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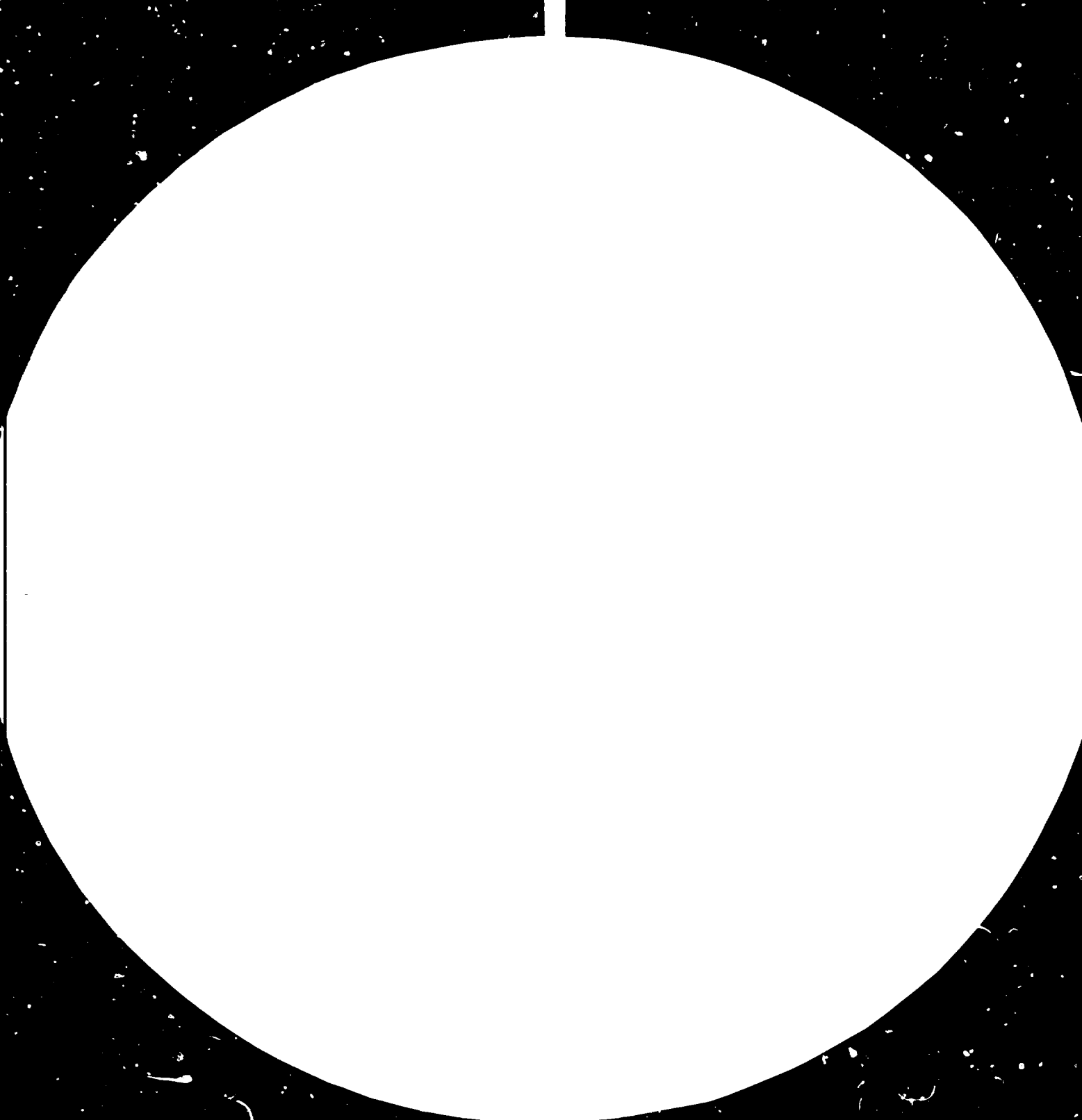

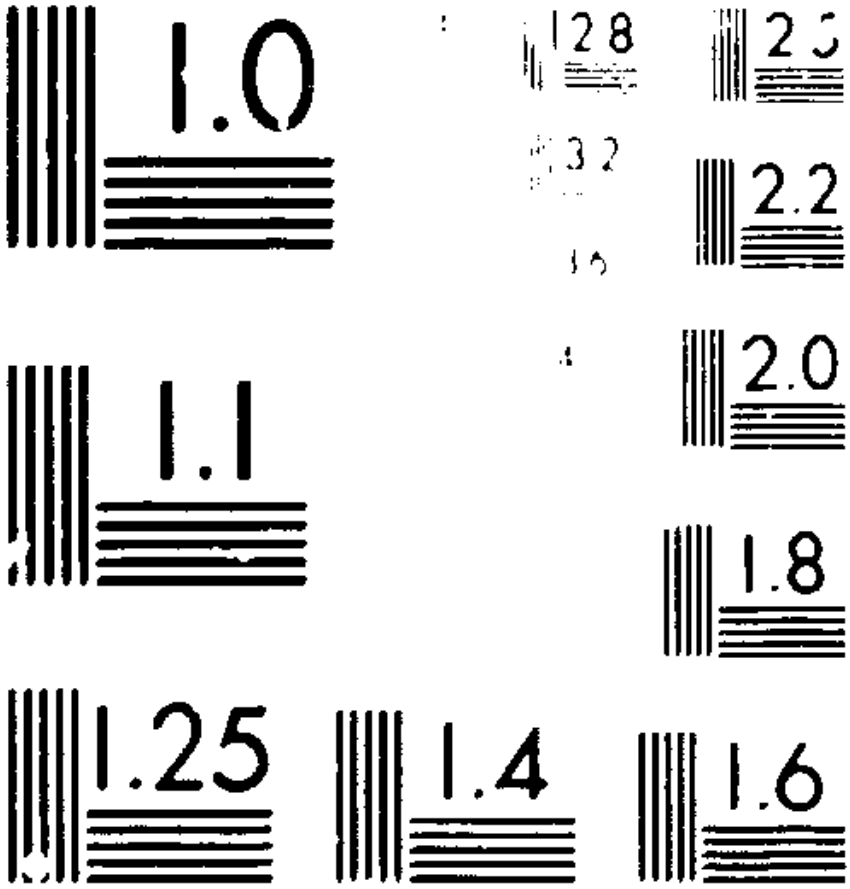
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PROSPECT OF SMALL-SCALE HYDRO POWER DEVELOPMENT IN BANGLADESH*

