahmaputra and Meghna

The Ganges and the Brahmaputra may not differ considerably as far as their average and maximum discharge is concerned, but their character is entirely different. Whereas the Ganges is predominantly a meandering river with a width in the order of 5km, the Brahmaputra is a braided channel, with a number of different channels and islands in between and a total width of 10 -15 km. Individual channels may reach a depth of 20-30 m, with locally maximum velocities of 2-2.5 m/s.

Although the low flow channel of the Ganges changes its course in between the high banks, bank erosion generally is not a very serious problem. The Brahmaputra, however, is notorious for its violent bank erosion, which may amount to over 1 km in one season, devouring agricultural land, villages and infrastructure.

The confluence of the two rivers, the Padma, is a relatively stable river. During the flood season, the flow velocities are strong, reaching values of 2.5-3m/s while the depth may go as deep as 45 m. The average width of the river is about 12.5 km.

The Meghna by contrast, is a fairly benign river: velocities are moderate and so is occasional bank erosion. In fact the bed of the Meghna is to wide for the flow it carries; it is shaped by the Brahmaputra, before it changed it course to the present bed, some two centuries ago. Waterlevels and velocities are under the

influence of backwater effects from the Lower Meghna.

The Lower Meghna, which is the confluence of the Padma and the Meghna, is tidal during the greater part of the year. During the monsoon velocities may locally be as high as 3m/s, while the depth may reach 50m. The avarage width is about 15-20 km. Also the Lower Meghna can locally be quite unstable, causing serious bank erosion.

2. Floods in Bangladesh

Floods in Bangladesh occur as a result of a number of different causes, or of a combination of two or more:

- **Flash floods in the eastern and northern rivers**
  These are characterised by a sharp rise followed by a relatively rapid recession a few days later, often causing high flow velocities that damage crops and properties.

- **Rain flood due to high intensity rainfalls**
  The very high local rainfall intensities and long durations in the monsoon will often generate runoff volumes in excess of the local drainage capacities.

- **Monsoon floods from the major rivers**
  Overbank flood spills of the major rivers and their distributaries cause the most extensive flood damage in Bangladesh. with the onset of monsoon all the major rivers start rising. The major rivers generally rise slowly and the period of rise may extend over several weeks. Most extensive flood damages are caused when the three major rivers peak simultaneously.

- **Floods due to storm surges in the coastal areas**
  Cyclones are most common during the pre- and post-monsoon periods (April-May and October-November respectively) and have fortunately not been known to coincide with monsoon peak floods.

Being situated as it is, Bangladesh has always been suffering from floods. While the cause or combination of causes is largely determined by natural factors, human activities in and also outside the catchments may have an effect on floods in Bangladesh

- **Greenhouse effect and related climatic changes**
  The reported gradual rise in global temperatures resulting from an increasing concentration of carbon dioxide and other gases in the atmosphere, may increase the snowmelt in the Himalayas, increase monsoon raifall in the region and lead to a rise in sea-level of between 0.15 and 0.30 m. Such changes, if they came about, could increase

monsoon season floodflow into Bangladesh and impede drainage from the lower river reaches. Since the climatic change and the possible results are still speculative to a large extent, it seems to be realistic to design for known rainfall and snow-melt conditions, until basic research produces more conclusive evidence of changes.

- **Deforestation**
  Deforestation in the upper catchment may influence the total volume of water available for runoff, modifying the time distribution of runoff and contribute increased sediment input to the rivers. However, research in these matters in other catchments does not make this train of cause and effects a universally necessary one. In some cases effects were reported to be exactly to the contrary. Moreover, the gradual rise of the Himalayas causes continuously a slice of the mountains to rise above the timberline, with the same effects as indicated above. Data on the effects of deforestation in the Himalayas are scarce and more research is needed, although unnecessary cutting of the forest is to be avoided in any case. In the mean time one may assume that the severity of natural events, in combination with the equalising effect of the long river course down to the delta in Bangladesh, will diminish any possible extra impact of deforestation considerably.

- **Earthquakes**
  These may cause major changes in river course or bed levels, but there are no signs of such major changes during recent years. Earthquakes are also known to generate massive landslides, which may block the rivers temporarily; the breach of the blockage will lead to an extra "hump" on the hydrograph. However, the effect would be small compared to the monsoon discharge of the Ganges or the Brahmaputra. The extra supply of sediment resulting from earthquakes is reported to be very serious in some cases, decreasing again the relative importance of deforestation. In Bangladesh, the delta of the rivers, the effects of a sudden increase in sediment supply would probably be limited.

- **Upstream reservoirs**
  Reservoirs operated so as to store flood runoff would have some effects of reducing at least early flood season flow. Reservoirs operated for other purposes than flood control would tend to be filled during the earlier part of the monsoon season and would thus probably modify the flood peak to a limited extent only, if at all.

- **Embankments**
  If these are built along the upstream reaches of the Ganges and the Brahmaputra, they will remove part of the flood plain storage, which will lead to higher peak levels and a steeper rise of water levels downstream during floods. Furthermore, if the deposition of sediment on upstream floodplains is prevented by embankments, then the sediment load transferred to downstream areas may well be increased.

While the effect of each of the individual issues may not be serious, the combined effect could be quite damaging to Bangladesh, certainly if they continue uncontrolled in future. Like for any river, close cooperation in the entire catchment is of great importance and it should be pursued actively by all riparian countries.

4. Possible remedies

Measures taken in relation to flooding can be distinguished into three categories:

- **Prevention of flooding**, by which the occurrence is prevented by all practical standards; e.g. for the design of the necessary works, a chance of failure of less than 1:1,000 years could be adopted.
- **Mitigating flooding**, implying that floods may continue to occur periodically, e.g. with an average chance of occurrence of more than 1:100 years.
- **Mitigating the effects of flooding**. In this case efforts do not concentrate on reducing the frequency of occurrence of floods, but rather on the effects that they may have.

The first two categories will include a programme of structural works, while the third will mainly consist of non-structural measures. As a rule measures designed to mitigate the effects of floods, will be relatively cheap and generate their benefits within a reasonably short period of time. Structural measures, on the other hand, usually require substantial investments and considerable time for studies, design and construction, while the effects may come only some time later.

Non-structural measures will include:

- **Flood forecasting and warning**, requiring the operation of a network of meteorological and hydrological measuring stations. Especially information from higher in the catchment is needed for a sufficient lead time. The present system in Bangladesh needs upgrading and extension; this applies also for the exchange of data with the neighbouring country India. Once reliable data on

coming flood events are available, an efficient system should be in place to disseminate useful information to the population in a comprehensible way. The population needs to be trained to understand the implications of the issued warnings and to react accordingly.

- **Flood preparedness**, comprising a wide range of pre-emergency activities, ranging from measures as crop insurance to evacuation and sheltering in the case of floods. In a country as densily populated as Bangladesh, this is a complicated matter, which is not made easier by the relatively low level of organisation of the rural population.

- **Flood proofing**, referring to measures designed to reduce damage and disruption if floods occur. This will have an impact on design criteria and construction standards if infrastructural works, public buildings and houses.

Structural measures can in principle comprise:

- **Storage reservoirs**. Since Bangladesh is essentially a flat country, reservoirs would have to be situated in the upper catchment, where topographical conditions are favourablable. However, as explained above, operational requirements of such reservoirs usually contradict those of reservoirs that also serve the interests of more upstream areas, in terms of irrigation and power generation. This matter is complicated by the fact that the upper parts of the catchments are located in India and that bilateral relations preclude any effective actions in this respect in the near future, if feasible at all. Moreover, a relatively large part of the catchment (and for the Brahmaputra notably that part where rainfall can be heavy) is situated too low to benefit from the controlling effect of reservoirs.

- **Channel improvement**. Bangladesh is in effect the delta of the major rivers, which implies that the system of river channels is in a state of dynamic equilibrium. Old channels may silt up and become derilict, while new channels may open up. Contrary to popular believe there are no convincing indications that there is a consistent tendency of river system to silt up; to the contrary, compared to the oldest map of the country, the so-called Rennell map, the delta of the major rivers demonstrate a remarkable degree of stability. In this environment, considering the huge amounts of sediment that are carried by the Ganges and the Brahmaputra, attempts to improve the capacity of the channels by recurrent means would be futile and a waste of resources. The capacity of some distributaries could possibly be improved by means of

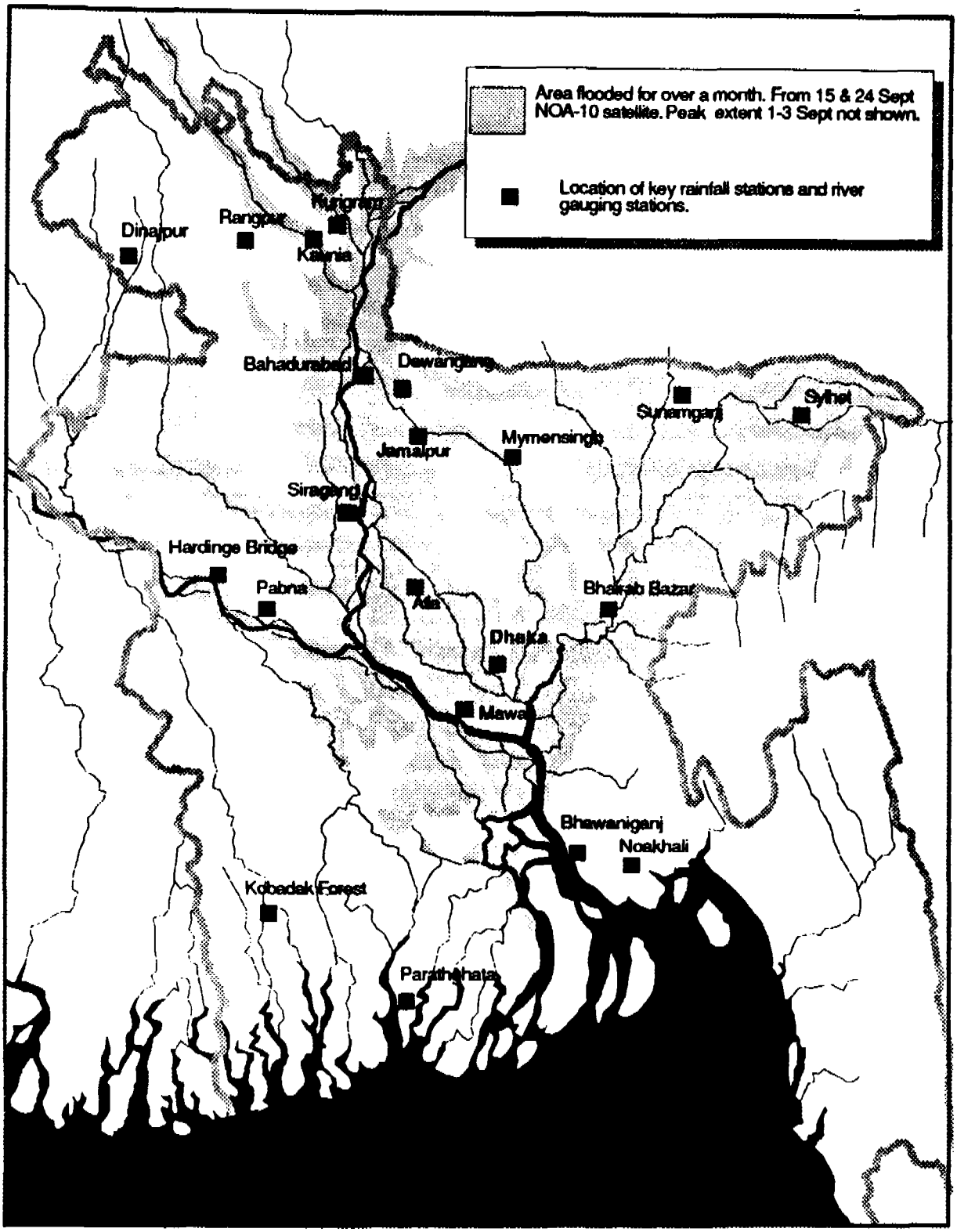


Figure 3: Floods of September 1988

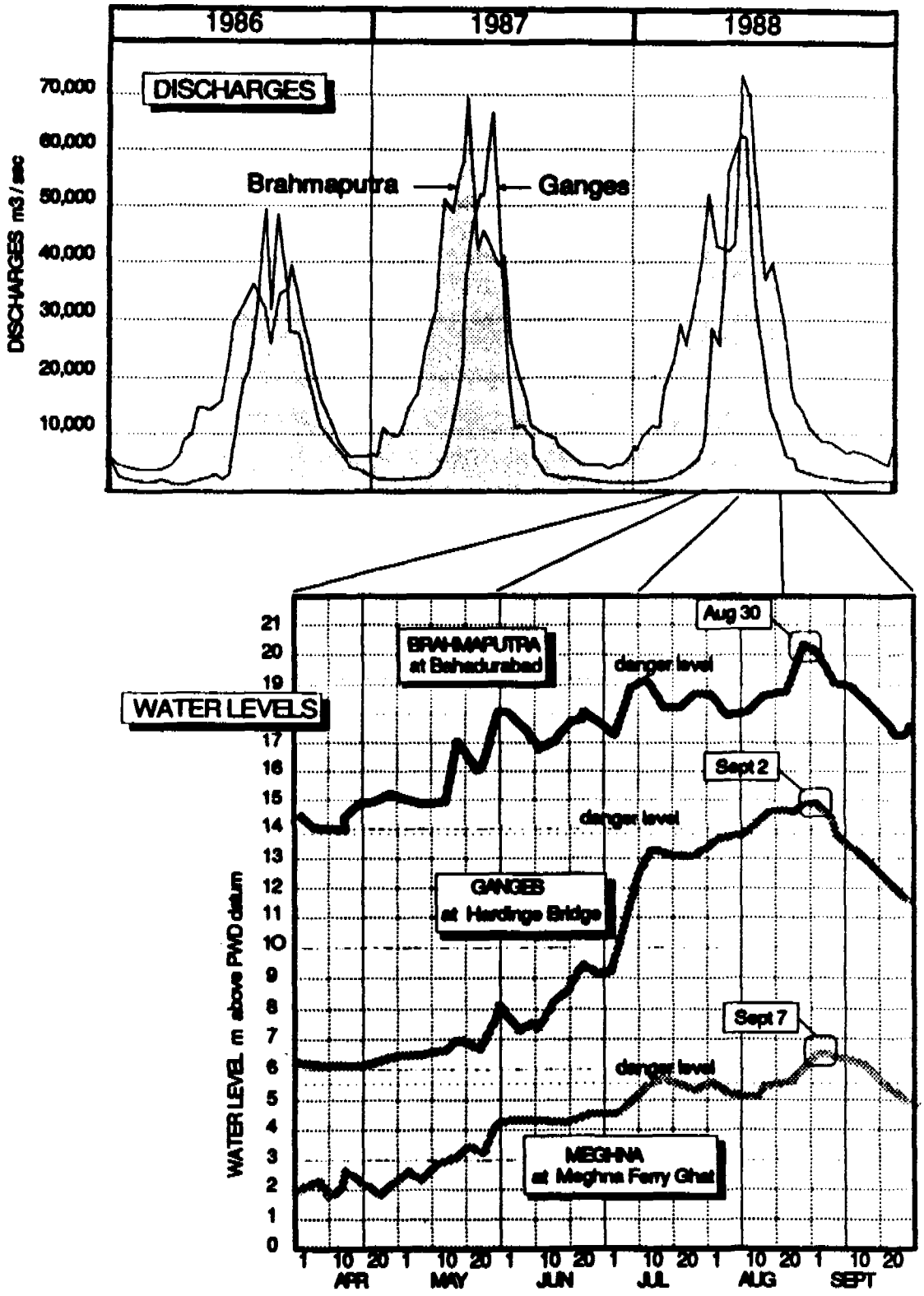


Figure 4: Main river discharges 1986-1988 and floodlevels 1988

permanent river training works, but this would have to be combined with a stabilisation of the river bed, which is technically complicated and very costly moreover, considering construction and maintenance. Besides the increase of the total capacity of the system in time of floods would be marginal.

