EFFECTS OF GREATER DHAKA TOWN PROTECTION EMBANKMENT ON THE CHANGES IN THE TREND OF SETTLEMENT PATTERN AND LANDUSE IN THE FRINGE AREAS OF EMBANKMENT

MD. ZAHID HUSAIN KHAN

DEPARTMENT OF URBAN & REGIONAL PLANNING,
BANGLADESN UNIVERSITY OF ENGINEERING AND
TECHNOLOGY, DHAKA.

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BY

MD. ZAHID HUSAIN KHAN

A Thesis submitted to the Department of Urban and Regional Planning, Bangladesh University of Engineering and Technology, Dhaka in pattial fulfillment of the requirements for the degree of

Master of Urban and Regional Planning.

Department of Urban and Regional Planning,
Bangladesh University of Engineering and Technology,
Dhaka.

February, 1993.

THESIS ACCEPTANCE FORM

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Approved as to the style and content by

Rowsona Hafiz 11/2/93.

Chairman of the Committee (Supervisor)

Head of the Department (Member) 1/2/93

Member 11/2/93.

Member (External)

DEPARTMENT OF URBAN AND REGIONAL PLANNING,

BANGLADESH UNIVERSITY OF ENGINEERING AND TECHNOLOGY, DHAKA.

ACKNOWLEDGEMENT

I take this opportunity to acknowledge my indebtedness to my supervisor Mrs. Roxana Hafiz, Assistant Professor, Department of Urban and Regional Planning for the constant guidance since the inception of this study and her whole-hearted encouragement during its progress. Without her constructive suggestions, continual encouragement and assistance the preparation of this thesis would never have been possible. I am grateful to Dr. Mir Shahidul Islam, Head of the Department of Urban and Regional Planning for his guidance. I am also indebted to Mr. A.S.M. Mahbubun Nabi, Associate Professor, Department of Urban and Regional Planning, who inspite of being burdened with lot of work could find time to provide me with suggestions and comments.

I am grateful to the United Nations Centre for Regional Development, Japan and Bangladesh University of Engineering and Technology, Dhaka for their financial support in pursuing this study.

I am also grateful to Dr. S. I. Khan, Environmental Management Planner, United Nations Centre for Regional Development, Nagoya, Japan for his suggestions and guidelines from time to time during his visit to Bangladesh.

Finally, I would like to express my deep gratitude to my parents, my wife and children for the hardship they had to endure during the course of this work.

ABSTRACT

There are many factors which determined the landuse pattern in an urban area. In Dhaka most of the fringe areas remain flooded during the rainy season. Till date most of these areas have remained undeveloped despite the skyrocketing demand for land in the city. A consequence of the ongoing Greater Dhaka Town Protection Embankment project will be that a large part of this area will be saved from annual flooding and therefore be suitable for urban uses. This will have impacts not only on the areas adjacent to the embankment but also on the city as a whole. Careful study, therefore, is needed to look into the likely impacts of the project on the landuse pattern in the fringe areas of the city.

Due to time and financial constraints the study have been limited within the areas only where earth embankment have been constructed, starting from *Tongi* road bridge upto *Kellar Morh* at old Dhaka. Areas covered with protection walls have not been considered in this study. Three typical areas were considered for field survey along the whole length of the embankment within *Tongi* and *Kellar Morh*. The study attempts to analyse the existing landuse and settlement pattern, the effect of the embankment on landuse and settlement pattern and also suggests a framework to be used for forecasting future landuse pattern in the study area.

Thesis Title: Effects of greater Dhaka town protection embankment on the changes in the trend of settlement pattern and landuse in the fringe areas of embankment.

Thesis Supervisor: Mrs. Roxana Hafiz, Assistant Professor, Department of Urban and Regional Planning, BUET, Dhaka.