by

Syed T.S. Mahmood**

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** Director, Project Planning, Power Development Board, Wapda Building, Motijheel, Dacca-2, Bangladesh.

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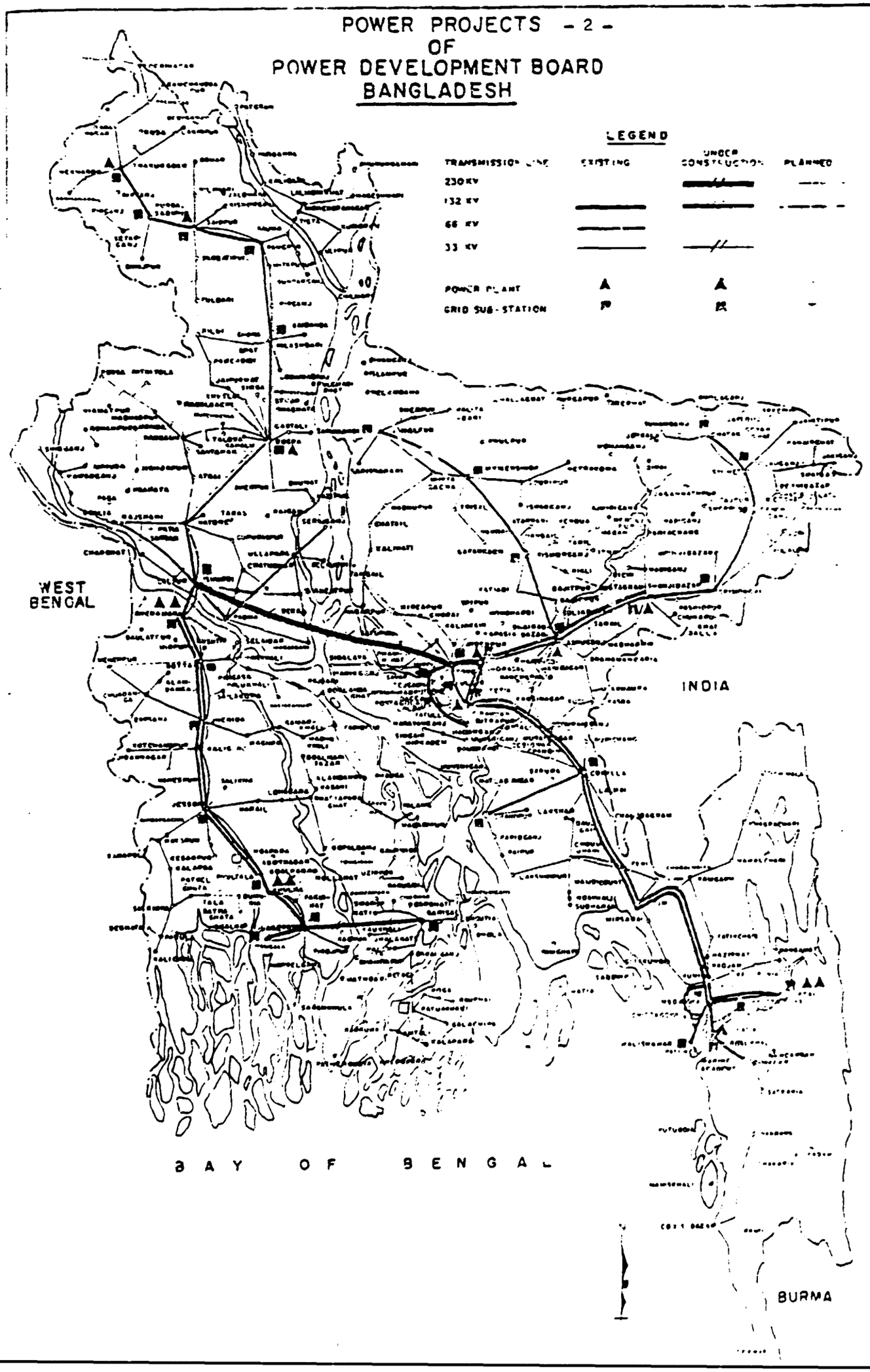
BACKGROUND .

Bangladesh is a densely populated country with an estimated 800 persons living per square kilometer as of 1979. The country is one among the least developed countries of the world having to do a great deal to improve the standard of living of its populace. Only about 3% of its population is directly benefited with electric light and power in their homes at present.

The country had a total peak demand of nearly 500 MW of electric power (September, 1980) with a total installed capacity of 838 MW. It has got two isolated grids separated by Brahmaputra-Jamuna-Meghna river system. These grids would be soon integrated by the construction of a 20 miles long river crossing 230 KV transmission link. The country has highest transmission voltage of 132 KV at present. Other voltage levels are 66 KV, 33KV, 11 KV and 400 Volts.

Bangladesh Power Development Board (BPDB) is responsible for development and operation of generation, transmission and distribution of electric power in the country. So long BPDB was solely responsible for all these, but recently a seperate Board has been established viz Rural Electrification Board (REB) with the responsibility of development of distribution system and electric co-operative in the rural areas.