- **Embankments**. Traditionally embankments constitute the main defence against flooding in practically all delta's in the world. They have also been built in Bangladesh and are still considered as the most effective means of protection. They have some disadvantages which should not be overlooked. As referred to earlier, they will affect the hydrology and morphology of the rivers, by changing the pattern of discharge of water and sediment. In particular the morphological effects could be serious, considering the enormous sediment-carrying capacity of the major rivers. Even a relatively small increase of it could result in a significant increase of the scouring capacity, which is very large already. Moreover experience elsewhere has demonstrated that the construction of embankments will not automatically produce the benefits that are needed to justify the investments. Benefits would have to come from an increased productivity of the protected areas, in this case mainly from agriculture. Additional investments in the protected areas are needed, notably in the improvement of the internal water management, to start the development process that will lead to increased agricultural benefits.

5. The Flood Action Plan (FAP)

After serious flooding in 1987, Bangladesh was struck again by heavy floods in September 1988. In 1987 it was the Ganges that flooded its banks. In 1988 the Brahmaputra caused wide spread flooding, see Figures 3 and 4. The Government of Bangladesh called on the UNDP to assist in an assesment of the extent and causes of the floods and in preparing a realistic policy and related plans to prevent a recurrence of such disastrous events. While a combined GOB-UNDP started its work, France supported a study of the same problems. Although the outcome of these studies differs to some extent, notably regarding the timing and technical dimensions of the planned works, they demonstrated sufficient consistence to allow GOB to request the World Bank in July 1989 to coordinate efforts to formulate a first stage of a comprehensive programme for flood protection, based on the two mentioned studies. The World Bank reacted positively and in the fall of 1989 FAP was developed and presented to the donor community in a meeting in Londen in December 1989. It was well received there and all donors involved in the watersector in Bangladesh pledges their support. In January 1990 FAP got its

official start during a donor meeting in Dhaka.

FAP is based on the Eleven Guiding Principles, formulated by GOB in the course of the joint GOB/UNDP study:

1. Phased implementation of a comprehensive Flood Plan aimed at :
   - protecting rural infrastructure;
   - controlling flooding to meet the needs of agriculture, fisheries, navigation, urban flushing and annual recharge of surface and groundwater resources.
2. Effective land and water management in protected and unprotected areas.
3. Measures to strengthen flood preparedness and disaster management.
4. Improvement of flood forcasting and early warning.
5. Safe conveyance of the large cross border flows to the Bay of Bengal by channelling it through the major rivers with the help of embankments on both sides.
6. River training to protect embankments and urban centres.
7. Reduction of flood flows in the major rivers by diversion into major distributaries and flood relief channels.
8. Channel improvements and structures to ensure efficient drainage and to promote conservation and regulation.
9. Flood plain zoning where feasible and appropriate.
10. Coodinated planning and construction of all rural roads, highways and railway embankments with provision for unimpeded drainage.
11. Encourage popular support by involving beneficiaries in the planning, design and operation of flood control and drainage works.

In accordance with the recommandations of both the GOB-UNDP and the French study, the basis of FAP is the belief that effective protection against flooding in Bangladesh is possible only by constructing a system of embankments along all major rivers.

FAP comprises the following elements (see also Figure 5):

PLAN COMPONENTS

1. Brahmaputra Right Bank Strengthening
2. Brahmaputra Right Bank
   - NW Regional Drainage Study
   - NW Diversion Drain
   - NW Interceptor Drain
3. Brahmaputra Left Bank
   - NC Regional Flood Control / Drainage Study
   - BL Embankment (N)
   - BL Compartment (N)
4. Ganges Right Bank
   - SW Regional Study
   - Gorai Intake & GR Embankment
   - SW & SC Drainage Improvement
5. Meghna Left Bank
   - SE Regional Study
   - Gumti & SE Drainage
6. North East Region
   - NE Regional Study
   - Rehabilitation Project
7. Cyclone Protection Project
8. Dhaka Town Protection
9. Other Towns Protection
10. Flood Forecasting & Early Warning
11. Flood Preparedness

SUPPORTING ACTIVITIES

12. FCD/I Agricultural Study
13. Operation & Maintenance Study
14. Socio-Economics Study 1 Active Flood Plain
15. Socio-Economics Study 2 Land Acquisition
16. Environment Study
17. Fisheries Study and Pilot Project
18. Topographic Mapping
19. Geographic Information System
20. Compartmentalization Pilot Project
21. Bank Protection Pilot Project
22. River Training / AFPM Pilot Project
23. Flood Proofing Pilot Project
24. River Survey Program
25. Flood Modelling / Management
26. Institutional Development Program

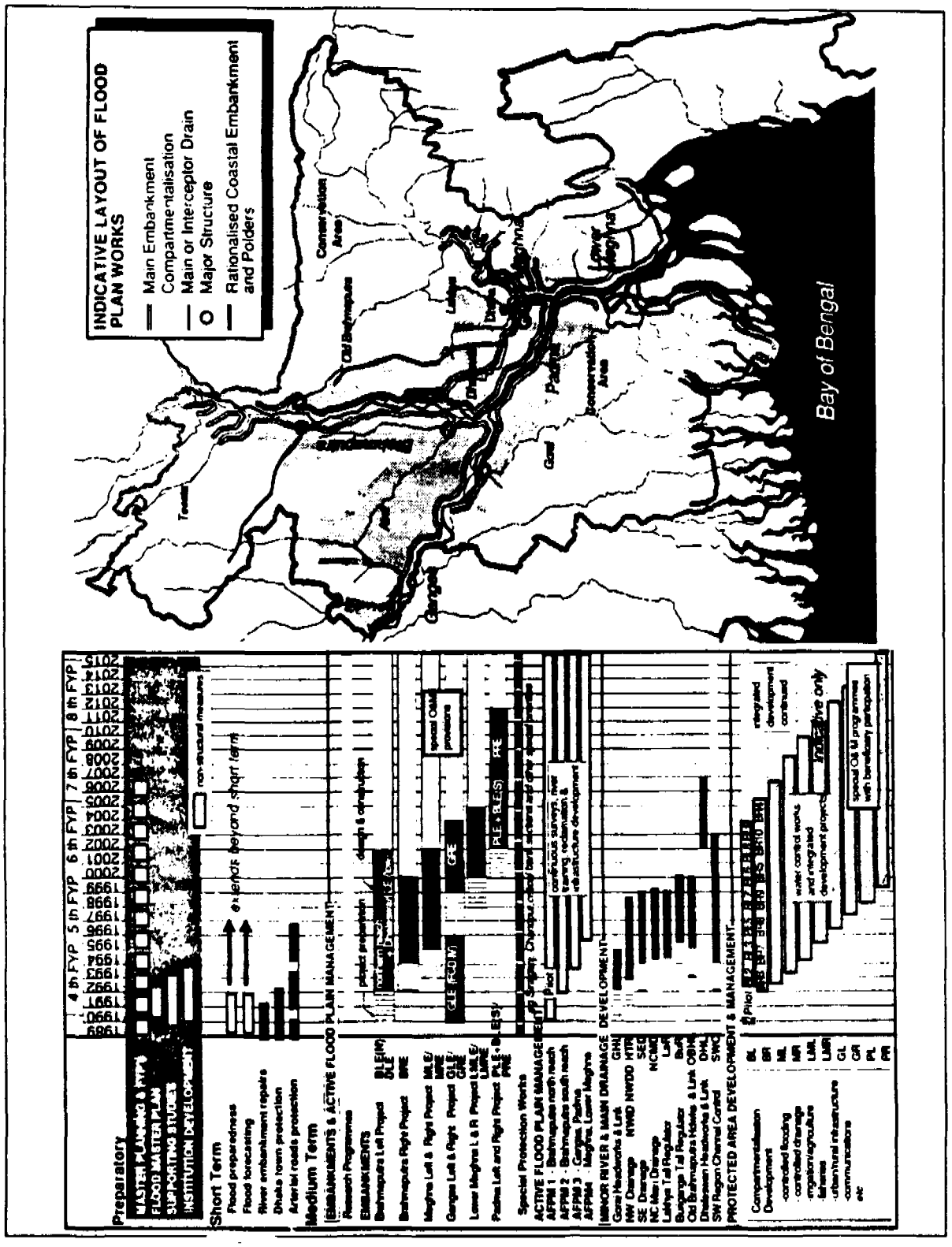


Figure 5: Long term program for flood protection
Source: Flood Policy Study GOB-UNDP, May 1989

It thus includes 9 components which are related to structural solutions to the flood problems of the country and 2 components which refer to non-structural measures. The 15 supporting activities are designed to reinforce the concepts underlying the plan components and to enhance their effectiviness.

FAP is extending over a period of 5 years and it is considered to be the first phase of a long term plan. The studies under the sructural components should demonstrate the feasibility of works along the mentioned river stretches. These will for the larger part be implemented during the next phases of the plan, during which also the next slice of studies will be taken up. In total the plan could extend over a period of 25 years or even longer.

There are a number of basic considerations, derived from the Eleven Principles, that underly FAP and its various components:

- Embanking the major rivers has to be done gradually, to avoid, or at least diminish the chance that the change in hydrological conditions would lead to uncontrollable morphological reactions of the rivers. If this would happen, the effects could be very serious indeed; not only could bank erosion appravate, but the rivers might also cut into new distributaries, which then could develop into uncontrollable eroding rivers. It would be hard to fathom the effects this could have on the country. For that reason FAP, being the first phase of a long term programme, concentrates on embanking some of the rivers only, leaving for instance the lower stretch of the Brahmaputra and the Padma as they are, to give them time to adjust to the changed hydrological conditions.

- Closing the protected areas entirely off from river floods may entail a too drastic change to the environment, which could be disturbing in a number respects, including agriculture, which may to some extend benefit from a moderate degree of flooding. Therefore controlled flooding will be introduced wherever practical and beneficial. FAP includes a pilot project in which various options for controlled flooding will be tested.

- Obtaining full benefits from flood protection requires more than just making embankments. Supplementary works within the protected areas are needed, notably in respect of the internal watermanagement; an efficient system of internal drainage should help to mitigate the effects of heavy direct rainfall. The principle of compartmentalisation has been adopted, by which the protected areas will be subdivided into smaller units with more or less uniform hydrological conditions. The same pilot project referred to above will also serve to study critical issues with respect to the concept of compartmentalisation.

- Works as foreseen under FAP, which will have a direct impact on the lives and living conditions of the population in the protected areas cannot be planned and implemented with the support and and participation of the local population. This is true for all works of such nature in Bangladesh; as yet there are no models available that could be followed in FAP. The pilot project mentioned before will therefore also be an exercise in mobilising local support and cooperation. Compartmentalisation is a tool to subdivide the protected areas into manageable units, suitable for an effective decentralisation of authority for operation and management.

- As long as no affordable technical means have been developed to stabilise the major rivers in Bangladesh, the planning of flood embankments has by necessity to be flexible, allowing locally to retire the embankments along deep channels, if threatened by bank erosion. However, a land-hungry country cannot afford to allow valuable land being lost to the river; developing effective means to arrest bank erosion and even efforts to force the rivers into an hydraulically more efficient bed and reclaiming land in the process has a high priority. For that reason FAP includes a pilot project under which various relevant methods will be tried out.

Fap, as it has been developed in the course of about one year, with the concerted input of several experts from Bangladesh and outside, has a number of clear advantages:

- It represents a realistic and balanced approach to a long term solution to the flood problems of Bangladesh, that acquired the support of all donors for the water sectorin Bangladesh. It is for the first time in the country, and possibly in any country, that all donors unite on one programme and that they are willing to have their input coordinated by the World Bank. This is an important improvement over the past, when donors used to operate independently, resulting sometimes in a waste of resources and a loss of opportunities.

- It is also for the first time that all ministries in Bangladesh, which are in one way or another associated with projects in the water sector, cooperate in an effective way, as has been achieved now. GOB set up a special system of coordinating organisations and procedures, which ensure the input from all ministries to be effectively taken into consideration.

- Effective procedures were needed to ensure that the realisation of the entire plan follows the adopted time

schedule as much as possible. As a result the control of the progress and the quality of the work done on each of the plan-components, is of a higher standard than ever before in Bangladesh.

6. Critical issues for FAP

FAP is not without critics, who level a number of objections, some of the most important of which are:

- FAP implies a too strong interference in the ecological balance of the country. A better approach would be to strengthen the ability of the population to live with the floods. Society developed over time a remarkable resilience to cope with floods and their effects, and efforts should concentrate on reinforcing this capacity.

  Although there is every reason to admire the resilience of the population and their ability to adapt to the risks of flodding, this should not be used as an argument to assume that the present situation is the optimum that the population would want. Always mankind is trying to manipulate his environment, in the search of a higher level of security and comfort. The present situation possibly represents the best that people could manage with the resources available, but there need to be no doubt that also in Bangladesh people prefer to be safe from the risks of floods and the limitations to their livelihood that they entail.

- Instead of increasing agricultural production by creating favourable conditions for the wet season crop, it would be better do invest the same efforts in efforts in increasing the dry season crop. Conditions favour a more efficient water management than will be possible during the wet season, when heavy rainfall can cause significant local flooding.

  It is true that the increase in agricultural production that the country has witnessed since independence is for a large part due to the remarkable leap forward in the productivity of the dry season crop, thanks to the rapid expansion of irrigation with groundwater. Especially since the government decided to give full opportunity to private enterprise did irrigation spread rapidly. However, there is a limit to what can be achieved in this respect; although there appears to be full recharge of the aquifer in the wet season, the the area under irrigation is approaching the point of saturation. As the increase in population must be expected to continue for some time more, the only opportunity left under the circumstances to make production match consumption

is an increase of the wet season crop, which will require a higher degree of water control than is possible without embankments and improved water management in the protected area, which is exactly what FAP is aiming at; see also Figure 6.