C O N T E N T S

LIST OF FIGURES

LIST OF TABLES

LIST OF PHOTOGRAPHS

ABBREVIATIONS

ADB	Asian Development Bank.
ADP	Annual Development Programme.
AIT	Asian Institute of Technology.
BBS	Bangladesh Bureau of Statistics.
BUET	Bangladesh University of Engineering & Technology.
BWDB	Bangladesh Water Development Board.
CAAB	Civil Aviation Authority of Bangladesh.
CBD	Central Business District.
CDST	Custom Duty and Sales Tax.
DIT	Dhaka Improvement Trust.
DMAIUDP	Dhaka Metropolitan Area Integrated Urban Development Plan.
DMC	Dhaka Municipal Corporation.
DND	Dhaka Narayangonj Demra.
DCC	Dhaka City Corporation.
DPHE	Department of Public Health Engineering.
DOE	Department of Environment.
DWASA	Dhaka Water Supply and Sewerage Authority.
EIA	Environmental Impact Assessment.
ERD	External Resources Division.
FAP	Flood Action Plan.
GDFCD	Greater Dhaka Flood Control and Drainage.
GOB	Government of Bangladesh.
GDP	Gross Domestic Product.
GDPP	Greater Dhaka Protection Project.
IEE	Initial Environmental Examination.
JICA	Japan International Cooperation Agency.
MSL	Mean Sea Level.
MPO	Master Plan Organization.
PDB	Power Development Board.
PWD	Public Works Department.
PHED	Public Health Engineering Department.
RHD	Roads and Highways Department.
RAJUK	Rajdhani Unnayan Kartipakkha.
UNDP	United Nations Development Programme.
UNCRD	United Nations Centre for Regional Development.
UDD	Urban Development Directorate.
ZIA	Zia International Airport.