POWER PROJECTS - 2 -
OF
POWER DEVELOPMENT BOARD
BANGLADESH



Out of total capacity, hydro electric generation accounts for only 80 MW. There is no mini hydro installation in the country at the moment.

THE LAND.

Geographically the country is situated in the northern hemisphere and lies between 21° and to 28° north lattitude and 88°E and 92°E longitude with about 55,600 square miles i.e. 143,953 square kilometers of gross area. Most of its part is a flat terrain formed of deltaic basin of the mighty Ganges and Brahmaputra rivers and their innumerable distributaries and tributaries (Fig.-I). However, a small area to the East-south-east is undulated where hill ranges of Burma and India found their descending slopes to the plains. Geopolitically, it borders India on the west, north, north-east; Burma on the south-east. Bay of Bengal is situated to the south of Bangladesh.

Formed of alluvial deposits of the mighty rivers, it is a flat plain in most part, Topegraphy from Northern Part dedlines from a high 85 M to Sea level in the southern parts within 400 KM, a slope of about 1 in 4700 (Fig - II).

The land is very fertile and extraction industry is still the major contributor to the country's G.N.P. Out of total land 65% is used for cultivation, 15% holds forest area and 10% is covered by the huge network of rivers, streams and swamps. Traditional cultivation is still carried out depending on nature

BANGLADESH

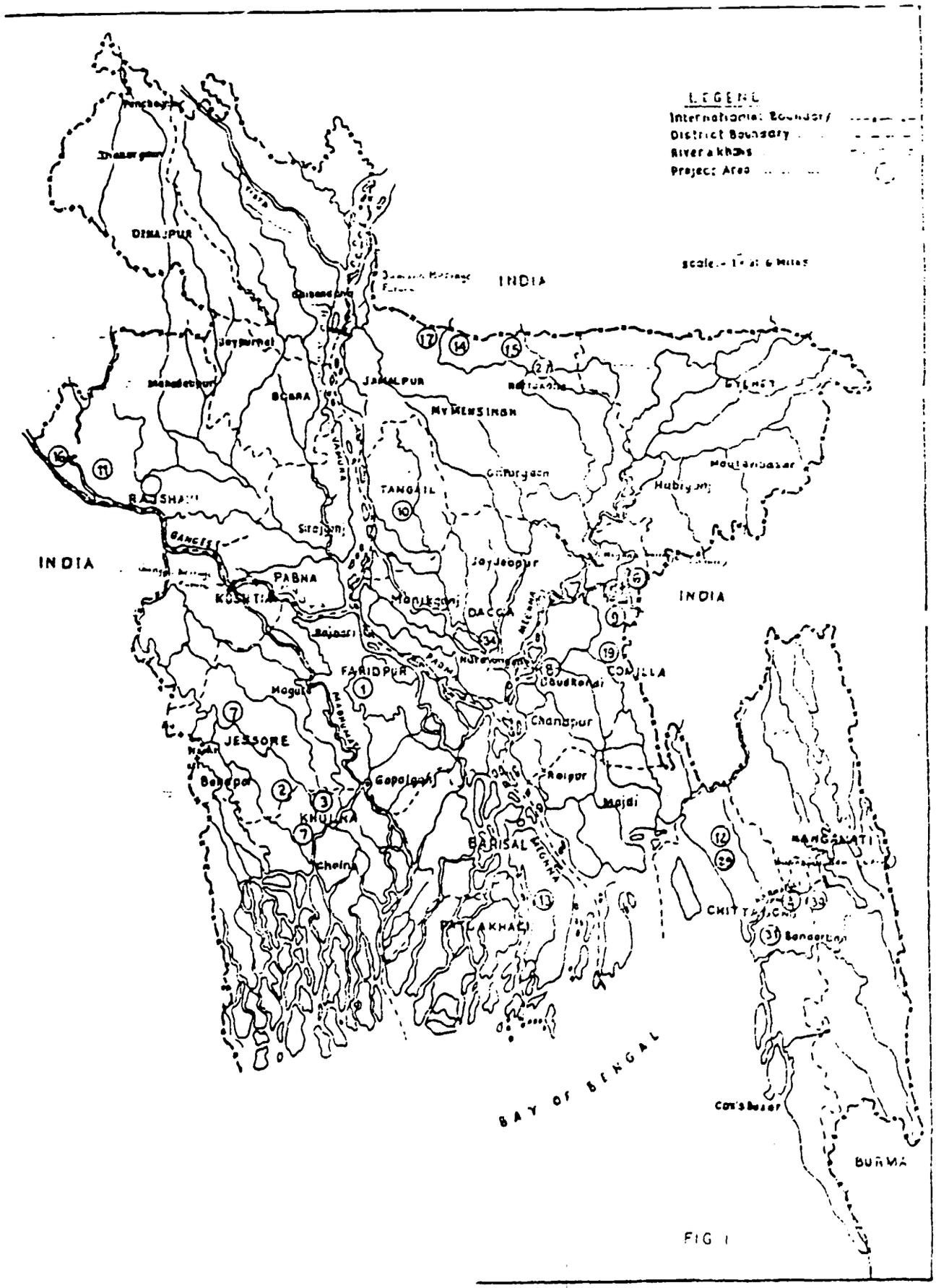
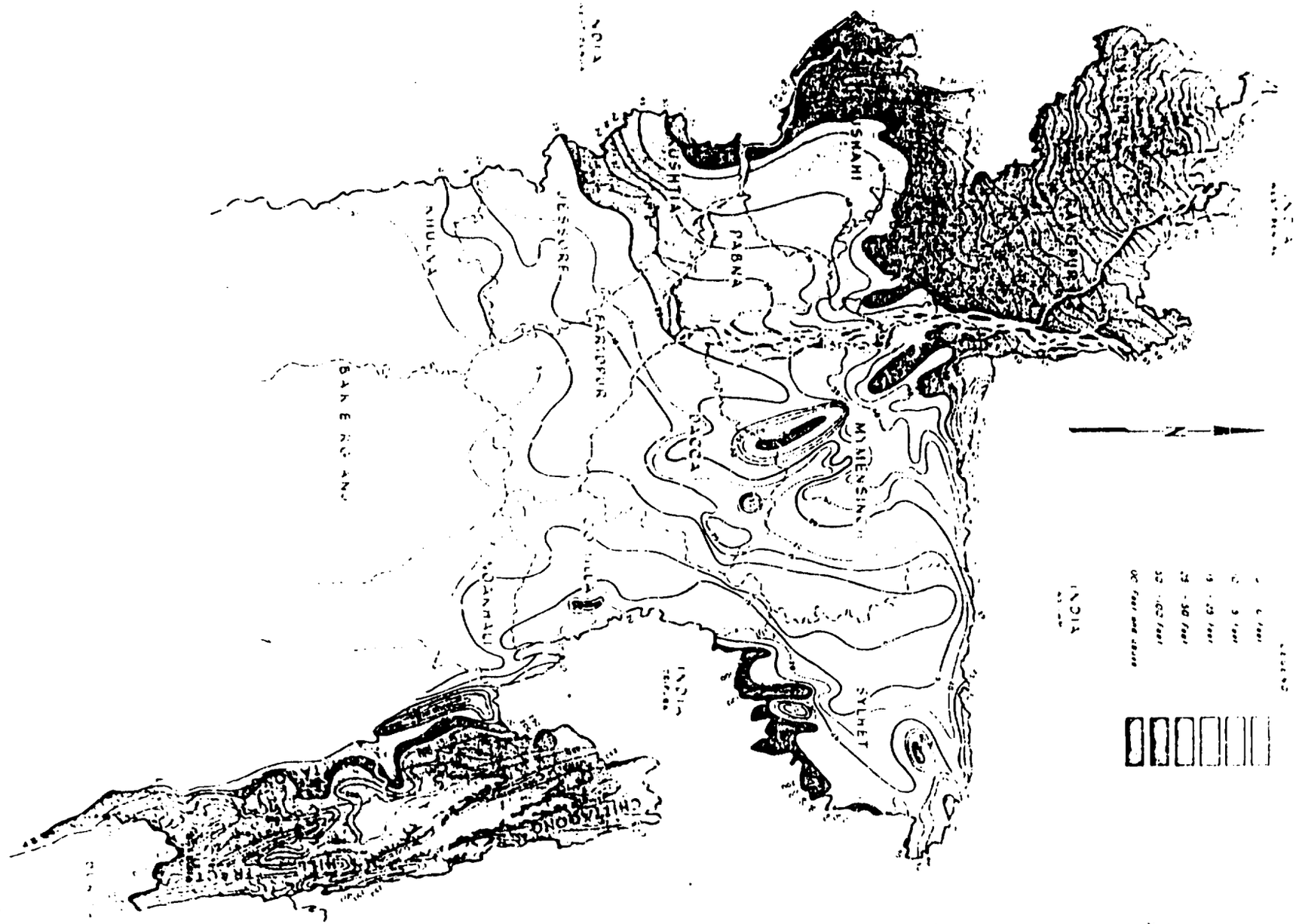