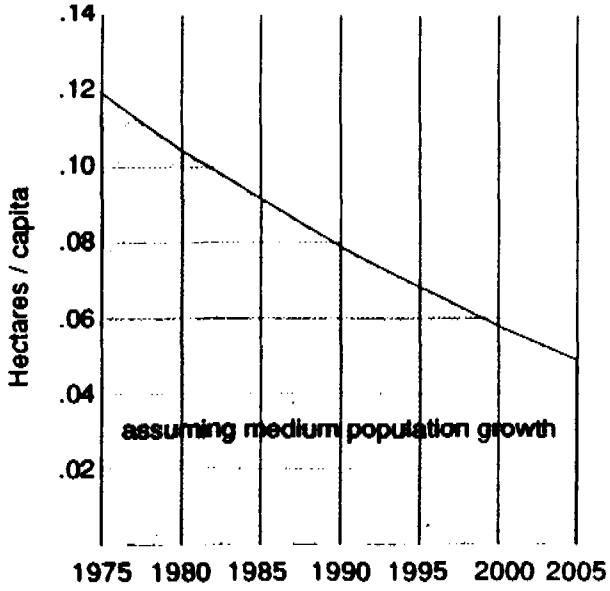


Figure 6: Net cultivable area per capita

While the above objections do not justify repudiation of FAP, one should be realistic enough to recognize some points that are critical to its eventual success. If one wishes to capture them under one heading, then it is the **sustainability** of the plan. It rests on a number of issues, which in combination determine whether FAP has a chance to be sustainable or not. The four most important ones are:

1. It is obvious that, if the technical works that make up FAP are not sufficiently durable, the plan cannot stand the test of sustainability. The contruction of embankments as such is not new in Bangladesh, and one may also expect that the introduction of appropriate systems for the internal watermanagement will not be too difficult. However, some of the foregoing paragraphs have indicated already how difficult it is to design affordable and practical methods to stabilize the course of the main rivers and to prevent embankments from being eroded away regularly. Yet, as long as no suitable methods for protection have been developed, the maintenance of which are in the course of time within the capabilities of Bangladesh, it will be difficult to expect major elements of the plan to be sustainable, the lack of which will undermine the credibility of the entire

plan. Efforts in this respect will need the assistance of foreign expertise initially. Gradually the required know-how should develop in Bangladesh. The River Research Institute, that is being set up in Faridpur, could be an element in this respect. However, the selected location sets a limit to the quality of the staff that is willing to settle there; an even more serious restriction is set by the fact that the institute has to operate under the rigid rules of a (semi) government organisation. Top quality staff in Bangladesh will be attracted to a career with RRI only, if remuneration and carreer ressemble those of a commercially run private enterprise.

2. As mentioned before, the support and cooperation that the plan can enlist with the local population is of fundamental importance. There are few examples in Bangladesh of water control projects that are successful thanks to people's support. On the contrary, there is ample evidence that without such support a water management scheme will not be sustainable. FAP 20 is an effort in building up and consolidating people's participation, during the phase of planning and building, and also thereafter, during the operation of the introduced water management systems. It is too early to indicate the organisational structure that eventually will emerge as being appropriate. It will have to fit in a decentralized system of local government, as GOB is in the process of introducing. It will require the development of an appropriate system of regulations and laws to support the effective decentralisation of authority and power, especially so if this relates to (semi-autonomous?) organisations of the inhabitants of a compartment or polder. The system should also allow such organisations to exercise their authority effectively, if necessary through the application of sanctions or penalties.

3. The necessity to develop logical and efficient institutional structures relates not only to organisations involving the population living in the protected areas and who benefit from the protection provide. It also relates to governmental institutions that are involved in the implementation of FAP. Bangladesh has a number of specialised government agencies that by their charter are designed to play a role in FAP. However, it is widely recognized that the existing structures and corresponding regulations do not always induce efficiency and dedication of the staff. There is no doubt that an effective implementation of the plan will require an adaptation of the structure of related institutions. A fundamental restructuring of the government agencies involved in FAP and a re-allocation of responsibilities is needed. It could be one by which the Bangladesh Water Development Board, now

responsible for all waterresources projects, limits its role to the embankments along major rivers and in the coastal zone only, including all related structures and that the responsibility for systems of a lower order is decentralized to locally based institutions yet to be set up. Such questions will be addressed under the related supporting study included in FAP.

4. The start and implementation of the first phase of FAP rests on the support of external donors. There is every reason to expect that this assistance will also come forward for the construction of the first slice of works, as a result of the ongoing studies. One even may expect that, depending of FAP, the donor community is willing to extend their support also to the next stages of the long term programme. However, as a rule the support will relate to the construction only and Bangladesh would be expected to assume the responsibility for effective O&M. It requires little economic vision to understand that this expectation is not entirely realistic: every year the national budget should increase, on a sustainable basis, by 4-10% of the size of the investment in the watersector in that particular year (the actual percentage will depend on the nature of the works). The potential for the annual budget increase should be generated by the growth of the national income, resulting from the investment made. There are some serious problems here. First of all it usually takes some years before a water management project will start yielding benefits. Secondly, such benefits will initially accrue to the local population and it requires an effective tax regime for the government to increase its income accordingly. Even then one may doubt whether the extra income to the government will cover the full costs of O&M. To illustrate the magnitude of the problem, it may be mentioned that the GOB-UNDP study estimates that over an assumed 20 years construction period, the total costs of the proposed long term flood protection plan, would amount to some $ 2.7 billion, out of which 33% for O&M. This would have to be borne by the national budget, in addition to those elements under the remaining 67% (expected to be provided by external donors) that are normally considered to be a national obligation, such as land acquisition.

The best approach would probably be one by which the responsibility of the central government for O&M is limited to the system of main river- and coastal embankments, including all built-in structures and that the responsibility for lower order systems is delegated to decentralized organisations. For internal water management systems such organisations could be made up from the local population, as described above, which would have to be empowered to raise revenues from the inhabitants under their

jurisdiction, to cover the costs of O&M. Resources for O&M of the main systems would still have to come from the national budget, generated by an increased revenues from taxation, resulting from increased income of the population in the protected areas.

As it will take some time to build up sufficient confidence with the population to make them willing to participate actively in the task of O&M and for the government to raise revenue from taxes in an equitable way, donors should be made convinced that they should participate not only in the investment part of the works, but also in O&M for a defined period. Failing this it must be feared that the works will not be maintained properly (as is rather the rule in Bangladesh), that resources are wasted and that as a result FAP will not be sustainable.

Sustainability appears to be closely linked to the self-reliance of the country. However useful external assistance may be, it only can contribute part of the solution to the flood problems of Bangladesh. Ultimately it will be the people of Bangladesh who have to make their own future, including the sustainability of the flood protection works.

Seminar on
Bangladesh Disaster: Issues and Perspectives

Cyclone and Coastal Protection

Ir. Mustafizur Rahman
Ir. Md. Zahidullah Khan

(Participant in S.E course) IHE

3rd September, 1991

Seminar on

BANGLADESH DISASTER : ISSUES AND PERSPECTIVES

September 3, 1991

CYCLONE AND COASTAL PROTECTION

Ir. Mustafizur Rahman, IHE, Delft.

Ir. Md. Zahidullah Khan, IHE, Delft.

Introduction

Undoubtedly it can be said that repeated cyclones are a great barrier to the way of economical development of Bangladesh as well as it's influence over social and political field is also of notable importance. It is not a new phenomenon in coastal belt, the south and south eastern delta of Bangladesh. The coastal area suffers each year from tropical cyclones and storm surges. The low lying coastal area of Bangladesh is extremely vulnerable to this hazard resulting in disasters. People of that area are experienced with cyclones originating from Bay of Bengal, one of the most volatile and unpredictable zone in the world. Since the late nineteenth century 174 severe cyclonic storm had been recorded with the highest frequency in October - November - December followed by April - May.

Effects

Cyclone storm causes a trail of devastation by inundating the land and overtopping the embankments up to the elevation of 9 to 17 meters if it occurs at the time high tide. Then waves approach to the shore for dissipating the energy by running up a sloping beach. The phenomenon brings the inundation of lands. The inundation caused by the cyclone of 1876 was reported up to 15 meters above normal tide level in some places. From historical data it has been observed that cyclones of different times caused a large numbers of toll of human lives every time. Among these cyclones, the most

refresh cyclone in our memory is the cyclone of 1970. It was reported that three hundred thousands people were killed by this cyclone. Again, the recent cyclone of 29 April, 1991 took the lives of more than 130,000 people and disrupted the lives of ten million people.

Death toll in some cyclones in Bangladesh :

Year	Death
1822	40,000
1876	100,000
1897	175,000
1960	5,149
1961	11,468
1963	11,520
1965	19,279
1970	300,000
1985	11,069
1988	5,708
1991	130,000

Source : Bangladesh Bureau of Statistics.
Bangladesh Meterological Department.

Causes

In many coastal stations the actual occurring sea levels deviate from the predicted astronomical tides (storm surges). This is mostly due to strong landward and seaward winds. Their effect is super imposed on the tides. Abnormally high sea levels can also result from differences in barometric pressure. The Bay of Bengal is one of a few others where these effects are very pronounced. Here, it is, usually of 6 to 9 meters. Storm surges are generated by depression moving

in the atmosphere. In the southern Bay of Bengal, cyclone is developed by depression and proceeds to the north to the coast of India, Bangladesh and Burma. The funnel shape of the Bay of Bengal with Bangladesh at the bottom causes the more harmful effect of cyclone in comparison with the other countries like India, Burma, because of the fact that at that place water are piling up. The damaging effect of cyclone in Bangladesh is caused by the increased water level due to wind set up and low barometric pressure in combination with strong winds.

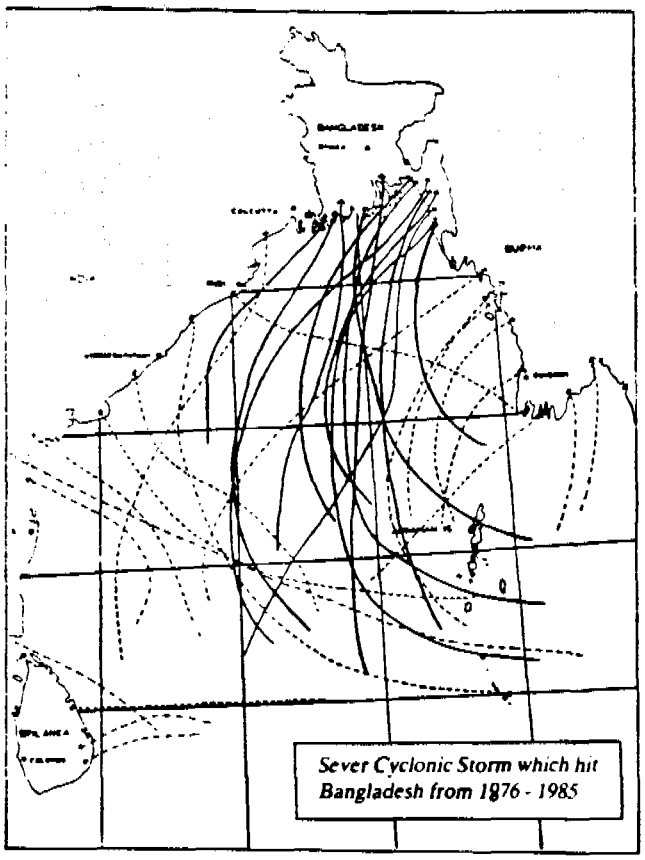


Fig. 2 Cyclonic storm tracks

Protective measure

After the cyclone and tidal surges of November 1970, a Cyclone Preparedness Programme (CPP) was initiated in 1972. The aim of the CPP is to protect and minimise the loss of lives and properties from such disasters in the cyclone-prone region of the country. The Cyclone Preparedness Programme for unprotected land should include the effective warning system and adequate infrastructure for pre-disaster evacuation. Physical infrastructures like embankments, roads, shelters and killas are a costly and essential part of cyclone protection and preparedness. From technical point, it is possible to design full cyclone proof embankment which is very costly. It might not be feasible economically, but if, it is considered on social aspects and humanitarian ground, then it reserves to have some considerations. Overall, it needs an intensive study from different point of aspects. Now-a-days, the effective cyclone forecasting system in Bangladesh has been developed significantly, even than, it requires further modernization. All possible measures initiated by Govt. and other organizations against the cyclone are not enough. Because, the people's active participation in that work like maintenance of structures, embankments is the most important factor to make the Cyclone Preparedness programme fruitful.

Cyclone can not be avoided, because rapid morphological changes are going on in the cyclone-prone region of Bangladesh due to simultaneous process of erosion and accretion. So, on emergency basis, some measurements are required to save the human life, among others, strongly built shelters with sufficient height reserves the first priority. Without providing shelter, all other activities regarding preparedness of cyclone will go on void. Because the people have no place to go in that situation even they are well informed. Not only human life, it is necessary to restore some measurements to protect the cattle. After the

devastating cyclone of 1970, a programme to build multi-storied permanent structures (mainly two storied on the top of pillar of about 4 meters height) to provide shelter to the people in the cyclone-prone region. The same number of killas (raised earthen mound) with 5-7 meters height to protect cattle. It was planned to complete the programme by 1977-78. But after construction of only 238 cyclone shelters and the same number of killas, the programme could not be completed for shortage of money. Again, after the cyclone of 1985, some more cyclone shelters of low height and small size were built with the assistance of Swiss Government.

Conclusion

It is believed that the recent increase in the intensity and frequency of cyclone is due to the growing ecological imbalance. This global detoriation is main due to the activities (green house effect, etc) in the western world. Therefore, it is increasingly becoming the responsibility of the global community to participate in resolving the problem.

We hope the ways and means to tackle these problems will be discussed in details by Ir. F. Koch and in the subsequent group discussion.

Thank you.

Seminar on

Bangladesh Disaster: Issues and Perspectives

Cyclone and Coastal Protection

Fred G. Koch

Delft Hydraulics

3rd September, 1991

INTERNATIONAL SEMINAR ON BANGLADESH DISASTER - September 3,1991

SUBJECT 2. Cyclone and coastal protection → not only a technical but also a social problem

Resource person: Fred G. Koch, DELFT HYDRAULICS

2.1 Introduction

This presentation will not elaborate on the characteristics of the cyclone phenomenon and of the coastal area of Bangladesh. This is supposed to be well known by the participants of this seminar. If not, reference can be made to the seperately enclosed article "The Land Reclamation Project in Bangladesh, a case study on cyclone preparedness" (Koch, 1988) and to the recent workshop "Living with Cyclones" organised in Bangladesh by the Land Reclamation Project (June 27, 1991).

To stimulate a fruitful discussion during this seminar it is considered to be more interesting to raise some questions related to the implementation of coastal protection schemes. The following questions will be posed and an attempt will be made to indicate some answer to these questions:

1. Is it feasible to protect the coastal areas against cyclones?
2. If not, what are the alternatives?
3. Is a design cyclone established?
4. What experience is gained from the existing embankments?
5. What are possible side effects of coastal embankment?

The discussion of these issues vil be followed by some concluding remarks.

2.2 Feasibility of protection against cyclones.

The question whether it is feasible to protect the coastal areas of Bangladesh against the severe cyclones generates a number of other questions. First of all it should be made clear that it is technically possible for civil engineers to design cyclone proof embankments. But, such a 100% protection will be very expensive, and the feasibility depends on the costs in relation to the interests to be protected. These interests are not only related to economic issues, social aspects are as important.

It certainly will be very difficult to justify the construction of the full protection on economic grounds only, because the economic value to be protected is mainly a moderate agricultural production, with the exception of some places like Chittagong and Cox's Bazar where industry and other

valuable infrastructure could be protected. Another possible major justification for the construction of protection works is the safety of the population. In many cases it is tried to give that also an economic value in order to include this safety in the economic analysis. This is very tricky and will lead to the ridiculous conclusion that human lives in one part of the world are more valuable than those in other parts. May be this explains why most of the large protection schemes in the Netherlands were based on political decissions instead of on economic analysis.

That coastal cyclone protection works in Bangladesh could possibly not be justified on economic grounds, means that a political decission guided by social reasons should be the basis. This is a major problem in the context of Bangladesh. For schemes involving large capital Bangladesh is dependent on foreign donors. Experience shows that donors are only willing to invest large amounts when the economic feasibility is made clear. This will lead to the conclusion that flood and cyclone protection works in Bangladesh are not feasible. Locations with towns and industry might be an exception.