CHAPTER – 1

The Problem, Objective and Methodology

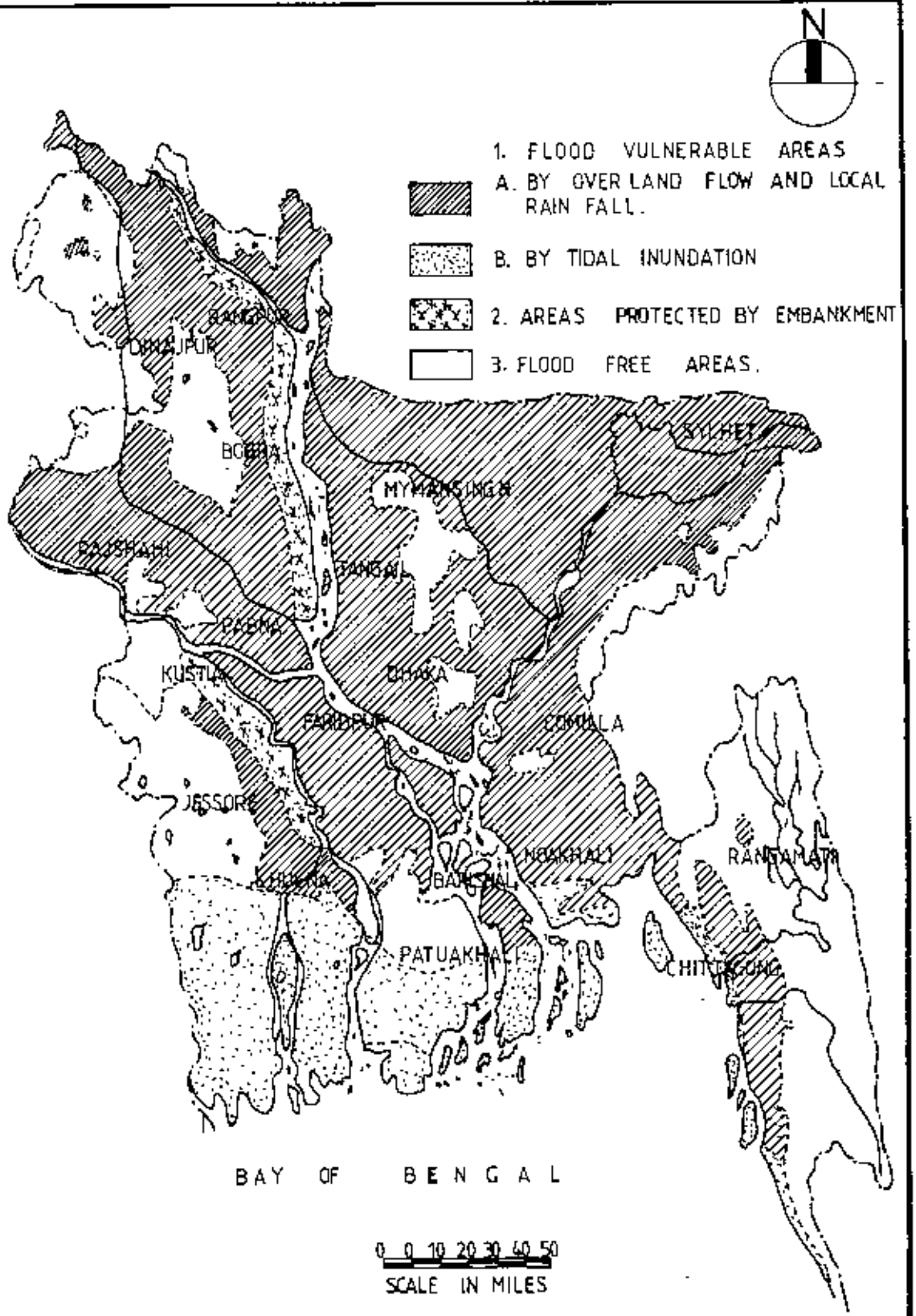
1.0 Introduction

Civililzations flourished near rivers or large water bodies. Rivers were, and still are, the sources for fresh water for the towns and villages located along its banks. Rivers act as routes for easy communication and transportation. Besides the beneficial nanture of rivers, they are also the cause of miseries and sufferings to human lives. When there is a high discharge in the river flow, large areas along the banks are inundated causing damage to lives and properties. On the other hand, inundation also allows the rivers to leave behind a layer of silt which is so highly priced by the crop growers.

The eastern and south-eastern regions of Asia covers an area with the largest concentration of natural disasters of metrological and hydrological nature. These generally constitute floods, windstorms, earthquakes, landslides, volcanic eruptions etc. Among all these natural disasters, flood is a major problem of Banglaldesh (Fig. 1.1.). Anticipating the gravity of the situation and the extent of damage that may be caused to the city life the Greater Dhaka Flood Control Embankment has been proposed. The aim of the embankment is to secure an environment safe to lives and properties, and to reduce their damages and losses to acceptable tolarent limits.

Recurring losses from floods have become a major obstacle to the socio-economic development of the city. This problem has grown mainly due to large expansion in the size of population and related development activities. The flood damage also depends on

Fig. 1.1. Flood Vulnerability Map



SOURCE :- MONIRUZZAMAN et. al. 1981.

the magnitude and intensity of rainfall, storms or cyclones, retention and retardation capacity of flood plains and implementation of flood control works.

This paper entitled "Effects of greater Dhaka town protection embankment on the changes in the trend of settlement pattern and landuse in the fringe areas of embankment" is an atttempt to study the impact of the embankment project on landuse, housing and setttlement along the areas of embankment. This paper does not include discussions about the designs or structural and construction details of the embankment.