FIG 1

TOPOGRAPHY

Fig. II



in major part. Small to large scale irrigation and drainage facilities have been built in some area to the extent of about 10% of total cultivable land. More effort is being put towards this to meet grain shortage which still continues @ 1·2 million tons annually.

The problem with land is that it is too meagre for about 86 million human beings to meet their need for cereals, timber, pasture and housing.

CLIMATE

The Climate of Bangladesh is of the tropical monsoon variety. The monsoon season extends June through September / October, during which 80% or more of annual rainfall occurs. Storms are sometime of several days' duration and of low intensity but steady. Maximum temperature may reach upto 35° celsius with high humidity ranging from 80 to 90 per cent during this period.

The dry months are November through May. During this period a short lived winter from December to January brings a pleasant cool weather. Lowest temperatures recorded are 4° to 5° celsius and daily average is about 17° to 21° celsius during December and January.

The highest temperature also occurs during the dry period between March and May. Highest temperature exceeding 43° celsius has been recorded. Lowest humidity of the year occurs during March and April and lowest recorded has been below 40 %.

Violent thunder-storm occurs during April-May. About 15-20% rainfall occurs during the period. Most of which occurs in April and May.

Winds are low throughout the year in the country, but somewhat stronger near the coast. The exceptions are high-velocity "nor'westers" and the monsoon Cyclones in the month of October. High winds of 75 miles per hour are experienced every year during such events.

RAINFALL.

There is a marked variation in the intensity of rainfall. It ranges from about 50 inches in the extreme West-central part to 200 inches (508 cm) along the north-eastern border.