Fortunately this is recognised more and more, and within the framework of the Flood Action Plan this matter is looked into. A solution is required in order to get the flood protection schemes implemented and not only studied.

2.3 Alternative solutions

In case it turns out that the construction of embankments for complete cyclone protection will not be feasible, this will certainly not mean that the construction of embankments is meaningless. It is experienced that the existing embankments mitigated the effect of cyclones. Let us therefor look at the different development stages of the rural coastal areas.

Unprotected outer embankment land

Settlements on these often newly accreted unprotected lands are in general extremely vulnerable to cyclone disasters. We all know the fate of the people that lived on Urir Char during the 1985 cyclone and the people that lived on Nijhum Dwip during the last cyclone. The raised maunds on which the houses are built were not high and strong enough to safeguard the people. In fact settlement in these unprotected areas should be forbidden. But in practise the people have no other choise than to take the risk in order to survive. It is different for the influential land-grabbers who

put pressure on their henchmen to settle in their interest on the unprotected lands. These land-grabbers take an exorbitant share of the profits and do not run any risk. A possibility to prevent this settlement might be to bring all newly accreted land under coastal afforestation. However, the Government itself is initiatig settlement in unsafe coastal areas through its Operation Thikana, which includes the construction of clustered villages on unprotected lands. This year the disaster on Nijhum Dwip would have been less if the population would not have been increased as a result of the attraction of the four clustered villages.

Land protected by embankments

An essential step in the development is the construction of embankments to reduce the flooding in order to increase the agricultural production. Often these embankments are designed with a height that accepts flooding once in 10 to 20 years, and they are certainly not cyclone proof. Still these embankments play a considerable role in the mitigation of cyclone disasters. Even when overtopped and breached they reduce the impact of the storm surge. In addition to the embankment special facilities are required to safeguard the lives of the people living behind the embankment. This could be the construction of higher maunds, killa's and cyclone shelters. For more details can be referred to Koch (1988).

Embankments in combination with a forest belt

Earthen embankments can be built to a heigth sufficient to prevent overtopping as a result of storm surges, even during cyclones. However, the impact of the surge and the attack by wind induced waves requires a too expensive bank protection in order to withstand the impact during the whole storm. A forest belt on the sea side of the embankment could reduce this destructive impact. It is expected that well designed and constructed earthen embankments (proper slopes, compaction and turfing) in combination with a forest belt could resist cyclones. But the problem can not be solved as simple as that, which will be made clear in the next sections.

2.4 Design criteria

Hydraulic criteria required for the design of embankments are the heigth of the storm surge and the wave set-up with their probability of occurence. These criteria could be established by statistical analysis of a long series of cyclone records or by mathematical simulation of

cyclones.

Since 1795 60 major cyclones have been recorded, which indicates an average frequency of once in three years. But during the 20 year period 1965-1985 25 damaging cyclones have been reported, indicating a much higher frequency. However, this series of records is insufficient for statistical analysis for the following reasons:

- The recorded data are in many cases not reliable or incomplete because during a cyclone instruments to record water heigths and wind velocities get damaged, certainly during the extreme events that are most important for the design criteria.
- The impact of cyclones depends very much on the location where it hits the coast. The same cyclone will result in a storm surge which will be much lover at the off-shore islands south of the islands Bhola and Hatia than at the mouth of the Feni river where the funnel shaped topography results in a much higher surge. This means that a statistical analysis will have to be executed for different locations based on the records of the cyclone that hit the coast at that same location. In that case the series of records, even when reliable, will be much less than sixty for each location to be investigated.

These days it is possible to simulate storm surges by mathematical models. Sophisticated models have been developed in the Netherlands to predict storm surges in the North Sea. A first attempt for Bangladesh has been made by the Land Reclamation Project by using a one dimensional model for flow simulation in the Bay of Bengal and the estuary. By introducing wind forces and barometric pressure the three meter storm surge of the 1985 cyclone could be reasonably simulated. Due to lack of means these experiments executed in 1986 could not be continued. At the moment the Cyclone Protection Project II is trying to simulate storm surges by means of two dimensional flow simulation models. By creating a time series of cyclones (wind speed and barometric pressure) it will ultimately be possible to establish design criteria.

2.5 Experiences with existing embankments

Lessons learned from experiences with existing coastal embankments will contribute to improved design of coastal protection schemes and will make clear that coastal protection is not simply the construction of dikes

only.

The major obstruction to coastal protection is the changing coast line. The morphologically active estuary shows a pattern of continuously changing coast lines as a result of erosion and accretion. This is more serious in the eastern part of the estuary, east of the Tentulia river, where the position of coast lines can change over more than 100 meters annually. Even erosion rates of 500 meters per year are observed. The morphological activity of the estuary does not mean that there is a continuous growth of the delta, unfortunately it is a process of growth on one location replaced by erosion elsewhere. The erosion is a major threat to any infrastructure like embankments, drainage sluices and complete towns. A clear example is the erosion of Hatia town. This erosion attack is much more serious in the eastern part of the estuary where strong currents of up to 4 m/s in channels with a depth of 15 meters wash away anything that is in its way.

The feasibility of most flood protection schemes is hampered by the uncertainty of the expected life-time. Either drainage sluices are silted up resulting in damaging water logging, or embankments and sluices are washed away by erosion. The applied practise of retired embankments has only limited value as is clear from the situation at the islands Bhola and Sandvip. It is a misunderstanding that a forest belt wil give some protection, the currents undermine the trees that simply fall in the water and are washed away. A prerequisite for sustainable coastal protection is control of the erosion. This will be an enormous task that should be implemented in phases and will take generations to be completed. The fight against erosion will not only be one of victories. Like in the history of the Netherlands we will now and then be defeated by the sea. However, with the experience gained in Bangladesh and the Netherlands the strugle will have more chances of success, and there is no reason not to start the fight. The Sandvip Cross-dam Scheme proposed by the Land Reclamation Project in 1984 would have been a major step forward, but for the earlier mentioned low rate of return this scheme was not taken up for implementation. Many of the erosion control schemes will have other benefits as well, for example a net accretion of considerable areas of new land.

What is also experienced is that more attention should be given to the design and construction of the protective works. In many cases embankments have been cut by the farmers because the designer did not give proper

attention to the drainage of the lands to be protected. The applied construction practises are responsible for weak embankments and sluices that are not functioning. Lack of proper clod breaking, compaction and turfing makes embankments vulnerable to storm attacks and are often damaged already by heavy rain only. Drainage sluices are often not properly working because of malfunctioning of the gates, and insufficient stilling basins that sometimes result in complete collaps of the sluice. This does not seem to be a difficult problem to solve.

A more difficult problem is the lack of maintenance, which weakens the embankments and puts sluices out of order. On the workshop "Living with Cyclones" the Additional Secretary of the Ministry of Irrigation , Water Development and Flood Control and Acting Chairman of the BWDB stated that it is beyond the capacity of the Government to provide maintenance and that the beneficiaries have to play an important role by making a contribution, if not in cash than by labour input. This is not an engineering problem but a social problem, and not an easy one. The share croppers that cultivate the land not even have the means to put in their labour. When they are not required for the cultivation of the land they often have to move to other areas to sell their labour because their farm income is often not sufficient to maintain the family. The other group of benificiaries are the landowners, which are often absentee landlords. The prevailing power structure might well be a bottleneck for such developments. In general the influential people have shown very little interest to invest in the land and the safety of the people. The establishment of local water boards is often mentioned as a possibility to organise a maintenance programme. However, the water boards in the Netherlands were originally initiated by the influential people and not by the marginal farmers or farm labour.

2.6 Possible side effects of coastal embankments

Especially in the western estuary the coastal embankments caused siltation of tidal channels. The embankments prevented flooding of large areas resulting in a reduction of the amount of water passing the channels each tide. As a result the channels silted up, which causes serious problems for drainage and navigation.

In many locations coastal embankments are responsible for serious drainage congestion. This results in water logging that seriously effects the productivity of the land. Drainage congestion is caused by one of the

following phenomenon or a combination of these:

- Faulty design of the location and/or the discharge capacity of the drainage sluices. This leads to the illegal cutting of embankments by the farmers, which you can see everywhere in Bangladesh. Involvement of the farmers in the planning and design phase could contribute to a better design and operation of the scheme.
- Natural accretion of new land on the seaside of the embankment blocking the drainage of the new land. This is the situation in the southern Noakhali area. Sometimes this natural accretion can create water logged areas without the presence of embankments, but clearly the embankment agravates the situation.
- The earlier mentioned siltation of drainage channels as a result of the reduction of the flood plain is most clearly manifest in the western estuary, and especially the area northwest of Khulna. At the moment the water logging is so serious that it is a real disaster. Farmers are even leaving the area, which is quite something in a country as densely populated as Bangladesh. When the Coastal Embankment Project was designed by the consultants Leedshill-DeLeuw in 1968 they already mentioned the problem and strongly recommended that this aspect should be studied in more detail. Unfortunately this recommendation was never given proper attention.

A third aspect that should be considered is the fact that embankments stopping the regular flooding of the lands also stops the annual deposition of sediments. Practical the whole of Bangladesh has been formed by these depositions and at present these depositions seem to balance the subsidence caused by tectonic movements. Allthough this is a very long-term effect an indication of the extent of the subsidence should be obtained. A comparable problem is the impact of the expected sea-level rise. The possibility that the subsidence will be neutralized by the natural deposition of sediments during floods will be prevented by embankments. The impact of the construction of coastal embankments on the combined effect of sea-level rise and tectonic subsidence requires careful consideration whenever large scale coastal protection works are formulated.

2.7 Concluding remark

It is clear that coastal protection is not a simple matter that mainly concerns the construction of dikes and sluices by straight forward

engineering. Coastal protection should be considered as part of coastal zone management in which all aspects (including environment) are integrated and where economists and sociologists have a major contribution to make.

A phased approach should be based on an overall coastal zone management plan. Implementation of a first step requires the political will of the Government of Bangladesh to fulfill the social requirements, and the readiness of the donors to go for a longer term involvement and to be prepared to go for large investments with a low rate of return. When these requirements are fulfilled, a first step can be made to coastal protection which in the long run (say hundred years) will lead to a high degree of safety even with respect to cyclones.

Seminar on
Bangladesh Disaster: Issues and Perspectives

Environmental Profile and Ecological Concerns of Bangladesh

Md. Reaz uddin

(Participant in EST course) IHE

3rd September, 1991

Environmental Profile and ecological concerns of Bangladesh

Md.Reaz uddin(Participant in EST course) IHE

1. Environmental Profile

1.1. Geographical setting and relief

Bangladesh, having a total land area of 143,998 sq. km, lies in the northeast part of South Asia, between 20 34 N and 26 38 N latitude 88 01 and 92 41 E longitude. The country is land locked except in the south, where the Bay of Bengal forms a coastline of about 710 km. The territorial waters extend 12 nautical miles and the economic zone upto 200 nautical miles.

The country (fig.1) is a large low flat deltaic plain except for small hilly areas built over the years by the deposition of the sediments brought by the three big rivers viz. Ganges and Brahmaputra, originating in the Himalayan mountains and Meghna, natured in the Khasi-Jainta hills in the north of the country. Thus it is a riverine landscape and numerous, often shifting streams and channels cris-cross the country thereby bringing water into intimate contact with the lives of the people.

The delta system - a maze of islets and channels through which these rivers discharge into the Bay of Bengal, is the largest in the world. An estimated annual sediment load of 2.4 billion tons is discharged into the Bay.

1.1. Soils and land use.

The soils resource could be divided into three major groups- flood plain, terrace and hill soils. The floodplain soils are alluvial deposits ranging from sandy soils deposited on higher ridges, silty clay loams on the lower ridges to silt clays, in the depressions. Fresh alluvium is extensively deposited closer to the rivers, while further away from the river, the older deposits exhibit properties beneficial to plant growth as a result of alteration due to soil forming processes.

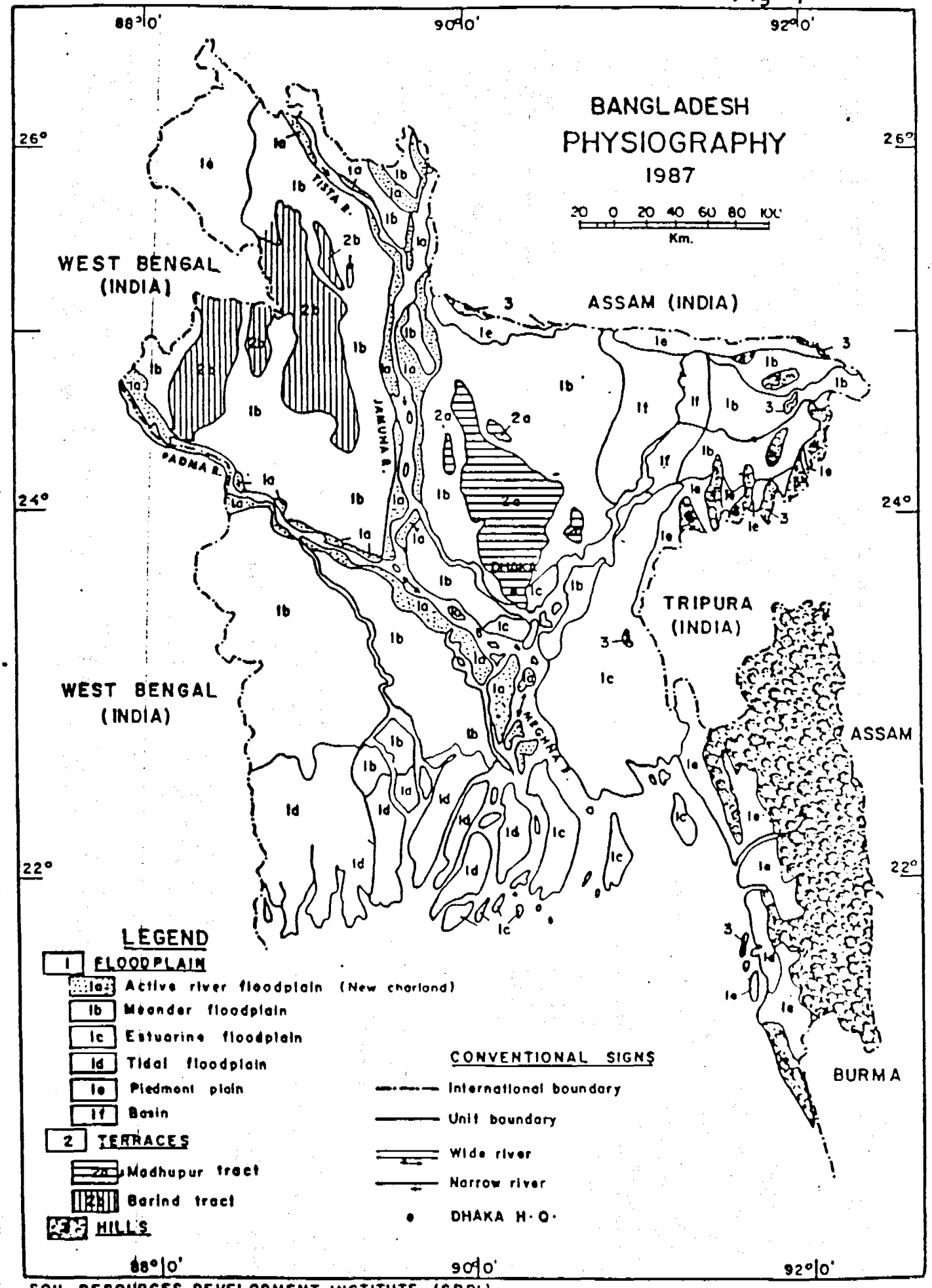
The hilly areas have mainly loamy soils of shallow depth, not suited for the cultivation of shallow rooted crops because of the poor water holding capacity.

