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FLOODS AND CYCLONES IN EAST PAKISTAN

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We shall all remember the disaster of the 12-13th November, 1970 for a very long time to come. Whether we were directly or indirectly affected by the event, all of us must feel very much concerned about the effect of the disaster. There is a feeling that these calamities are getting worse and more frequent and the question is frequently raised as to when something effective is going to be done to protect the people of the extensive coastal areas. It would, therefore, be appropriate to explain briefly what the problem is, what can be done, what is being done and, possibly most important of all, what cannot be done.

Located around the largest delta in the world, about 23,000 sq. miles of low-lying land, East Pakistan is subject not only to the annual drenching from a monsoon climate but, in addition, to the huge volumes of water and sediment coming down from the mountains in the north, to the tremendous power of the tides that surge in from the funnel-shaped mouth of the Bay of Bengal and to the vagaries of seismic activity that can cause immense physical change within a short time.

The Ganges and the Brahmaputra, which are amongst the largest rivers in the world, have their confluence within East Pakistan. Their combined flow, after being augmented by the waters of another big river the Meghna, passes into the Bay of Bengal through an expansive estuary. The drainage area of the three rivers covers 600,000 square miles but only 7.5 percent of this lies within East Pakistan. Unfortunately, these are no storage sites within East Pakistan that could assist in flood or low flow regulation. The problem is further complicated by the great magnitude of the peak flood flow (5 million cusecs or about twice the historical peak flow of the Mississippi river) and the enormous sediment load of the combined rivers of about 2.4 billion tons annually. The enormous transporting power of the Ganges and the Brahmaputra has resulted in major shifts of their channels in recent centuries. As the land slope is very flat, conditions for drainage are not favourable and the insufficient capacity in the river channels causes the flood waters to spill over their banks and inundate a large part of the country during the monsoon season.

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It is the characteristics of a delta that the rivers build up land with the passage of time. As the sediment-laden water spreads out over large areas its velocity of movement slows down to allow the suspended material to deposit. The land gradually builds higher and higher forcing the deltaic activity to move further seawards. This process does not stop at the coastline. A 'contour' map of the sea-bed in the Indian Ocean published in the National Geographic magazine sometime back, showed very clearly how the Ganges-Brahmaputra-Meghna delta was also forming continuously for many hundreds of miles into the Bay. If the water was removed from this area, it would look like a continuation of the coastal regions.

Superimposed on the flood effects caused by the nature of the incoming rivers, is the very prominent tidal cycle. Off the coast the sea level in the Bay of Bengal has a daily range which reaches its maximum during the highest tides of the year. As the tide rises, water waves flow in towards the land and force their way up the channels and khals of the dense drainage network. They expend their energy while they travel so that the tidal variations are gradually reduced until a line is reached where the range is entirely contained within the natural banks of the channels. However, this is not the case when a cyclone disturbance occurs. On November 12-13, the tidal wave, with its energy sustained by the very high wind speeds of the cyclonic storm, forged a path across the coastal areas independently of the natural channels and was responsible for the huge damage and loss of life that occurred.

Deltas represent one of the most complex hydraulic problems. The interactions between the amount of upstream discharge in the rivers and the tidal levels, between the freshwater and seawater and between the various current and the movement of sediment are some of the least well-defined of all natural processes. Even when mathematical relationships can be derived they are often so complex that only partial and approximate solutions can be obtained, even with the benefit of modern computing devices.

The World Bank, USAID and other agencies are now assisting EPWAPDA by providing funds and expert technical advice to study some of the most critical areas. In particular, Dutch Engineers, who have had so much experience with delta development in their own country, will be coming to East Pakistan very shortly to make a special study of the coastal areas in the south-west region. The regional study of the north-east part of the province along with a hydraulic study of the major rivers is being taken up with French assistance. A study of the south-east region is already in progress. These regional studies will knit together into an integrated unit the many projects already formulated in these zones. The projects and land and water studies of

EPWAPDA in their turn should fit into a conceptual overall developmental plan for the Province as a whole. Such a plan should deal with industrial development and agricultural production guidelines, set migration policies, macro-economic targets etc., so that the regional and local programmes are properly integrated with each other.