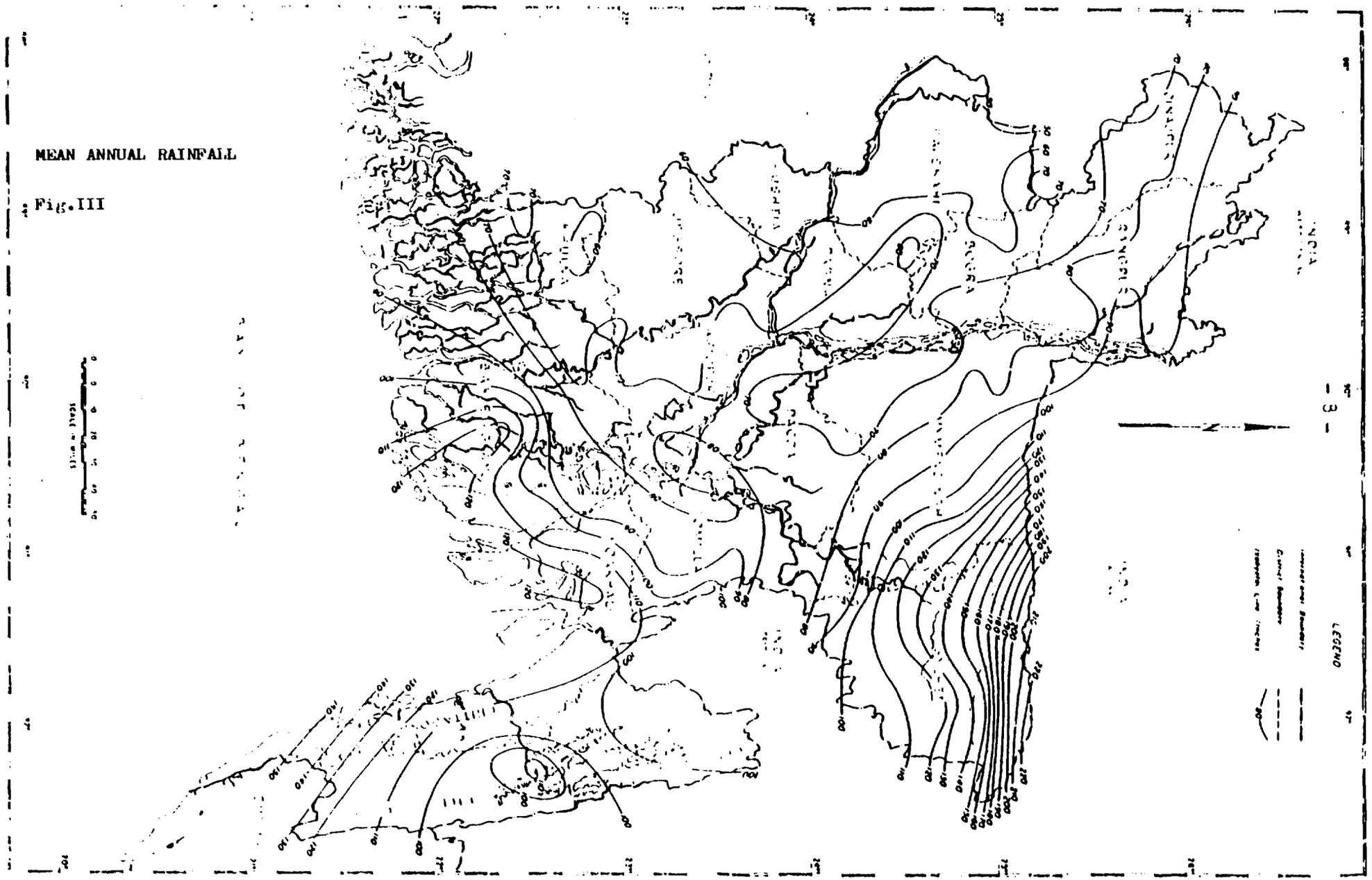
Rainfall in the territory of Bangladesh accounts for a runoff of about 100 million acre-ft. of water. Records of rainfall are available from 1902 with missing records from 1911 to 1932 except for the district of Sylhet in the north eastern Part. These data are collected both by Meteorological Department and Water Development Board. The isohyetal map of annual rainfall using long term averages would show the distribution of intensity in the country (Fig - III).

SURFACE WATER AND RIVER SYSTEM.

The large rivers constitute the main surface drainage system of Bangladesh. The Ganges-Padma, the Brahmaputra-Jamuna and the Meghna. Although these rivers carry a tremendous amount

MEAN ANNUAL RAINFALL

Fig.III



of discharge but have small gradient in the territory of Bangladesh before meeting the Bay of Bengal. The average discharge of these rivers amounts to 1170 million acre-ft. of which 1070 million comes from out side the country.

There are a few rivers which originate completely in side the country and empty in to the Bay of Bengal. These are located in the Chittagong and Chittagong Hilltracts.

A huge network of river crisscrosses the country. The river regimes are undefined as overbank flow even during normal flood is usual phenomenon. Besides 3 large and a few more medium sized rivers there are nearly one hundred significant distributaries, tributaris and streams in the country.

HYDRO ELECTRIC POTENTIAL.

Considering the average run-off and topography (avge. elevation 15 M above Sea level), there is a theoretical potential of about 52×10^9 Kwhr of hydro electric power per anum in Bangladesh. However, only a fraction of it can be harnessed because of flatness of land. So far about 2.3% of this has been developed. Preliminary assessment is that another 1% is achievable at reasonable cost in conventional installations. No survey has been made yet as to how much can be achieved through mini or micro hydro installations.

Surface water development programmes have been carried out since early fiftees. The programme materialized so far includes among some irrigation projects, a multipurpose dam on the

Karnafuli River in the South-eastern part of the country.

Karnafuli Hydro electric Station.

It has got a power house with 80 MW installed capacity in two units. The third unit of 50 MW capacity is under installation and expected to go in to operation by June, 1981. This is a rolled earth fill dam 43 M high above river-bed. It has got a storage capacity of 4.35 million acre ft. The Turbines are Kaplan type, 55000 horse power each at rated head of 20.7 M.

The Karnafuli development has got a potential of about 1200 Mkwhr of which about 800 Mkwhr has been so far utilized. With the 3rd unit added, it may still justify addition of another 100 MW to utilize about 90% of average potential energy out of impounded water. The river is, of course, of flashy nature by virtue of peculiar hydrology and lot of water needs spilling during July through September particularly during wet years. The dam can be further raised to increase the potential by about 15%.