A broad classification of present day land use is shown in figure 2.

Agriculture constitutes the largest single use of the land. There are about 7.5 million ha of land which fall into three agricultural classes from moderate to very good and could be cultivated throughout the year, some during both the seasons.

The expansion of the capital city and other cities and towns has brought about tremendous pressure on the land. Soil erosion, salinization, sedimentation, declining productivity and deforestation are

Fig: 1



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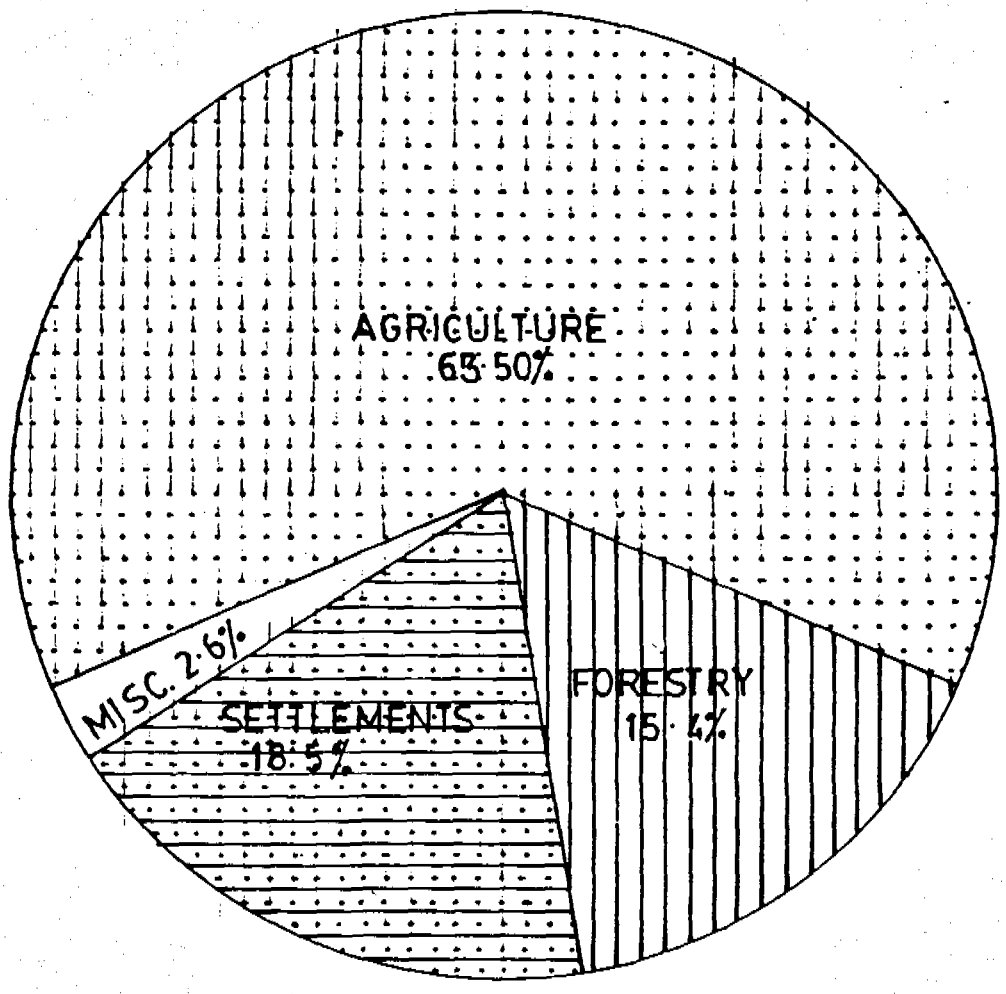

FIGURE : 2 : LAND USE PATTERN

some of the other problems associated with the soil quality and land use.

1.3 Climate

The climate is subtropical with marked summer, winter and monsoon seasons; the rainfall being the monsoonal, inter-monsoonal or cyclonic in origin. Eighty percent of the rainfall is during the monsoon months from june to september. The mean annual rainfall could be as high as 5,000 mm in the eastern tip of the country and the low in western parts. Cyclones are frequent during summer months. Sometimes the wind blows at speeds of over 125 kmph and create storm surges as high as 10 to 12 m in the coastal region.

The humidity ranges from about 75 percent in the winter to over 90 percent in the summer. The temperature is generally high; maximum ranging between 33 C and 35 C in the summer months. The mid winter is of short duration, from November until February; January being the coldest month, but the temperature rarely go below 8 C.

Global warming is a major concern now in Bangladesh as half of the territory has an altitude lower than 20 feet above sea level.

1.4. Forests and Wildlife

What would once have been lush tropical and subtropical forest over much of the country, has dwindled to 1.3 million ha or 9 percent of the total land area.

The natural forests are of three main types viz. Tropical evergreen/ semi over green, in the eastern districts of Sylhet, Chittagong Hill Tracts and Cox's Bazaar; moist/ dry deciduous in the central plain and the tidal forests in the coast line. There the Sunderban is the largest single tract forest (mangroves). These mangroves are facing tremendous pressure from various uses and signs of degradation are quite evident.

Zoogeographically, Bangladesh lies at the confluence of the Indian, Himalayan and South East Asia faunas and the wildlife had depicted a rich diversity. But in the face of mounting pressure from an estimated 115 million people, striving to improve their living standards, on a reducing per capita land resource, wild life has naturally been at the loosing end. Loss of habitat has been a major cause for its declining fortunes.

1.5. Water and Fishery.

Water, basic to all life, determine to a large degree the lifestyles of the people and the economy of the country. While water is abundant during monsoon months, it is in short supply during the winter months.

Sources of water could be grouped into two: surface and ground. The extensive riverine network has enabled the development of a traditional system of navigation.

Flooding is an annual feature; its magnitude varying from year to year. Due to the flat terrain, storage of water in multi-purpose reservoirs is

not possible and the monsoon waters have defied control over the years. In fact the effects of manmade ecological problems in the water shed, are severely felt in the country,through which the Ganges-Brahmaputra-Meghna river system enters the sea. The fact that much of the river system lies outside the country, makes the task of flood control and resource utilization more difficult.

Ground water with an estimated potential of 12000 million cu.m, constitutes an important source and its rational development could be solution to the winter water shortage and permit higher productivity from the land.At present 80 percent of the population obtain its potable water supply from the ground water. so a rational use of ground water for irrigation is also necessary.

With the abundance of water, makes the fishery resource in the country one of the richest in South East Asia. The fishery can be classified into three main types- inland, coastal, aquaculture and marine.

1.6. Energy and Minerals.

Presently natural gas meets about 58 percent of the primary commercial energy, while 37 percent is from imported oil. Oil has been discovered in the northern areas of the country and efforts are underway to determine cost benefits of extraction.More exploratory geological surveys are also being carried out to identify newer deposits of energy rich minerals.

More than 80 percent of population still depend on biomass for their daily needs.However use of agricultural residues and dung cause concern as the productivity of farm steadily diminishes when the organic material is diverted elsewhere. Therefore the possibility of expanding the use renewable sources of energy, e.g. solar, wind and tidal current receiving attention.

As regards to stock of other minerals; these include limestone and coal. But coal has not been yet extracted.

1.7.Demographic pressure and man made pollution

The country finds herself burdened with a large population, growing unemployment and under employment and a gradual eroding of the physical qualities of life which dictates indiscriminate use of natural resources for survival.

Domestic pollution from sewage comes number one to the water resources. For which in rural Bangladesh, poor sanitation is the major cause of diarrhoea . This single disease largely cause for high children mortality rate prevailing in the country.

Moreover residues of fertilizers and pesticide are also causing added problems to the water bodies.

Industrial pollution is not yet severe as the industrial sector has not yet assumed a large dimension but pollution is prevalent . Very few

industries have their treatment facilities. So, from almost all the industries, untreated wastes are directly discharged into the river or nearby water bodies.But as the rivers in Bangladesh are quite large and in monsoons it rains heavily,it helps diluting the pollution load and carries into the sea.

Atmospheric pollution is still at low level. Only in major cities it is causing some concern out of vehicle exhausts.

2. Ecological Concerns

2.1 Population- resource ratio

Population growth is the most important constantly changing factor in the ecological equation affecting the demands on the natural resources of Bangladesh. Greater number of people require more food production,more energy, more water, more fish and more land.

2.2. Hydrological situation

Next to population the most important variable affecting the environment in bangladesh is water.The ecological significance of changes in water region can be traced to agricultural production, fisheries production, desertification, health, forest destruction, domestic and industrial disruption.

Dams have altered the hydrological flow. The Farrka barrage in India has reduced dry season flow in that portion of the ganges which flows through Bangladesh by more than 50%. Embankments, road construction,drainage, channels, river training and river closures have all changed the normal flow patterns.

Reduced water flow in the major rivers during the dry season reduces the pressure at the salt water interface along the coast.Salinity in the south-western region has increased significantly in the dry season in recent years following the reduction of the ganges flow.This has already resulted ecological imbalances in the mangroves of the Sunderban.

With lower dry season flows, there is less pressure which is also counteracting landward migration of salt water into underground aquifers in the coastal areas.

Recent recurrent floods followed by droughts indicates the sign of extreme hydrological situation in Bangladesh.

2.3. Natural calamities.

Natural calamities in themselves are not indicative of the stable state of affairs in respect of specific environment. Therefore the environment problems of Bangladesh came under sharp focus pursuant on the severe floods of 1987 and 1988 and several other natural calamities of the recent past including the cyclone and tidal surge at Cox's Bazaar,Chittagong on 29th April 1991. which damaged Bangladesh beyond measure. It has been now a battle between man and nature in which nature has the upper hand because of inadequate protection measures against such onslaught.

2.4.Global warming consequences.

Widespread apprehension of inundation of vast coastal area of the

country due to speculated sea level rise because of much talked green house effect has aroused a serious concern to all Bangladeshi people.Woods Hole Oceanographic Institute of the United States of America made long term projections of the relative rise of sea level in the Bengal delta will range from 0.8 to 1.5 m by the year 2050.The corresponding rise by the year 2100 will range from 3.4 to 4.6 m. displacing 30 to 40 percent population in the Bengal delta, inundation of 26 to 34% of the habitable land and eliminating 75 to 85% of the mangrove areas including the Sunderbans.

In such a dreadful situation a projected 140 million people by the year 2000 will further exacerbate pressures on the very limited resources base.

2.5.Other concerns

There are a number of other conditions within Bangladesh which are also causing serious concerns. These include; soil quality deterioration, encroachment of forest land and signs of desertification in northern parts of the country.

3. Conclusion.

Environmental problems which Bangladesh is facing now are mostly global and regional in nature.These require global and regional approaches in solving them.

There are also conditions within Bangladesh and to face that chellenge the governmental efforts are directed towards population control, poverty alleviation,reforestation pollution control etc. with ultimate goal of sustainable development.

In the above context the country's heavy dependence on the natural resource base : for agricultural development, development of source of energy within the country and the current effort at greater industrial growth naturally has set the stage for planner to pause and take a hard look at the road ahead and how best it could be traversed in the interests of sustainable development.

Seminar on
Bangladesh Disaster: Issues and Perspectives

Ecology and the Bangladesh Disaster

W. van Vierssen

IHE

3rd September, 1991

ECOLOGY AND THE BANGLADESH DISASTER

On the ecological profile of Bangladesh and the sustainable use of its natural resources.

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ABSTRACT

The environmental characteristics of Bangladesh are described in terms of climate conditions, soil and ecosystem types. Less than 15% of Bangladesh is covered with forests of which the largest part consists of mangrove forests. Inland forests have been cut mostly.

The monsoon dominates the cycle of flooding and receding water in the inland. The cultivation of crops and capture fisheries are alternating sources of livelihood in the floodplains. More than 50% of Bangladesh is affected yearly by floods. As a consequence, floodplains play an important role in the capture fisheries of Bangladesh. Up to 75.9% of the annual harvest comes from inland fisheries and 23% from marine capture fisheries. More than 65% of the inland capture fisheries depends directly or indirectly on the floodplain. Agricultural practices and fisheries are closely linked in Bangladesh. It is suggested to integrate capture fisheries and agricultural activities, since they both are largely influenced by the flooding regime.

The concepts of ecoengineering are recommended as a framework for the development of natural resources in Bangladesh. Ecotechnology is based on the self-organising capacity of ecosystems at low levels of external energy inputs.
It is suggested to explore the possibilities to integrate a number of ecotechnological approaches in agriculture, fisheries and forestry.

INTRODUCTION

The cyclone and tidal surge which severely inflicted upon Bangladesh on the 29th of April 1991 was a harrowing experience for all who were involved. The number of casualties was high (approximately 150,000) and the event will certainly affect the lives of many during the years to come. The occurrence of random cyclones, tidal bores and recurrent annual floods is not abnormal in this part of the world and has to be accepted as a natural phenomenon. This does not mean that we should accept the situation in which people suffer from the consequences to such an extent as in April. It will be a tremendous challenge to minimise the direct effects of such events, but we indeed should do our utmost to accomplish this. However, there are a number of man-induced changes in the environment that even exacerbate the present risks in Bangladesh. The steadily increasing concentrations of so-called greenhouse gases in the atmosphere will probably cause a dramatic sealevel rise in the Gulf of Bengal of 0.8 to 1.5 m by the year 2050. The predictions for the year 2100 are even more dramatic; a rise of up to 4.6 m is expected to occur and for Bangladesh this means that about 40% of the population would become displaced.

Another serious problem is the shortage of water during the dry season. All sorts of hydraulic works have changed the hydrology of large areas during the last decades. Dams are designed to benefit people, but

many experience that this is not always true. The Farakka Barrage in India is believed to reduce the water flow in Bangladesh during the dry season with 50%. On top of that, salt intrusion in areas at the mouth of the river becomes a serious problem.

Further, the population in Bangladesh is growing and with a projected population in the year 2000 of 140 million, daily life is expected to become extremely troublesome. The most basic needs such as firewood, clean water and proper nutrition will definitely not be satisfied for most of them. Even at present, 70% of the population suffers from rampant malnutrition.

Looking at these facts, one could be tempted to throw in the towel and conclude that there are no ways to escape the misfortunes brought to the Bangladesh people.

It is quite obvious that some of the phenomena mentioned above will be very hard to control, however, we should try to concentrate on that what could be possibly done to improve the living conditions of the Bangladesh people.

In the process of trying to accomplish this, it is absolutely necessary to recognize the importance of the ecological boundary conditions. Without doing that we will find out sooner or later, that we overestimated (or maybe even ignored) the carrying capacity of our living environment.

We may ask ourselves how the environment of Bangladesh could serve its inhabitants optimally and how we could use it in a sustainable way. The present paper will briefly summarize some of the ecological characteristics of Bangladesh with emphasis on the lowland areas. Moreover, I will try to identify ways to develop its natural resources sustainably and indicate what kind of future activities would be beneficial to reaching this goal. Within the present context I can only touch upon these subjects briefly.

NATURAL CONDITIONS

Climate and Soils

The climate is warm (average maximum 20-40 °C, minimum approximately around 0 °C) and humid and is characterized by a clear seasonality; a hot summer from March-June, a hot humid monsoon period with heavy rains from June-October and a relatively cool and dry winter from November till March.