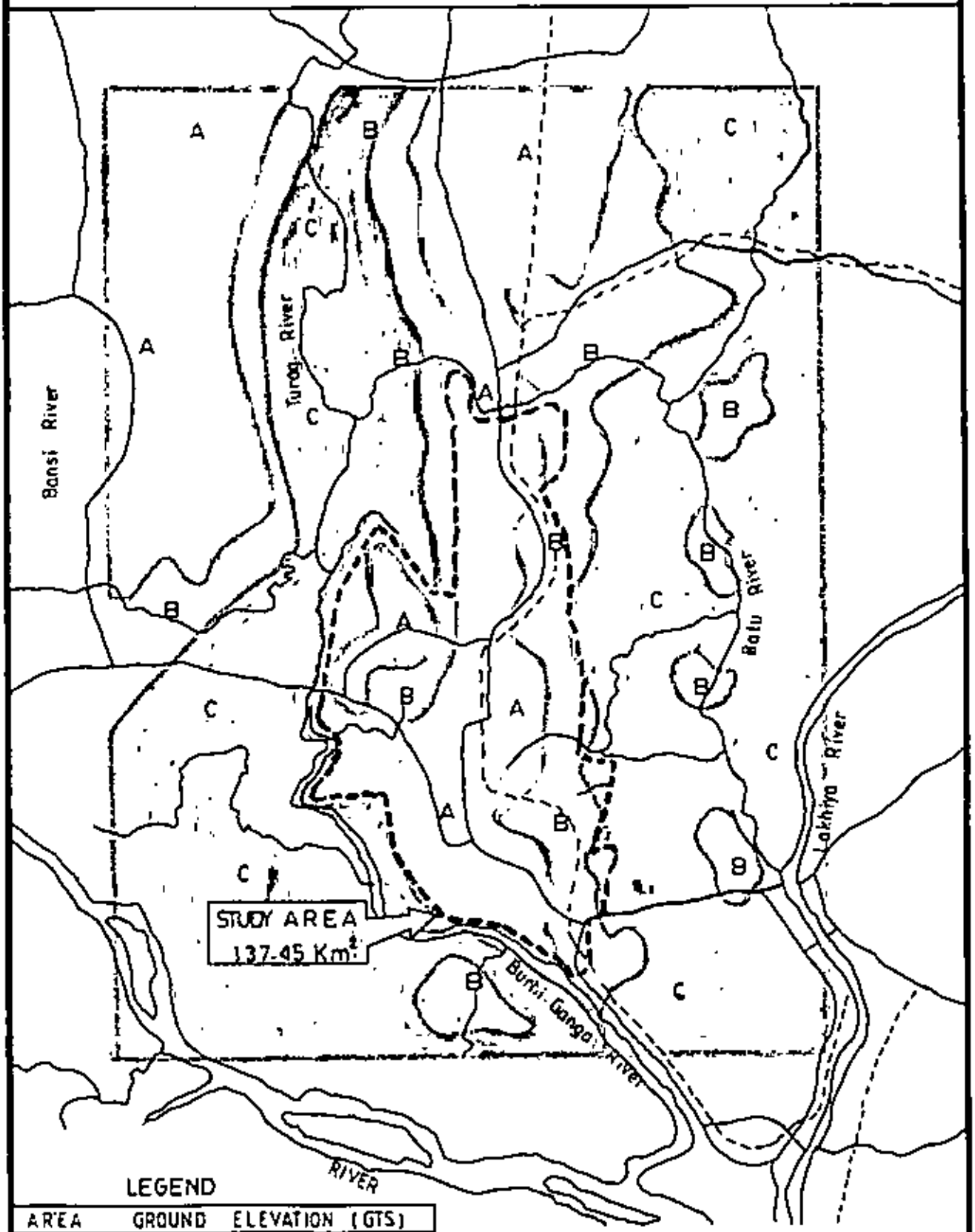
1.1 Background of the study

Dhaka, the capital city of Bangladesh, is located on the southern edge of the *Madhupur* jungle terrace and is surrounded by rivers on all four sides. *Tongi* khal on the north, *Balu* river on the east, *Turag* river on the west and *Buriganga* river on the south. The greater Dhaka area encompassed by these rivers cover approximately 260 sq.km.

A dominant feature of the greater Dhaka area is the limited availability of floodfree land. The central part of Dhaka city is developed on the hilly land with an elevation of 6.0 m to 8.0 m above mean sea level. The fringe areas are, however, located in the flood plains of the *Buriganga* and *Balu* rivers with a level of 2.0 m to 6.0 m GTS (Fig. 1.2).

The fringe low-lying areas are flooded 2.0 m to 4.0 m during several months every year by overflowing of the surrounding

Fig - 1.2 Ground Elevation of Dhaka Metropolitan Area



SOURCE :- Dacca Metropolitan Area Integrated Urban Development Project, 1987

rivers. Even the central part of Dhaka city is affected during major floods. During the past four decades, the flood stage of the Buriganga river at *Mill Barrack*, located near old Dhaka exceeded 6.0 m GTS six times, damaging the central part of Dhaka city as well.

The three rivers, namely *Buriganga*, *Turag* and *Tongi* are fed by the *Bansi-Jamuna* river system. The *Balu* river in the east falls into *Sitalakhya*, a tributory of the old *Brahmaputra* near *Demra*. Water levels in the surrrounding rivers are affected not only by discharges from upstream and local rain fall but also by backwater from downstream rivers: *Dhaleshwari*, *Sitalakhya*, *Meghna* and *Ganges-Padma*.

Flooding in the city results from heavy rainfall, high surrounding water levels and an inadequate drainage system. Inadequate attention towards the operations and maintenance of the drainage system has compounded past flooding. Flooding problems are aggravated when heavy rainfalls are late and coincide with flooding of the rivers.