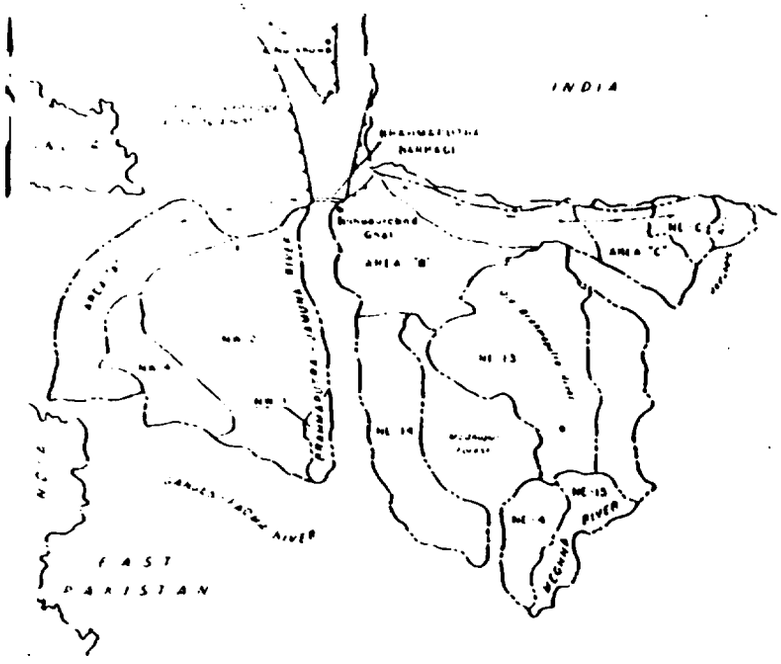
Hydro Power Potential at a few specific spots.

A theoritical potential can be computed on a limited head at Hardinge bridge on Ganges-Padma, Bahadurabad on Brahmaputra - Jamuna, Bhairab on Meghna river (Fig-I). On the basis of lowest mean flow a total approximately 2766 million Kwhr is computed @ 3.66 to 6.1 M head. Average flow would yield about 4 to 5 times more. It is not practically possible, however, to harness that much. For example, the Brahmaputra-Jamuna river has annual peak discharge of over 2 million cubic feet per second which the river

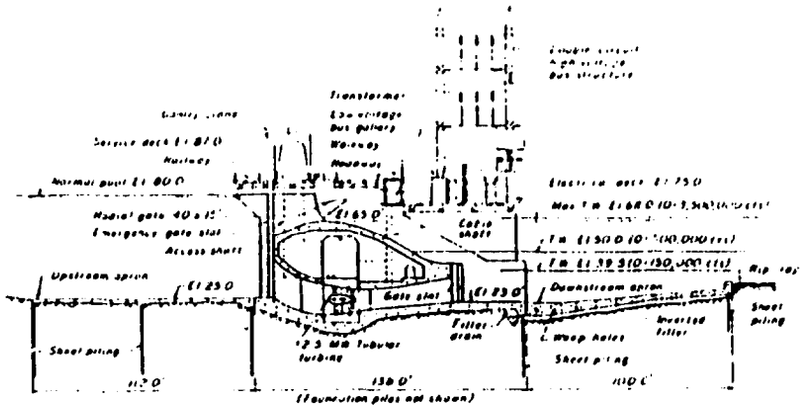
bank can not hold even under free flow condition. No reservoir can be built to hold water without submerging the whole territory. Of course, some barrage can be built for the purpose of irrigation at the three locations indicated and electric power can be produced by using low head high discharge bulb-type turbines. Some of them can be used just in the dam and some canal drop tubular or bulb. turbines can be used very conveniently.

Brahmaputra Barrage.

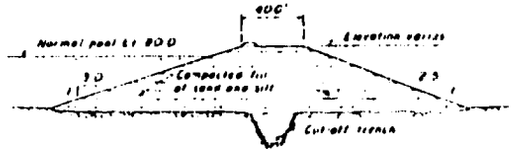
A preliminary study of such development on Brahmaputra-Jamuna river at Bahadurabad was made along with irrigation development, lock gate etc. The study indicated about 400 MW of firm capacity obtainable with 400 Nos. 2.5 MW bulb-type turbines along a 6.8 KM long dam, located in the spillway bay cavities below the weir slab (Fig.IV) and another 100 MW at the canal intake as canal drop plant. Estimated cost (1964 prices) was equivalent to US$730,000,000. The present cost would be at least 3 times, if not more. This is a huge investment which Bangladesh can not afford without external assistance. Similar constraint would prohibit any such development on other two rivers. However, development of the Ganges-Padma at Hardinge bridge has got a better prospect. But Bangladesh may leave these prospects for some future year to realize. Other small rivers, numerous tributaries and distributaries have got hydro potential. But no comprehensive survey has been made yet in the form of a feasibility study except for two. One of them is located in Chittagong Hill Tracts and may be taken up for implementation in the near future.