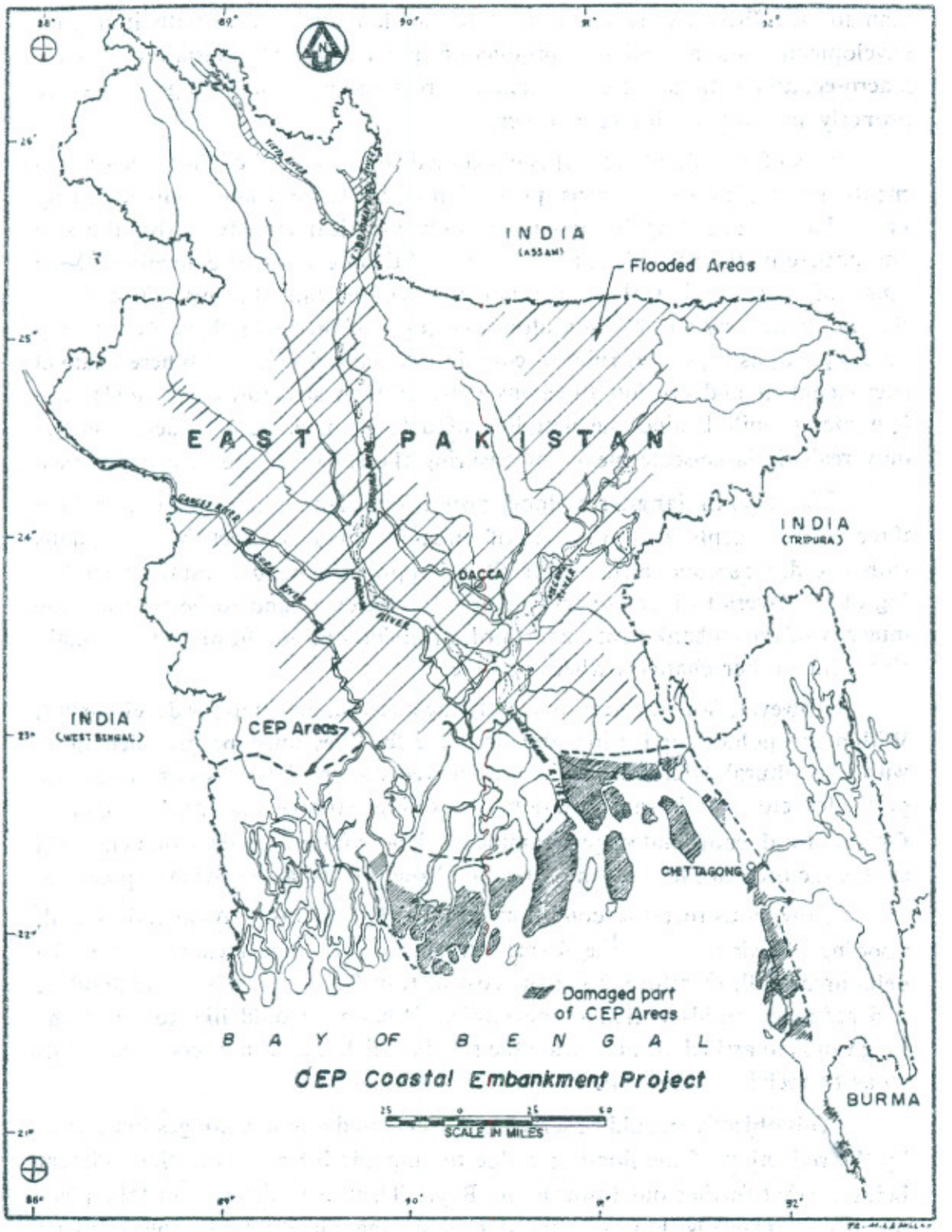
In so far as flood control is concerned, since control of the upper catchments is not within our means, protection of lands from flood inundation by embankments and empoldering is the only practical remedy. Also the size and nature of the rivers is such that most of them cannot be controlled in the sense of constraining them permanently within embankments. The dykes that are being and will be built along the edges of the main channels can only be designed, as a general rule, to contain overbank flooding. Where channel encroachment and erosion threatens these earthen structures, secondary embankments built behind the first line of defence must be considered as the only realistic large-scale means of ensuring the safety of the protected areas.

The overall long-term flood protection plan will, therefore, include three basic elements, first, a system of embankments to protect the flood plains from overflow; second, a channel rectification programme to arrest the meandering of the rivers to increase their hydraulic efficiency, and to help ensure the integrity of the embankments, and third, diversion of flood flows from the main rivers into other channels where feasible.