The greater Dhaka area was hit by the catastrophic floods during the period of August-September, 1988. The *Buriganga* river at *Mill Barrack* recorded the highest flood stage of 7.58 m in its history on September 04, 1988. The flood frequency is estimated to be 100 years. The flood submmerged almost all of the Dhaka metropolitan area, leaving only 58 sq.km. of the high elelvated land of Dhaka city unsubmerged. Major flooding of Dhaka city continued for 18 days from 30th August to 16th September, 1988.

Approximately 1.9 millilon people or 56 percent of the greater Dhaka area was affected (JICA - 1990). During 1988, rivers in Bangladesh started to rise sharply from 20th August onwards due to intensive rainfall in the northern parts of the country and the upper catchments; flood peaks of both the *Ganges* and *Brahmaputra* river system synchronised. The contribution of local rainfall to this flooding was not significant. While no official figures of flood damages in Dhaka are available, the Dhaka City Corporation estimated that some 400 km of roads were damaged and 60 percent of the 1900 km internal road system was submerged. From the estimates of JICA for an area of 137 sq.km. which includes the major built up part of greater Dhaka, the Jansen committee estimated flood damages in the order of Tk.500.00 million to Tk.1000.00 million.

1.2 Objectives

The main objectives of the study are:

(a) To analyse the existing landuse and settlement patterns in the fringe areas traversed by the embankment.

(b) To identify any changes in population movement and landuse and settlement patterns within the embanked area.

(c) To identify and analyse the factors influencing the land market in the area.

(d) To analyse the prospects for different types of urban landuse in the area.

(e) To develop a model for forecasting future landuse pattern in the area.

1.3 Methodology

Methodologically the study is a combination of normative survey and participants observations. However, indirect (revealed preference) methods to ascertain perceptions on future landuse pattern was also employed. For normative survey 300 predesigned and pretested structural questionnaires were administered to collect necessary data which were subsequently analysed to aarrive at the pertinent observations made in the study. The questionnaire survey was carried out through random sampling of the population of the study areas.

In conformation with the objectives the following procedure was followed as regards collection of data/information:

(a) Collection of data from secondary sources:

(i) Part of the study was based on data/information available through published books/studies, various related materials and stastistical data from office records and other secondary sources.

(ii) An intensive literature survey was made to acquire knowledge about policies, principles, methods of flood control at home and abroad for better understanding of the problem.

(b) Collection of data from primary sources:

(i) Preliminary survey was made to gain general impression regarding study area through observation and interviewing the local people.

(ii) On the basis of the evaluation of data from preliminary survey the elements for detailed survey was formulated.

(c) Statistical analysis were completed in tabular forms.

(d) On the basis of these studies a critical review was made on the present as well as future landuse pattern and finally a framework to be used for forecasting landuse pattern in the study area have been developed.