GENERAL LAYOUT



TYPICAL SECTION OF SPILLWAY



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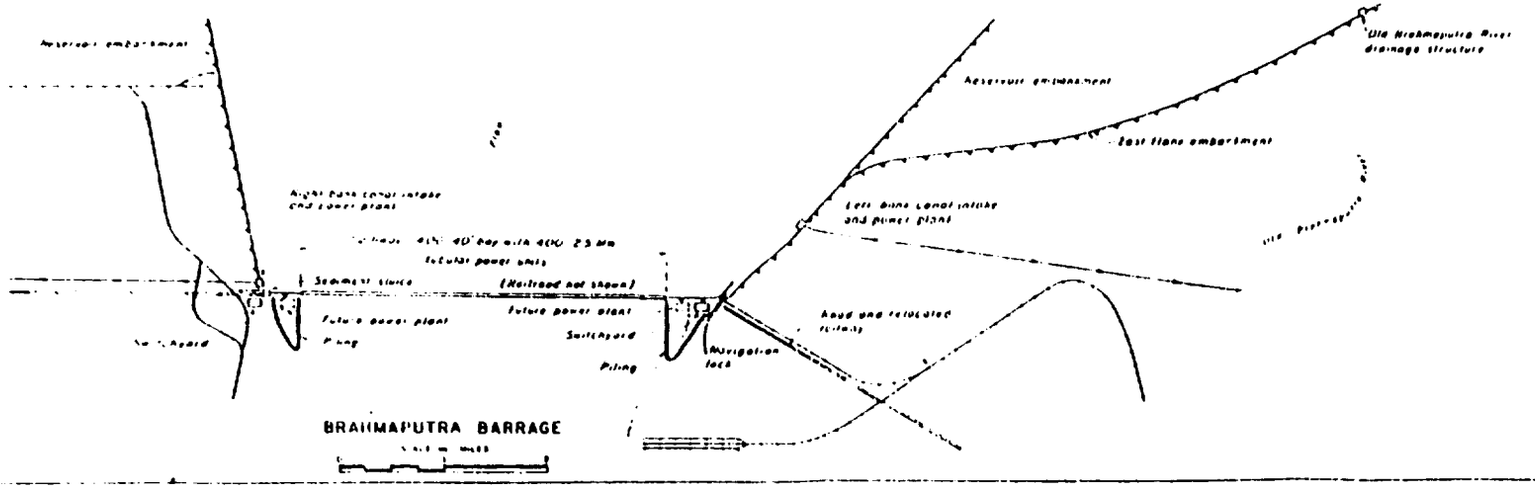


BRAHMAPUTRA BARRAGE

LEGEND

- International Boundary
- Roads Improved
- Pakistan Eastern R R
- Project Limit
- Embankment
- Diversion Canal
- Drainage Pumping Plant
- Additional Areas Commanded

Note
For identification of project numbers see Plate XI and Plate XII-1

BRAHMAPUTRA BARRAGE PROJECT

FIG. IV.

Sangu Project.

The proposed project is on the river Sangu in the Chittagong Hill Tracts on which two dams are planned, one located upstream in the hills and the other downstream near the plains. The upper dam is basically a power dam where a mean head of 42 M. would be available and conventional Francis wheel may be employeed. The downsteam dam is basically an irrigation barrage where some mini-hydro installation is contemplated. It is possible to install two 2.2 MW bulb-type turbines and generate about 18.6 Mkwhr firm energy from these. Bangladesh can embark on the barrage project even earlier than the up-stream dam. The preliminary estimates of early sixties were US$ 62 million for the entire development of which the downstream power plant and irrigation system would cost about US$ 19 million at 1960 prices. At current prices the development at downstream barrage would cost about 7 fold i.e. US$133 million. It is estimated that power plant would account for only about 2.5% of this cost. The small power may not justify the total investment but it may be worthwhile when irrigation and navigation are considered simultaneously.

Old Brahmaputra Project.

A Low dam was conceived on the Old Brahmaputra River near Mymensingh Town. This river is a distributary of the Brahmaputra-Jamuna river. The dam was for developing multipurpose benefits of which 40,000 Kw installed capacity in terms of power was possible. Here also bulb-type turbines of 8.0 M. head could be employeed. Feasibility study was made but construction could not be taken up

as huge amount of capital was involved (about 113 million US Dollars as per 1964 estimate).

Teesta Barrage.

A barrage for irrigation is under construction on Teesta River. Recently power generation possibility by utilizing Polar Wheel turbine is being investigated to harness some power from the barrage. The amount of power that can be generated is not yet confirmed.Bangladesh Water Development Board is constructing the barrage

POTENTIAL FROM SMALL RIVERS

A preliminary assessment of Matamuhari river in Chittagong Hill Tracts, Lungla, Mahasing, Manu in Sylhet, Mahananda in Rajshahi, Mathabhanga in Kushtia and Nabaganga in Jessore indicate a potential of 552 million Kwhr of energy on average flow of these rivers. There is ample opportunity for mini-hydro power development on these rivers as well as on other rivers in the country. However, unless these are taken up on the basis of multipurpose development such as irrigation and power, optimum utilization of potential would not be possible. In that case alternative small scale mini-hydro approach can be employeed. The feasibility study which would be undertaken soon may indicate the possibilities.

THE PRESENT STATUS OF MINI-HYDRO DEVELOPMENT IN BANGLADESH

In view of present world crisis of fossil fuel as well as conservation of its own resorces of natural gas, Bangladesh is seriously considering to tap all feasible hydro potential by

utilizing mini-hydro technology. The country's energy demand is growing. The present per capita generation including the industry's inhouse generation is only to the order of 32 Kwhr. Therefore, scope for growth of electric power demand is there with the allround economic activities which has been planned. Second Five Year Plan (1981-85) estimates an energy demand of 4507 million Kwhr in the year 1984-85 compared to about 2400 mkwhr in 1979-80. A part of this could be met out of mini-hydro generation. Country's first one may be on the Teesta barrage project.

There is a great possibility of mini-hydro as well as micro-hydro development in non-conventional plants and its appropriate use in the rural areas for pumping irrigation water, running husking mills, cottage industries and lighting the homestead in Bangladesh.

Action Under way.

A comprehensive study is being taken up to assess the potential and to establish the technical and economic feasibility of developing small hydro power facility on the numerous rivers in the country.

Immediate plan to incorporate power generation facility in Teesta Barrage Project has been initiated by the Power Development Board. A Belgium firm (ACEC, Brussels) is studying the prospect. Polar wheel turbine generator may be used in this case in which this particular company has expertise. Polar wheel concept utilizes the tubular turbine where poles are mounted on the tip of the blades.