However, flood protection is only the essential first step for development. Within the polders, irrigation and drainage facilities must be provided along with agricultural extension services, improved distribution of seeds, fertilizers, pesticides etc., rural transportation, marketing, storage and credit facilities. Only a total coordinated programme of land and water development will enable the province to meet the demand of food for its fast-growing population.

Now let us revert to conditions in the delta regions. As already stated, flooding is axiomatic to the formation of a delta. The reclamation of the delta areas will, therefore, be at the cost of transferring elsewhere the flooding and sediment build-up that is inevitable. What we would like to do in the long run is to artificially accelerate the rate at which the delta migrates seawards so as to reclaim more land.

This objective would be served if the increased drainage congestion caused by the reduction of the flood area due to empoldering results in the sediment being carried further out towards the Bay. Then aggradation will take place seawards. There is, however, the danger of aggradation taking place inland which would require raising the embankments higher and higher gradually to maintain the desired level of protection.


INDIA
(ASSAM)
Flooded Areas
EAST PAKISTAN
INDIA
(TRIPURA)
DACCA
INDIA
(WEST BENGAL)
CEP Areas
CHITTAGONG
Damaged part
of CEP Areas
BAY OF BENGAL
CEP Coastal Embankment Project
SCALE IN MILES
BURMA

Dredging the channels can improve their conveyance capacity and hence reduce overbank flooding. This is, however, suitable only for the smaller rivers and khals because of the enormous quantities involved in the main channels.

An effective way in accelerating land reclamation is afforestation. Plantations of trees that are able to grow within the saline tidal areas, will reduce the flow velocities and hence the energy of tidal waves and also allow the suspended sediment to settle out in confined areas where it becomes effective in building up protective bunds.

A method of land reclamation that has been found to be satisfactory when used in the right location, is the construction of 'cross-dams'. These are low dams built adjacent to a channel in such a way that the sediment-laden water is directed into quiescent areas wherein the deposition of the suspended material takes place naturally. The 'cross-dams' built in the Noakhali District have been effective in reclaiming many thousands of acres of agricultural land.

The November 1970 disaster has focused attention on the coastal areas, particularly those that were devastated by the cyclone and its attendant tidal wave. A preliminary damage assessment was made immediately after the disaster. Aerial photography of the whole area was also taken, so that the situation can be interpreted from the maps to determine precisely the requirements of the affected areas. A tentative reconstruction programme for the cyclone-devastated area was formulated immediately after the disaster. This includes housing, embankments, fisheries and communications, water supplies and other public health and sanitation measures, community shelters, agricultural supplies, irrigation facilities and afforestation. The programme is aimed not only at reconstruction but at the creation of an environment that can stimulate progress. However, it is important to realise that the people of the coastal regions have migrated further and further into inhospitable areas—lands that cannot at any cost be rendered completely safe from natural disasters.

During the November disaster, the tidal wave was recorded at least twelve feet above the level to which the normal tide would have come at that time, and may have been even higher in some areas. Embankments to completely eliminate overtopping under such extreme conditions do not appear to be economically feasible. However, experience in the coastal areas of Patuakhali and elsewhere last November confirmed that the dykes of the EPWAPDA Coastal Embankment Project, even those constructed with sandy material or without any protective armouring, withstood the onslaught well. They saved thousands of lives and reduced property damage. The question of extending such embankments to other areas which now have no embankments and the

possibility of protecting the embankment slopes against damage and washout from overtopping is being studied. The Coastal Embankment Project at present protects lands from inundation by saline sea water. A scheme for water management within the empoldered areas is now under study. This is aimed at increasing production in these areas by provision of irrigation and better agricultural facilities. This would be done by the development of supplementary ground water supplies for early Kharif and Rabi irrigation and the gradual closure of tidal estuaries so as to inhibit saline intrusion and improve the availability of fresh water from upstream catchments, ground water sources and rainfall.

The long-term plan for these regions must concentrate on the development of effective warning systems, solidly-buiit housing and public buildings and suitable shelters constructed in all remote areas so that the loss of life can be minimised. The programme should include a study of the storm surges which are directly responsible for the heavy toll of lives so that prediction of their occurrence can form part of the cyclone warning system. There is also a great need for the institution of permanent disaster squads which can go into action immediately on the occurrence of a cyclone disaster.