CHAPTER – 2

Bangladesh : Country Monograph

2.0 Country and population

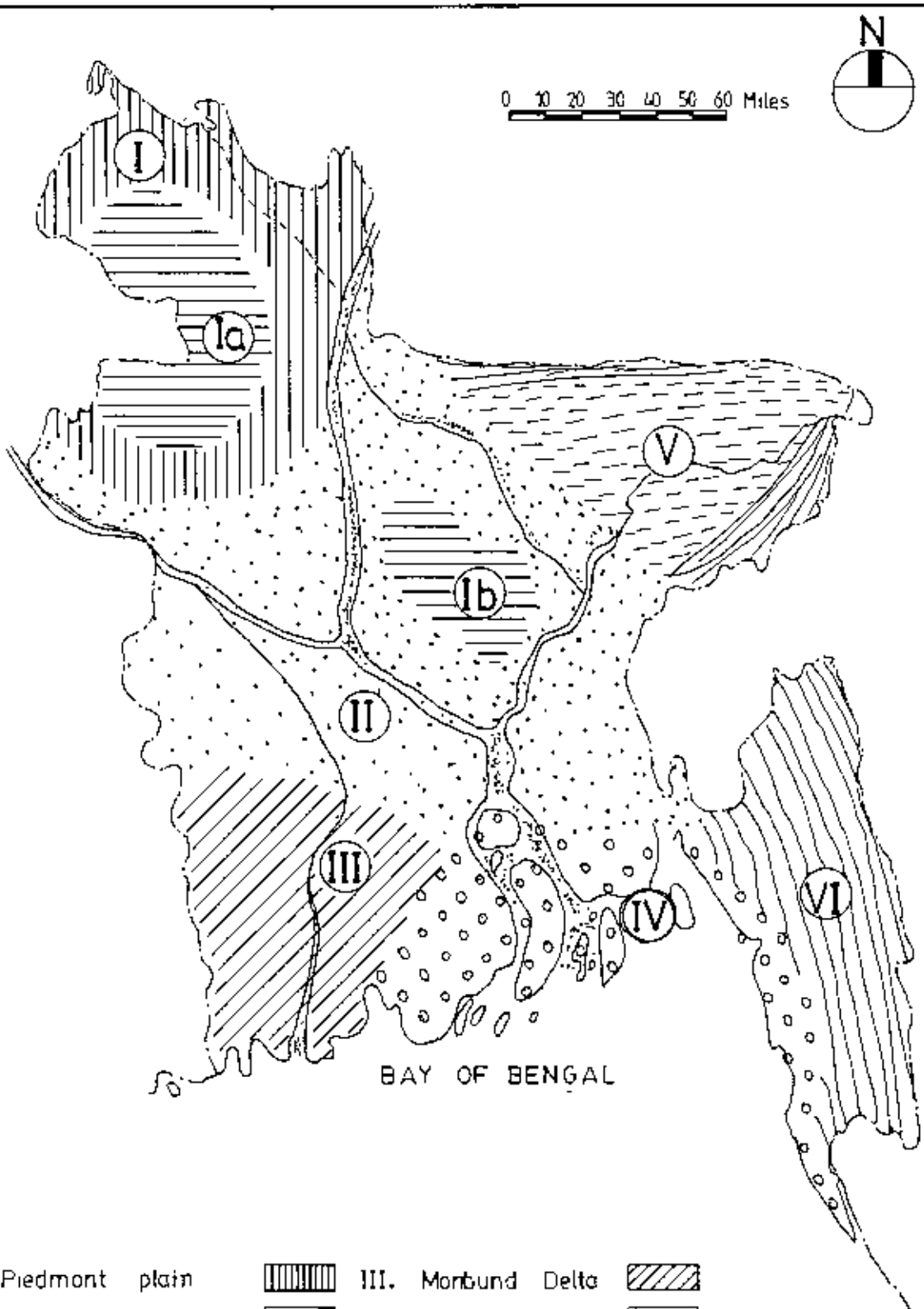
Bangladesh became an independent and sovereign country on December 16, 1971. A low-lying riverine country covering 143,998 sq.km. formed by the rivers Ganges, Brahmaputra, Meghna, Karnafully and Sangu. Bangladesh is bounded by India on the east, west and north. There is a small boundary with Burma in the south-east. Lying south of the Himalayas, Bangladesh is a fertile extensive deltaic plain. Its southern shores are washed by the Bay of Bengal. More than 85 percent of the country is flat alluvial plain criss-crossed by rivers and their innumerable tributories. These rivers provide a cheap means of transport, irrigation and abundant supply of fish.

The climate is characterised by high temperatures, heavy rainfall and excessive humidity with distinct seasonal variations— summer from March to August and a short winter from November to February. Summer monsoon rains vary from 1000 mm in the south-east and 5000 mm annually in the north-east. The rains are often associated with tropical cyclones. The country can be divided into six physiographic regions (Fig. 2.1):

(a) Alluvial plains:

The piedmont alluvial plain includes the districts of Rajshahi, Rangpur, Dinajpur, Bogra and the western part of Pabna. This region has limited rainfall and low domes of undulating terrain. Inadequate rainfall, silted up rivers, and the lowering down of the water table make for arid conditions in Barind. The Madhupur tract of old alluvium includes northern Dhaka, western Mymensingh and Tangail.

Fig. 2.1 Physiographic Regions of Bangladesh



I. Piedmont plain
Ia. Barind
Ib. Madhupur
II. Central Valley Flat
III. Monbund Delta
IV. Coastal Area
V. Haor Basin
VI. Hill Tracts

SOURCE- Country Monographs, ESCAP, Vol-2.

(b) Central valley flat:

Lying east of the area of old alluvium and south of the Haor region, this region is intersected by a network of rivers. It includes the districts of Dhaka, Comilla, Noakhali, Faridpur and parts of Tangail, Pabna and Kushtia. The annual rainfall is about 2500 mm in most of the areas.