The preliminary information received so far indicate that 4 such machines each 2 MW capacity can be installed on the canal head of Teesta Barrage. It is also learnt that the main barrage can not be used as the head available is less than 2 meters. The formal report is still awaited and a decision would be taken as soon as it is received.

The manufacturing capabilities in Bangladesh can produce runner and shafts of simple machines easily. Bilateral cooperation in this respect would be very helpful and welcome, particularly on technology side. Bangladesh is keenly interested in the technology and looking seriously to it. With this end in mind recently a batch of engineers was sent to China to study the mini-hydro development. Their experience would be utilized. We also intend to send people to India, Philipine and Nepal to benefit from their experience also.

TECHNICAL PROBLEMS.

If the country were not a flat one and monsoon flood were not there simple weirs could be constructed on the small streams or rivers and bulb-turbines or other kinds of wheels could be driven as a runoff-the river basis. Overbank flooding is a factor that tends to render the construction costly and makes the installation unsafe. About 6 to 10 M fall in water level and drop of flow to one-twentith compared to monsoon takes place in dry season.

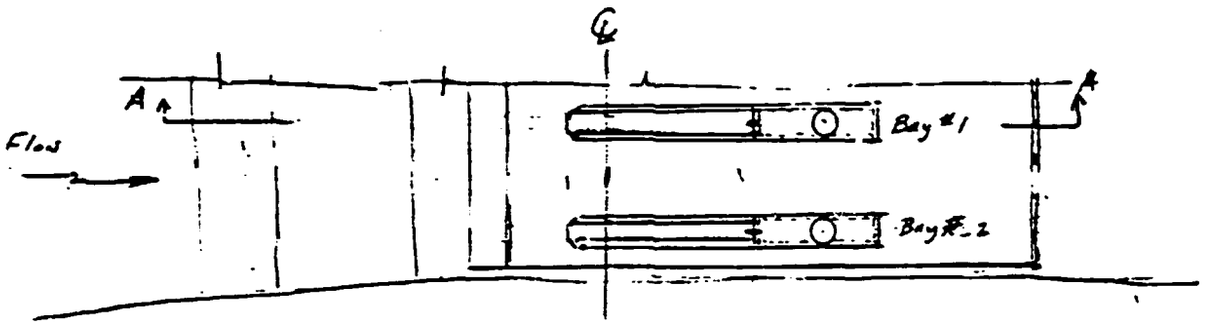
Moreover, the need for irrigation is in dry months when rainfall is very low. Therefore, if the water is impounded only to the extent of bank height and low inflow continues, simultaneous generation of electricity and some pump irrigation from

downstream is possible. (Sketch-1). It is obvious that an optimum balance must be struck before any physical construction is taken up. On the other hand, foundation conditions are not good on account of alluvial soil and any hydraulic structure that has to be built needs more attention and investment. It is therefore, important to consider all the constraints, possibilities and experience of other nation in these respects to keep the financial involvement minimum.

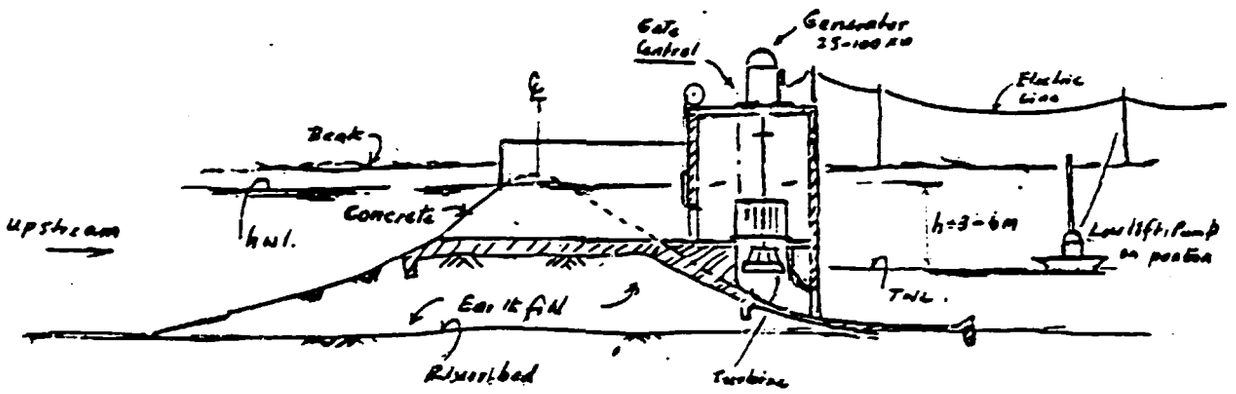
The cheapest development is of course desirable. As Bangladesh is but a small country, grid power can be made available any where with minimum investment. If some marginal benefit is not attainable then the only merit the mini or micro-hydro would deserve is in the conservation of fossil fuel. This is also worth considering.

ORGANIZATION

Bangladesh Power Development Board would be planning these in the initial stage of conception and initiate all the Schemes. For convential multipurpose barrage Bangladesh Water Development Board would be involved in most of the cases. Rural Electrification Board can operate the mini and micro-hydro plants. The Boards being under one ministry i.e. Ministry of Power, Water Resources and Flood Control, coordination would be no problem.



PART PLAN



SECTION A-A

MINI-HYDRO INSTALLATION ON SMALL RIVER

JSM

SKETCH - 1
NOT TO SCALE

CONCLUSION

Bangladesh has got a large potential in the flowing water but very small amount of this has been harnessed. Large scale development, such as on Brahmaputra-Jamuna or Ganges-Padma would be very costly, and will take considerable time to implement. There is however, large scope for mini to micro-hydro development provided the technology suits the peculiar situation or appropriate technology is adopted to meet the condition. Even a fraction of one percent of gross potential of 52 billion Kwhr means a substantial achievement.

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