Low-lying flat areas dominate Bangladesh. Only in the north-east and southeast, hilly areas occur. The rest is lowland. These lowlands are dominated by the rivers Padma, Ganges, Jamuna, and Meghna. Most of the lowland soils are either old alluvial soils, recent alluvial soils or coastal saline soils. The alluvial soils are rather poor in nutrients and this is one of the reasons that agricultural productivity, on which 70% of the population directly depends, is low.

In coastal areas, where mangrove forests once dominated the transition zone between land and water, soils contain large amounts of sulphide.

Forests

Originally, Bangladesh was characterized by 3 types of forests. In Chittagong and Sylhet the wet evergreen and mixed evergreen forest occurred. This type of forest is usually dominated by *Dipterocarpus*, *Artocarpus* and *Pterygota* tree species. The understory of such forests originally consisted of bamboos.

A second type of forest is the moist deciduous sal forest, a forest dominated by sal, *Shorea robusta*. The third type of forest is the brakish water mangrove forest.

Unfortunately, most of the natural forests have been cut to cultivate the land. Officially, 15% of Bangladesh is said to be still covered by forests. However, most people admit that this figure is an overestimation. Most of the wet evergreen and mixed

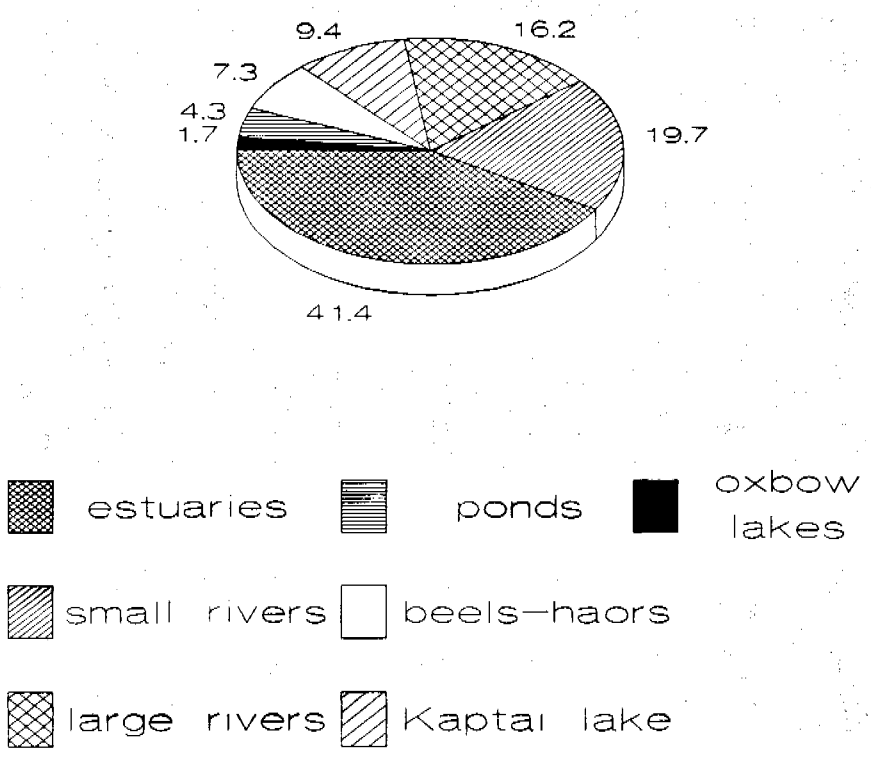

Fig. 1. Diagram of the distribution of different aquatic habitats over the total area of surface water in Bangladesh.

evergreen forests growing on the slopes of the hills are severely threatened nowadays by slash and burn (Jhoom) agriculture. The sal forests almost completely disappeared.

Coastal mangrove forests do still occur. Bangladesh owns approximately half of the Sundarban mangrove ecosystem (the rest belongs to India), but even these forests are reportedly plundered for their natural resources. Different environmental factors such as tidal movement, soil type, salinity and inundation frequency determine the zonation patterns of the plant species in these mangrove forests. *Avicennia* is a pioneering species growing at the outer fringes of the mangrove forest. It is followed by *Ceriops*, *Bruguiera* and *Rhizophora*. In areas which are above the high tide mark, *Excoecaria*, *Aegiceras* and *Heritiera* species occur. Since many mangrove timbers are termite resistant and are high calory firewood as well, one can imagine that these forests are severely threatened by over-exploitation. Not only the vegetation suffers from it. Once, many wild animals characterized nature in Bangladesh. More than 120 wild species of mammals, 578 species of birds, 124 species of reptiles and 19 species of amphibians occurred once. Many of them became extinct during the last century.

In the mangrove forests, the rare Bengal Tiger (*Panthera tigris tigris*) still occurs although in rather low numbers (several hundreds). The Javan Rhinoceros (*Rhinoceros sondicus*), the Wild Buffalo (*Bubalus bubalus*) and the Swamp Deer (*Cervus duvancelli*) became extinct.

Marine, intertidal areas

Beyond the mangrove forests, vast areas of the intertidal zone which are flooded twice a day are totally devoid of vegetation because

the natural conditions are too harsh. They may be devoid of vegetation, they do harbour many migratory birds, that feed on the benthic infauna (invertebrates).

The presence of migratory bird species in these areas is well-established. It means that these areas are not only locally important but that they are functionally linked to other areas in the world. Therefore, their importance has to be seen in a wider and international perspective.

Inland waters

The inland landscape is characterized by numerous freshwater habitats and agriculture. Associated with the seasonality in rainfall, flooding occurs in large inland areas of Bangladesh. In Fig. 1 it can be seen how the different aquatic habitats add up to the total area of approximately 13,500 km^2 of surface water (dry season). This is approximately 9-10% of Bangladesh. However, during the monsoon, more than 50% of Bangladesh is flooded or affected by the floods, making the floodplain a very prominent semi-aquatic habitat category. It is also interesting to know that there exist approximately 800,000 ponds which are partly being used as fish culture ponds.

Most of the land is cultivated and even inundated lowlands are used for agriculture when they are temporarily dry (during winter). Major crops are aman rice and jute during the monsoon period and boro rice, potatoes and vegetables during winter.
Although definitely a nuisance and many times even a threat to people, the floodplain clearly plays an important role in the food supply of people. It has to be realized that 55% of the annual protein intake comes from fish. Many people in Bangladesh spend at least some time on fishing (capture fishery). It has been established that 73% of the households undertake some sort of fishing activity. Now, looking at the data in Fig. 2, we can

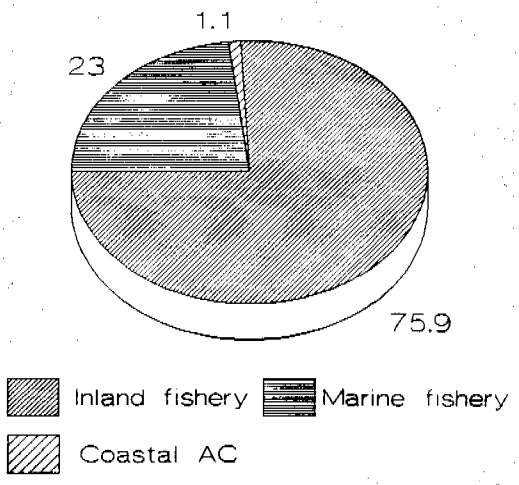

Fig. 2. Distribution of total annual fish harvest over various types of fisheries. AC=aquaculture.

see that almost 76% of the annual fish harvest comes from freshwater capture fisheries. From Fig. 3 it becomes clear that floodplains are equally important as rivers as far as the harvest is concerned.

Knowing that many young fish feed in the very productive floodplains during their earliest life-stage, it is not surprising to see that in fact 68% of freshwater capture fisheries depends
on the river and its associated floodplain.

A central role in northern Bangladesh is played by the haor-beel system. A haor is a bowl-shaped depression between the natural levees of a river. They may contain some water throughout the year. A beel is a depression in an area which mostly contains water throughout the year because it retains the water after being flooded during the monsoon. The part of the beel surrounding the central and deepest part acts as an important feeding ground for the young fish. It may dry up in the course of the dry season, but has been able to support the young fish during their early stages. Boro rice is cultivated in the emerging lands when the water levels drop in autumn. There has been quite

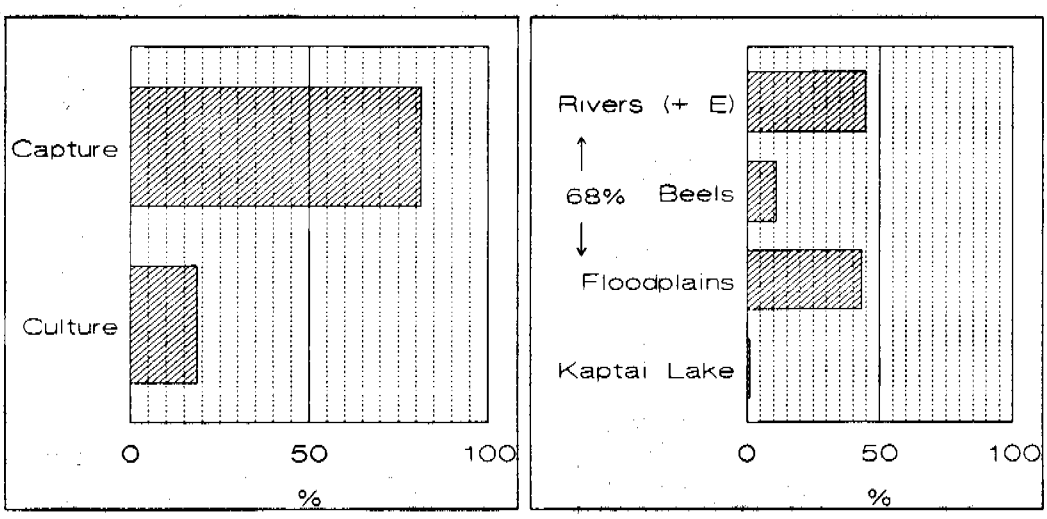

Fig. 3. Sources of freshwater fish. Left: cultured vs. capture fisheries; right: aquatic habitats. E=estuaries.

some environmental stress on these aquatic ecosystems recently. As a result, dense aquatic vegetation has declined over the years. It is known that up to a certain limit, a positive correlation exists between the presence of submerged macrophytes and fish productivity.

ENVIRONMENTAL CONCERNS

It is quite obvious that the dense population of Bangladesh largely determines the landscape characteristics nowadays. As has been stated before, deforestation has taken place on a large scale. The inland (floodplain) forests have been cut to give space to agriculture and aquaculture (fish-farming). This is one of the reasons why the situation as far as the availability of firewood is concerned is very alarming.

Further, flood control, drainage and irrigation (FCDI) have had adverse effects on fisheries. As explained earlier, capture fisheries production largely depends on the availability of the floodplain for supporting the young of the year fish.

FCDI seriously reduces the floodplain size during the monsoon. This may inhibit the migration, breeding and feeding of fish. The total surface area of freshwater may also shrink because beels and haors are not reached anymore by the floods. Moreover, barrages in rivers may disrupt the migration of anadromous fish (*Hilsa*) and prawn. This means that in addition to the clearly beneficial effects of FCDI practices, they adversely affect capture fisheries. The submersible embankments that have been designed to protect boro rice from early flooding were expected to minimise such effects. However, there is clear evidence, that the timing of spawning may still be disturbed by them. It is estimated that in the year 2005 capture fisheries production will be 15% lower than that of 1984 because of the loss of floodplain area to irrigated agriculture.

Apart from the so-called physical pollution of the aquatic habitats, the growing population causes a growing chemical pollution of the aquatic habitats. It is quite understandable that in many cases, the haor, baor, beel or pondwater is used multifunctionally. However, household purposes can be quite conflicting with fisheries purposes. Manuring a pond to increase fish-

production is not always compatible with a drinking water function.

Increasing industrial activities may exert another stress on the aquatic environment. Especially during the dry season, the available water volume shrinks and together with the growth of industrial activities, pollution in inland waters is expected to grow considerably.

In the coastal zones of Bangladesh, many mangrove forests have been transformed into shrimp culture ponds. Shrimp culture can be very profitable. Especially on export grade shrimps (*Penaeus monodon*, *P. indicus*) good profits can be made. The fry to stock the cultures used to be collected in the surrounding mangrove forest area. This had to be done because shrimps do not reproduce in captivity. Fry used to be readily available since young animals spend their early life in the mangroves and only move to deeper waters when they grow older. This means that the sustainability of the traditional culture method largely depends on the balance between pond area and mangrove area. However, with the expansion of more developed aquaculture technologies, there has been a growing demand for local fry as well as mangrove area.

To balance the loss of mangrove area and to test the hypothesis that mangroves protect the shores from erosion and people from the immediate dangers of cyclones and tidal bores, mangrove plantations were set up. However, it has to be tentatively concluded that mangrove trees only successfully establish themselves where the coast has stabilised and that mangroves only reinforce this stabilisation.

However, including mangrove plantations in the development of polders may be very profitable, since the plantations may provide wood (for fuel and construction material), act as wind break and protection against waves, but may also benefit wildlife and may provide feeding grounds for young fish and shrimps.

SUSTAINABLE DEVELOPMENT AND ECOTECHNOLOGY

From the above it clearly follows that any large scale activity to develop a specific natural resource in Bangladesh is likely to affect the availability of any other natural resource. Controlled by the flow of the water and thus by the ways these flows are managed by man, nature provides the basic living conditions to the people of Bangladesh. People largely depend on what nature locally provides. Therefore, any future efforts to raise the living conditions for the people of Bangladesh should be based on a proper analysis on how to optimise nature's contribution to that goal.

The approach should be that we should try to design human society with its natural environment for the benefit of both.

To develop such approaches is the task of people working in the field of ecological engineering and ecotechnology, who should work in close cooperation with civil and agricultural engineers as well as sociologists.

Human beings have to be considered as a part of nature in stead of apart from nature. Especially in Bangladesh where many resources are limited this approach could be optimally suited to develop natural resources. Ecological engineering aims at manipulating nature in such a way that only small amounts of supplementary energy are needed to control the system and in which the main energy drives are still coming from natural sources.

The main energy drive in Bangladesh is clearly the flow of the water.

When we look at the problem of pollution we see that the traditional engineering approach to solving it is the sanitary engineering. This field became environmental engineering in the course of the time. Both require quite considerable inputs of additional energy to be successful, a prerequisite not demanded by the eco-engineering approach. Therefore, ecotechnology-based environmental management is possibly more appropriate

than environmental engineering in situations where energy is scarce. In fact we make use of the self-organising capacity of ecosystems and minimise energy inputs.

The above may easily daunt engineers, who have been very successful in the field of environmental sanitation when energy was not a directly limiting resource. However, the analogy between agro-ecosystems and water resource ecosystems is obvious. When we look at the 4 most important interconnected system properties, productivity (output per unit of input), stability (constance of productivity), sustainability (ability to maintain productivity in spite of major disturbance of the productivity) and equitability (evenness of distribution of the water resource ecosystem among the actual or potential human beneficiaries) we see that very often there are significant trade-offs between them. History shows that when productivity is very high, sustainability and equitability tend to be low.

Especially in a situation in which external resources are limited any plan for development should contain a proper analysis of the trade-offs between these systems properties.

In my opinion this means that priority should be given to an ecology-based environmental technology in Bangladesh. I think that the ecotechnology application in the field of environmental management could be very rewarding in such a situation.

For the development of agriculture this means that its benefits can only properly assessed after taking into account the interest of e.g. capture fisheries. For planning energy production it means that we should look for ways to optimise nature toward this goal. One could e.g. incorporate the growth of marsh plants in agricultural schemes to satisfy the needs for more fuel for heating. The results with a marsh plant such as *Cyperus papyrus* in Africa are very promising in that respect.

The use of submerged plants as fodder or green manure as well as the use of floating plants or even whole wetlands for domestic and even industrial waste water purification are other examples of exploiting nature in an optimal way.

The speeding up of sediment accretion (e.g. prior to empoldering) by planting selected species is also feasible. In China good experience has been build up over the last decades with *Spartina*, a species introduced from western Europe.

In all cases, nature has to do most of the work because we want to minimise the energy input by man. When we define productivity as output per unit of input it may even not be low at all in cases in which nature organises itself at the ambient conditions shaped by man. In cases when very vulnerable plant and animal species or even whole ecosystems are risking extinction because of man-induced environmental degradation, it may be wise to protect them in nature reserves.

However, it is inevitable that we start to look for ways to integrate man and nature in a more balanced way. It just means that we have to start looking for ways to get as much out of nature as possible by making use of the major natural driving force. However, we may bring an ecosystem in such a state that it becomes very efficient (=highly productive), it does not mean that we do not have to pay a price for safeguarding appropriate levels of stability, sustainability and equitability.

Therefore, it does not mean that there are no longer limits to population growth. It is quite obvious that the environment in Bangladesh will definitely not be able to support all its people when there comes no end to the growth of the population. What we could try to establish is the optimal use of the environment, taking into account the systems characteristics mentioned earlier.

HUMAN RESOURCES MANAGEMENT

To develop environmental management strate-

gies within the framework as indicated above, it would be necessary to have the disposal of a group of well-trained environmental scientists. To understand the functioning of nature in Bangladesh very specific knowledge is needed. After screening the international literature we have to conclude that Bangladesh is quite underrepresented in that respect. In order to be able to take up the task of developing its own strategies of sustainable development of the environment it is an absolute necessity that Bangladesh disposes of more qualified environmental scientists.

CONCLUSIONS

On the basis of the information as it is summarised above, we arrive at the following conclusions.

The natural environment of Bangladesh is dominated by the hydrological conditions. The natural flow of water is largely controlled by man. Models to describe the flow of the water as linked to environmental conditions such as the topography, the morphology of a river and riverine areas, rainfall distribution, are available and are in fact no constraint for further development of the water and agriculture sector.

However, hardly any models are available which describe the consequences for agriculture, fisheries or the living environment of major changes in flow pattern. Since man is so closely linked to nature in Bangladesh, this relationship is extremely important but is not easily to describe. The boundary conditions to develop such models should preferably be derived from the concepts of eco-engineering. This technology derives the optimal use of the environment from the self-organising capabilities of ecosystems at low levels of external energy inputs.

Within that conceptual framework, the flow of the water should be controlled in such a way that both agriculture and capture fisheries are benefitted. Further, in coastal zones, protective measures should be taken to conserve mangrove ecosystems and traditional fisheries. Land reclamation and afforestation programmes should take place as an integrated activity.

Fuel production for cooking should be taken up as an integral part of land use policies. Moreover, waste water management should be an integral part of agriculture and fisheries because nutrients are limiting productivity and uncontrolled waste discharges have adverse effects on ecosystems.

There is not enough expertise presently available in Bangladesh to develop integrated environmental management guidelines based on local characteristics of the environment . A first step to improve this situation would be to support human resources development in this sector.

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Seminar on
Bangladesh Disaster: Issues and Perspectives

Floods in Bangladesh: Prospect for make a living for the poor Majority

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(Participant in M.Sc. programme) ISS

3rd September, 1991

FLOODS IN BANGLADESH:
PROSPECT FOR MAKE A LIVING FOR THE POOR MAJORITIY

A.S.M.GOWSER REZA.

BACKGROUND:

Bangladesh,a deltaic region of South Asia is criss-crossed with about 230 rivers that have a linkage with the upper riparion country, India. Due to the deltaic location of the country associated with high rainfall concentrated in the summer months and the onrush of water from outside the country, Bangladesh is flooded almost every year. The intensity, coverage and timing of flood, vary from year to year, but some flooding in some parts of the country every year is almost certainty.

There are four basic types of floods:Flush floods, standing floods, sea surges and riverine floods.The riverine floods which occurs in Bangladesh when river overflows its normal streambed because of heavy rains anywhere in the river watershed. The alluvium the river deposit is the key to the delta's richness. In these rich soils agriculture flourishes. Even a small amount of land can produce enough crops for a society to prosper. Not only agriculture fish flourishes in both the rivers and the discharge zone. A riverine environment shapes the daily life of the society. Agriculture and aquaculture dominate the economy. The people basic diet depends on abundant sources of water and the flora and fauna within.

FLOODING AND IMPACT OF FISH REPRODUCTION:

As the economy of Bangladesh is mainly based on agricultural output, it is fishery which is inseperable and inevitable part of its agricultural and economic activities. The deltaic environment of Bangladehs is extremly rich in fish resources 300 aquatic species. The fishery resources of the country contribute substantially to the economy. It plays an important role in providing nutrition, employment and livelihood to an estimated 1.6 million Bangladeshi full time fisher folk community. Besides, it contributes to substantial foreign exchange earning on a regular basis.

Breeding and reproduction of almost all the inland water fish and prawn species are tightly bound to the sequence of annual flooding. The rise of water level in rivers and streams triggers phisiological changes leading to sexual maturity of fish inhaviting the flowing rivers. Similarly early mansoon rainfal in combination with early enundation of flood plains stimulate fish in beels and other static water bodies to become sexually mature. As soon as connection between the beels and flowing rivers are restored by rise of water in the rivers, sexually mature river breeding fishes such as the major coups from beels migrate to the rivers through linking canals. In the rivers, the major carps undertake upstream migration, of ten to a long distance seeking their spawning ground. Some species of inland water fish and prawn make a downstream migration to reach their spawning grounds in the estuaries. One such spe-

cies is giant freshwater prawn or golda chingree. Adults of this prawn make their downstream spawning migration into the estuaries between January and July and breed there. Their fertilized eggs undergo early development in the saline or brackishwater environment. On attaining juvenile stage, they migrate upstream into the freshwater environment in the rivers and into the inundated floodplains where they feed and grow rapidly.

BENIFITS OF FLOODING:

A riverine environment promises perennial floods and the riverbank societies adopt to survive and most after the disaster appear if floods did not occur periodically. The benifits of floods for outweigh their negative effects in Bangladesh, the barsha festival celebrate the flood season and when waters cover some areas people take their boats and venture out of their villages to trade and renew commercial and familial links. In case of Bangladesh flood is a fortune to the majority of the rural population are poor. During the flood time the poor enjoys the equal access to the water, can provide protien for their children and make a good living over fishing, collecting vegetables and other aquatic resource i.e. snails clams and turtles pontry rairing, lime making and for their own subsistance. Integrated farming and fish culture in the flood plain environment contribute an improved livelihood of the rural house holds.BARC studies confirmed the high returns per hectare from combined livestock, aquaculture and crop. Flooding in riverine environments often increases crop production especially when natural varities are grown. After the massive 1988 floods in Bangladesh, the forecast was losses of 40 percent of the normal harvest but the country actually produced 10 percent more rice than normal, other staples also showed higher yields (USAID 1989).Now I like mention the positive aspect after a severe flood.

* Floods deposit rich silts and replenish top soil with nutrients vital to agriculture. After widespread flooding, there is almost always a bumper crop and the next harvest season that partially makes up the losses from flooding.

* Floodwaters carry nutrients that stimulate fish development and increase the number of fish. Floods may restock fish in isolated ponds, lakes that do not flow year round.

* Floods improve the natural varieties of flood grains.

* Water left standing in fields may help recharge shallow aquifers. Floodwaters may replinish water supplies in lakes and ponds.

* Floodwaters purge the rural environment. This can have a major impact on public health. Some observers have noted that diarrheal diseases usually dealine after widespread floods.

* Floods deposit sandbars that can be seeded to form barrier islands. These can be used to expand land area and as barriers against tropical storm surges.

* Floods deposit silts that can be mined. At a minimum, sand can be collected for construction. More important, the mud can be used for topsoil, construction and landfill.

* Floods can be used as a source of energy.

FLOOD AS DISASTER:

Flood gives rise to many problems. They damage crops and takes lives. They often lead to property loss, a cummulative increase in personal and national debt, the increased incidence of certain diseases soil erosion, the siltation of rivers and irrigation canals and damage to and the destruction of public infrastructure, roads, railways and other transportation.

Since flooding usually occurs annually in Bangladesh what seperates the normal and uneventful flood from a disastrous flood usually by the magnitude of the flood, measured by the number of people killed, the extent of damage (Physical and economic), the incidence of increased diseases and other factors. But the disasters identified differently by the different groups of people of the same society. For landless agricultural labourers, a destructive flood is one that reduces their job prospects or prevents them from going elsewhere in search of work. For non-farm villagers, a flood is defined as water penetrating and damaging commercial building, water penetrating and damaging houses or water preventing the transport of goods. Urban people define flood similarly to non-farm villagers, adding that when floods occur normal business is disrupted, schools are closed for long periods, food and fuel hard to get, and basic servises (water supply, electricity and communications) do not function for long period. Government usually classify floods disastrous according to the level of government infrastructure that has been damaged and destroyed and the number of houses and communities affected. But most rural people define flood " when waters rose faster than one could take preventive measures", implies that if warning could be given in time, floods may not be so destructive, response of indegenous local flood preparedness.

CONFLICTING ISSUES ON MITIGATION:

For mitigation of any flood their are two options either " flood control" or "living with floods". Usually the flood control program supported by the urban dewlers, non farm village workers, technical communities as Engineers, construction firms, builders, government ministries, large land owners, the group those who will be harmed by flooding or those who will benifit from flood control works, have the strong voices in the policy planning process. On contrary small subsistance farmers, fisherman, brickmakers, sand vendors, environmentalist, ecologist and development workers, they are less powerful. In case of Bangladesh to deal with the annual flooding the engineering solution lobby influenced the government to undertake numerous flood control and drainage (FCD)

and Flood Control, drainage and irrigation (FCDI) projects all over Bangladesh. These projects were completed with very little environmental and social considerations and often with faulty design. This proccess has been changing the aquatic environment of inland water bodies, adversely affecting inland water natural fish productions both in quality as well as species diversity. Under the flood protection scheme 2.0 million hactres of currently flooded lands would be flood free by the year 2005. Thus by the year 2000 an estimated 110,000 tons of loss of fish harvest may occur.

RURAL POOR AND THEIR DEPENDENCE:

Historically the poor people restored to exploiting common resources to make a living as their access to own resources are limited. The decline of common resources have thus adversely effected the welfare of the rural poor. The flood plains provide them with the only harvestable common resource during the flood season.

Because surface water is often a common property resource (CPR) which is equally accessible to the poor, rather than being privately owned like land(where access is skewed towards the rich), the productivity of these common property resources (CPRS) has been eroded more than if they had been privately owned. This depletion of CPRS raises a number of problems which are linked to equity issuses:

(i) The reduction of harvests from capture fisheries in the Atrai, Sylhet, Gopalgonj, and Barishal Basin. Thes capture fisheries still engage over 50% of members of rural households (farmers, landless) in the lean season. The captured fish resources provide much needed nutrition, particularly protein and cash income for the family.

(ii) The decline in aquatic life, like snails, turtles and clams. These are gathered for subsistence by the poor and they also use them for poultry rearing and lime making.

(iii) The loss of water in the form of soil moisture which is necessary for rich production by poor farmers who traditionallly augment their nutrition and income by growing local boro near inland water bodies in the dry season in non-irrigated areas.

(iv) The loss as result of obstruction and declines of inland water transport by traditional means. The main loosers are the part and fulltime boatman, a traditionally poor group.

(v) Traditionally, women and children used to participate in the flood plain common resource harvesting. Their decline therefore disproportionately effect them.

FLOOD PLAIN AGRICULTURE:

Eighty percent of cultivated land may be regarded as flood plain in Bangladesh. The rivers and ground waters of the flood plain have been manipulated to provide irrigated

agriculture. Bangladesh has extremely rich fish resources with over 300 aquatic species.These not only help our environment but contribute to improve livelihood of rural households. BARC studies report that the very high return per hectare from combined livestock (ducks), aquaculture and crops fare extreamly well vis-a-vis anly crop cultivation. Fisheries also have a large export, the growth of the fish exports from $ 19 million in 1977-78 to $ 140 million in 1987-88, testifies that.

Aquaculture resources has already been drastically reduced in certain areas as a result of construction polders, dams, blockages and embankment. If such ways of prevention continues, both fish and aquatic species will be extinct altogether. "Compensatory hatcheries and nurseries would require considerable additional investments, and could do little to compansate for the loss of anadromous and catadromous movement of many fish such as hilsa and prawns" (BARC, 1089).

Agriculture in Bangladesh is to be viewed from a holistic, i.e., farming systems and income generation should be accorded its due share of priority.Therefore, development strategy, particularly water resources management in Bangladesh needs to look away from the conventional wisdom and technology of environmental manipulation. Rather, it should concentrate on harnessing the existing resources, thriugh minimum interference and sustainable procedures to optimize the production possibilities. This will not only be economically efficient but also socially acceptable natural resource management policy. The future of millions of rural poor people in Bangladesh indeed depend upon careful management of the only common and open access resource in Bangladesh, i.e., the flood plains. Their destruction and degeneration would result in exacerbating the agonies of poverty in Bangladesh. Again, if these natural resources are properly and equitably managed, the welfare of the rural poor, who are the majority population could be maximised with minimum investments and effords.

CONCLUSION:

There is an strong consensus evolve from the evaluation of different (FCD) and FCDI projects) that technically and economically viable projects have failed to meet the social equity and the development needs of the very communities that the projects set out to help.

For the mitigation of flood the development agencies need to have clear and well thought out policies and strategies for the majority of society are rural poor in case of Bangladesh. Therefore, the projects those are "socially feasible " will ensure the distribution of benifits equally should be considered.

In conclusion I like to mention that flood in Bangladesh are a reality that in a sense have to be accepted. However such acceptance should be guided by the concious principle of

(1). maximising the benifits and minimising the sufferings.

(2). The riverine floods occurs more often in Bangladesh are the most difficult to control and the ones for which a

"living with floods" strategy is most feasible. (CUNY F.C)

(3). and due to global warming Bangladesh and other south east Asian countries broad areas will be covered gradually by rising sea water level in the coming years.

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Seminar on

Bangladesh Disaster: Issues and Perspectives

Socio-Economic and Demographic Aspects of Natural Disasters in Bangladesh

Dr. Subinay Nandy

DDP, Bangladesh

3rd September, 1991

SOCIO-ECONOMIC AND DEMOGRAPHIC ASPECTS OF NATURAL DISASTERS IN BANGLADESH[1]

Dr. Subinay Nandy[2]

The very name of the present seminar suggests something which is widely propogated: Bangladesh is synonymous to disaster. Floods and cyclones have become a regular phenomenon causing enormous damage to the economy and loss of lives. We are getting used to the fact that discussions start about disaster when it hits and our activity virtually ends when the obviousness of the disaster gradually disappear. In today's seminar we have heard qualified statements and explanations about floods and cyclones. Their causes and possible steps to prevent them are also discussed. What we have heard so far deals mainly with the techinicalities of the problem and our task is to add to the human part of it.

What we call natural disasters are in fact natural hazards. This is not semantics but I mean it. Hazards become disasters when we fail to tackle them adequately and appropriately. Hazard like cyclone is completely natural. Floods and their severity however are to some extent controlable and man-made. To me the most serious disaster we are facing is the mass poverty. From the period of independance Bangladesh has received on average more than two billion US dollars per year in foreign aid. This in addition to the internal resources suggest that poverty is a problem not only related to scarcity of resources. Poverty eradication thus is importantly a matter of political will, determination and proporities. Disasterous effects of floods and cyclones are to be seen in that context and should not be treated in isolation.

In this presentation we would like to focus into the following aspects:

- Evolution of practices and organisations in managing natural resources, focusing particularly on control and use of water resources;
- Disasterous impacts of recent floods and cyclones;

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[1] Paper presented in the Seminar: 'Bangladesh Disaster: Issues and Perspectives', held on September 03, 1991 in Delft, The Netherlands.

[2] Socio-Economic Adviser, Delta Development Project, Khulna. The project is a joint programme of Bangladesh and The Netherlands under the Bangladesh Water Development Board. Views expressed are author's own and do not necessarily reflect the viewpoint of the project. The paper heavily draws on the materials of the seminar of the Flood Study Forum on 'Floods in Bangladesh: Bangladeshi views' held in January 1990, Dhaka.

- Possibilities of better organizational steps to face natural hazards more effectiviely.

1 EVOLUTION OF FORMS AND ORGANISATIONAL PATTERNS IN USE OF WATER RESOURCES

Historical evidences show that all countries in delta areas had tried to construct necessary infrastructure for flood protection, irrigation and drainage. The territory which is now Bangladesh was not an exception either. However, from ancient times it had its own specific forms and organisations for such activities. For convenience, we would divide them into the following three phases:

Pre British period

History gives quite elaborate description about use and management of water resources during the *Mughal* period. Rulers of *Mughal* and pre-*Mughal* periods were solely dependant on agriculture and related activities. Revenue from land tax was the main source of resources for the exchequer. In those days from one third upto half of the produce had to be given by the producers as tax. At the same time a significant part of these collections used to be spent on development of infrastructure for flood control and irrigation. In the middle ages the Turkish Sultans stressed excavation of ponds as one of the measures for retention of surplus water to be used later for irrigation. *Mughal* emperors on the other hand emphasized construction of dikes along the major rivers and planned excavation of canals etc.

Organisation of such works is the most intersting part for our purpose. During *Mughal* rule all these works were under the competence of a separate organization (*Poolbondi* or *Pushtbondi*). This department represented the *Jamidars* to the provincial rulers. Interestingly, regular maintenance of bridges, roads and other water related infrastructure was an important issue at that time. A group of field workers (*Pushban* or *Ostoprahari*) were responsible for checking the works and report to the *Jamidars* immediately of any eventual damage. The *Jamidar* in his turn would alert the concerned special village committee (*Gram Saranjami*) for taking necessary steps. The committee usully consisted of leading villagers and a number of volunteers and was responsible for execution of works ranging from re-excavation of rivers to construction, repair and maintenance of all water related works. Activities of the committee was controlled by the village administration (*Gram Panchaet*), comprised of elderly villagers. The system ensured that works were executed at different levels by local organisations. The central *Poolbondi* department was responsible for bigger works covering areas of more than one *Jamidars*.

Period under the British rule

Historical records provide information about two disasterous floods in the city of Dhaka in 1784 and 1787. It is explained that with the establishment of the British rule *Poolbondi* department was abolished. *Jamidars* were released from their responsibilities for organising works related to *Poolbondi* department. *Gram Panchaet* and *Gram saranjami* were also abolished. Role of beneficiaries were given out to hired contractors and eventually resulted into poor maintenance and late repair or construction of works. It should not however, be concluded that these were the only reasons for increased poverty in the then Bengal. Structural changes in tenancy relations and consequently social relations, geographical changes, population explosion, introduction of crops for external markets and other factors caused a serious setback to the then prevailing rural life.

Contemporary period

The system prevailing now in Bangladesh is a continuation of the system introduced by the British rulers. Here we need not go into the discussion about how the system works now a days. Only one comment seems justified: What we see now are engineering works and these works are often very weakly related to agriculture and socio-economic situation of the areas concerned. Flood control or issues related to use of water resources are more treated in the context of technical poosibilities and cropping patterns etc are designed to meet up these needs. Benfit:cost ratios are calculated basing on these parameters. However, the designed cropping patterns and other projected activities are adopted rarely or slowly and mostly they are adapted by the farmers.

2 DISASTEROUS IMPACTS OF FLOODS AND CYCLONES

During the current century the territory under Bangladesh was encroached by severe floods several times. Records of estimated material damages are available from 1954 and are as follows:

Year	Estimated damage (Million Taka*)	E F F E C T E D	
		Area ('ooo'sq.km)	Population (mln)
1954	1500		
1956	1580		
1962	600		
1966	1200		
1968	1100		
1970	20000	52	
1974	4000	83	30
1980	4500	52	20
1987	35000	65	20
1988	40000	98	50

Source: Elahi K.M., 1988. * 1 US Dollar = 36 Taka (approx)

Estimated figures on damages caused by cyclones are difficult to get. However, cyclones are more damaging in terms of taking human lives. The most recent cyclone of 1991 took about 500 000 human lives while the most damaging flood of 1988 killed 1600 people! Notwithstanding the overall severity, the incidence and impact of hazards are quite uneven. Southern part of Bangladesh suffers less from floods but takes the most of the cyclones. It is also notable and understandable that poorer groups suffer most.

To understand the possible impacts of any intervention in rural areas, access of different population groups to resources (particularly cultivable agricultural land) seems necessary. This also holds true to assess impacts of natural calamities on different farming groups. The average size of farm holding is about 1.4 ha. This might give an impression that Bangladesh is a country of predominantly small farmers. However in a situation of badly skewed land ownership pattern less than ten percent of farmers control about 50% of land. About 50% of farmers are landless or own only upto 0.2 ha. It is also estimated that about six million people, mainly belonging to the poorer category, live in areas along the main rivers and on islands in the river channels[3].There are quite interesting studies where it is shown how the structural situation with relation to ownership of agricultural land predetermines benefits of new projects and interventions to be reaped by only the better-off groups. On the other hand, in cases of natural calamities the poorer ones suffer most. It is understandable, since they have poorer and more fragile houses, have little cash or other resources to survive any crisis. Cyclones usually hit in April-May, when stock from the last harvest is empty. Floods occur in a period when poor farmers have used all their resources for just planted *aman* crop.

One survey in the catchment of Jamuna river showed that more than 60% of small farmers (cultivating upto 1 ha) have lost some land in erosion and flooding. More than 80% of farmers from the same group lost atleast one house in flood. Our experience with 1988 cyclone in Khulna area confirms these findings: As a result of severe cyclone (combined with water surge) for about four hours, 14 persons were killed and about 30% of the cattle population was lost. The cyclone killed a big number of dears in the Sundarbans and damage to mangrove forest was extensive. However, damage to housing was most obvious. Almost all the small farmers lost atlest one house.

I would not like to give details of the calamity that our country has seen during and after the cyclone of April this year. But I would like to mention few points which gives us hopes and aspirations:

- In many areas of the cyclone hit region farmers were found

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[3] Fred Pearce. The rivers that won't be tamed. *New Scientist*, April, 1991.

to start working in their fields in next few days after the cyclone hit;

- Many local intiatives came up in helping each other. Assistance from Dhaka and abroad started reaching the areas not earlier than seven days after the 'disaster'. Enormous human misery and sufferings could not stop those people from working on their own to grow atleast something for future months.

One could argue, should it not be the practice and rule that local level measures are encouraged more instead of bringing in materials from Dhaka only in the aftermaths of such happenings. It appears that in those areas investments in making high embankments can partially be diverted to construction of shelter places. These houses can in normal times be used as schools. We saw some such schools in cyclone-prawn areas but their number is quite low compared to the needs.

3 POSSIBLE ORGANISATIONAL AND INSTITUTIONAL STEPS FOE FACING NATURAL HAZARDS MORE EFFECTIVELY

After the 1988 floods, search for solutions of flood probelm intensified and has so far resulted into a *flood of solutions*. Now we hear about a new initiative and an ambitous Flood Action Plan (FAP) has been taken up with a wide variety of components. Reportedly people involved with this plan neither believe that the flood situation can completely be controlled (French option) nor do they advocate merely living with the floods in a helpless state of acceptance (USAID approach). They propose to keep the floods at a possible level of control (Control flooding)- possibly a rather unconventional strategy. It is beleived that allowing a tolerable level of flooding is beneficial to agriculture and fisheries. The programme intents to involve beneficiaries of the programmes in the upkeep and maintenance of various projects. Experts advise to change the main cropping season from monsoon to winter. This needs expansion of irrigation coverage using copious quantities of underground water, usually replenished each year by flood water. Even in irrigated areas, crop yields of cereals grown in winter are generally less than *aman* (grown in monsoon).

An important issue for designing any development project should be that they help the poorest group. We can indicate some possible implication of totally controlling annual flooding by making high embankments. The number of people depending for their livelihood on fishing is estimated to be about five million and fishing supplies about 80% of the country's animal protein[4]. Already by now natural stocking of *beels* (Wet depressions) are badly damaged as connection between the *beels* and rivers are cut off. If any new plan envisages further embanking of areas the situation would just go worse.

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[4] *Ibid*

A significant implication of flood control by embanking is loss of agricultural land under embankment and borrow pits, excavation of canals etc. Bigger the embankment more land you need. It is quite usual that people having land in the areas close to the rivers would suffer most from this. Generally these are the poorer ones. We have experienced such problems during construction of internal irrigation boundaries. It appears that to ensure proper irrigation to, say 50 hectre of land, about one hectre of land has to be given up. In many cases we tried to persue the beneficiaries of the construction to compensate the loss. But it does not work. We have all valid points to be worried that in case of even bigger construction projects a small group will have to give up the very little they have. The handful of social impacts studies envisaged under the FAP has yet to begain. Moreover, findings of these studies have so far hardly been used in designing actions.

Strictly engineering solutions are not giving envisaged results. We can mention the Coastal Embankment Project (CEP), implemented in late sixties and early seventies. The project in general has succeded in providing security to crops against tidal flooding (saline during dry season). However, lack of maintenance of structures and infrastructure has resulted into a situation where farmers even cut the embankments in some places to get rid of the logged water. We can mention the case of *Beel Dakatia* in Khulna, where about 70 000 ha of land have virtually become uncultivable because of drainage problems. In 1990 population of the area had to cut embankments and roads in several places to get rid of the water inside the polders. It is true that CEP has brought a lot of positive changes in the coastal areas of Bangladesh. But very high embankment has created a feeling of security provided by the state and initiative of the people are gradually disappearing. Expansion of settlement areas is a case under question. One survey showed that from 1952 to 1974 the population of the country increased by about 60%. At the same time expansion of settlement areas was about one percent. With construction of dikes the settlement areas extended indiscreminately to flat and low areas (without making high platforms). This could lead to catastrophic loss of life and property if, for any reasons, a polder embankment were to be breached during the flood season. In the field we have observed such situation. We feel that all Flood Control Projects should have a clearly spelt out programme to regulate land use and there should be practical legal means to enforce them.

It is certainly true that demographic changes have made management of extreme situations difficult. Nevertheless, we tend to believe that this is not the main cause. We started the paper with the history of resource management quite delibarately. A closer look at the way the *top* handles situations of calamity, clearly brings to the understanding that role of local people is virtually absent. As if all our duties are accomplished by distribution of relief materials. People gradually have become receipants only. Emergency reliefs are necessary but role of society does not end there. We have to aim at something not at all radical: people should have a more effective say and role in

decisions on development (this was the case in old time). If a flood control programme is designed, it should first be accepted that the project is agricultural development project. Relevant experts should have more decisive voice, at least at equal with the engineers. Construction of infrastructure should at one hand be to improve production and on the other hand can be designed as income generation opportunities for the poor. We have many such expamples. It is just a matter of replicating and applying them in a much broader scale.

In the foregoing discussions we tried to make some points of differnt factors which should be given adequate and due consideration in designing programmes aimed at *disaster* management. Concluding, the following issues are put forward to be considered in our future programmes. For easiness of our discussions we would group them into two groups:

a) issues concerning policy and institutions;
b) Issues to be considered in implementation.

a) **Policy and institutional measures:**

- A proper flood and cyclone warning system should be introduced. We understand that technically it is possible. Imams, school teachers, village administration leaders and other leading villagers should be involved in developing a network for transmission of any warning. Village administration should have clearly defined responsibilities in cases of emergeny and they have to be made accountable for their works. Organisations like *Gram saranjami* can be reintroduced for implementation of envisaged works. Memebers of these groups should be imparted training on rescue operations, primary medical assistance etc.;

- Legal mechanisms have to be included in the all development projects that land use is in line with the projected objectives. If embankments are constructed for agricultural development, unauthorised cuts for shrimp cultivation, for example, should be prevented. People in flood vulnerable areas have to be advised not to construct settlements in low areas;

- Crop insurance schemes need to be introduced. The system would maintain continuation of economic life in situations of crisis. This could be an interesting alternative to providing relief materials to the effected population. Agricultural land and houses can be insured for situation exceeding certain limit of flooding or damage by cyclone;

- All planned development programmes should be aimed at poverty eradication as one of the components. Conventional cost:benefit ratios in these cases may not always be attractive but this can help to some extent diverting fruits of such projects to resource poor population. Earth works in connection with construction can be executed through organised groups of landless and marginal farmers, instead

of contractors. In organising regular maintenance such groups (preferably women groups) should be involved. Embankment Maintenance Groups of women are successfully working in the Delta Development Project (DDP), BWDB, Khulna. Structure Maintenance Groups are operating in the Rural Employment Sector Programme (RESP) under the Ministry of Local Governments, Rural Development and Cooperatives in Faridpur, Madaripur and Kurigram districts. These experiences can be explored in designing new programmes;

- In all development projects soil scientists, agronomists, agro-economists and agricultural extension specialists should be given a more responsible role in identification, design, appraisal and implementation;

- Better coordination of long term and short term measures in connection with floods and cyclones are required. One coorinating body should supervise long term measures (like implementation of projects) and short term measures (like distribution of releif etc.).

b) **Measures to be taken up in short term during implementation of programmes:**

- Important structures and buildings like storage godowns, medical centres, schools, tubewells etc. should be constructed above the expected flood level and they should be strong enough to withstand any eventual cyclone;

- To meet emergency needs, small stocks of releif materials, like *Chira, Gur*, water purifying materials, rehydration materials (ORS) should be kept at local level. Local organisations should be made responsible for these stocks;

- The government has apparently planned construction of shelters-cum-schools in all areas with high risk of flooding and cyclone. The programme should be implemented with utmost priority. Construction of helipads in each Upazila is clearly an action of lower priority;

- **Alternative** crops, **tolerating late planting should be** spread through a better organised extension service. Bangladesh Rice Research Institute (BRRI) has introduced a new *aman* variety (BR-22) which can be planted as late as in September without substantial decline in the yield. Seeds of this variety should be made more easily available to farmers in cases of early flooding;

- Objections from those whose livelihood might suffer as a result of project implementation should be taken into consideration. New cropping patterns are to introduced in consultation with the farming community of the area. Again the skewed land distribution situation has to be kept in mind and not only a handful of farmers, controlling most of the land should be given attention to.