(c) The southwest moribund region:

The southwestern part of the country forms into a moribund delta and the rivers flowing through this area are either dead or dying. It includes the districts of Khulna, Jessore and most parts of Kushtia districts bordered by the Sundarbans, a complex of mangrove swamps.

(d) Northeastern part:

Comprising the district of Sylhet, it consists of a low depression commonly known as 'Haor' through which rivers pass sluggishly. This region is flanked by hills on the north and the east.

(e) Hilly region:

The region consists of the eastern part of the Chittagong district, Chittagong Hill Tracts, Bandarban and the northeastern peripheries of Sylhet and Jamalpur districts. There is very little land available for human settlement and cultivation.

(f) Coastal areas:

These are islands in the district of Patuakhali, Barisal, Noakhali and Chittagong. A number of major rivers flow through these areas and land is generally fertile but often affected by saline water intrusion.

According to the 1991 census, the total population of Bangladesh is 1,07,993,000 and population density per sq.mi. is 1917. The per capita availability of land is 0.38 acres and average household size is 5.75 persons. The population of Bangladesh has more than doubled from 42.6 million in 1951 and the population growth rate rose from 1 percent in 1950's to 2.2 percent in 1990's (Table 2.1).

The effect of high population growth on human settlement is manifested in (a) the rising level of population density and increasing pressure on land, services and infrastructures, and (b) the deteriorating environment of human settlements associated with poverty and malnutrition. The land/man ratio has been decreasing with the increase of population and more agricultural land area is being used for homesteads in rural areas.

Urbanization is recent phenomenon in Bangladesh and by third world standard, Bangladesh is a low-urbanized country. Urban population was estimated at 11,842,707 (13.17 percent of the total population) in 1981 compared to 6,623,024 (8.8 percent of the total population) in 1974. An urban area is generally defined as a concentration of at least 5,000 population where the community maintains public utility service, electricity etc. and which is generally a centre of trade and commerce. Urban area includes municipalities, town committees, cantonment boards etc. In 1941 only 3.66 percent of the population lived in urban areas, rising to 13.17 percent in 1981 or increase of 359 percent. The growth of urbanization during 1941-1981 can be seen from Table 2.2.

Table 2.1 Population size and rate of growth

Census year	Population size (in million)	Rate of population growth (in percent)	Birth rate (per 1000 population)	Death rate (per 1000 population)
1951	42.60	1.00	47.80	38.20
1961	53.40	2.00	50.20	28.40
1974	76.40	2.80	47.40	19.00
1981	89.94	2.36	44.00	19.00
1991	107.99	2.17	34.10	11.80

Source: Statistical Yearbook of Bangladesh, Twelfth Edition, November, 1991. Bangladesh Bureau of Statistics, Statistics Division, Ministry of Planning, Government of Bangladesh, Dhaka.

Table 2.2 Rate of Growth of Urban, Rural and Total Population of Bangladesh by Census Years (1941-1981)

Census Year	Urban Population (in %)	Rural Population (in %)	Intercensal Change in Urban Population (in %)	Rate of Growth (%)		
				Urban	Rural	National
1941	3.66	96.34	43.20	3.59	1.58	1.65
1951	4.34	95.66	18.38	1.68	1.00	1.00
1961	5.19	94.81	45.11	3.72	1.83	1.92
1974	8.78	91.22	137.57	6.70	2.33	2.62
1981	13.17	86.83	87.00	6.70	2.30	2.36

Source: Census of Pakistan, Volume 2, 1961 and Bangladesh Bureau of Statistics, Ministry of Planning, Government of the People's Republic of Bangladesh, 1974, Bangladesh Population Census Report, National Volume, The World Bank, Urban Sector Memorandum, May 1981.

2.1 Urban settlement patterns

The hierarchical administrative centres established at divisional, districts, sub-divisional and thana levels during the British regime became centres of trade and commerce and developed into small and medium sized towns. Almost all urban areas in Bangladesh have strong village characteristics. Only Dhaka and Chittagong have big sections of purely urban built-up areas. In most town nearly 75 percent of the houses are kutcha (made of bamboo, grass, reeds) and paved streets and brick built houses co-exist with kutcha houses, open fields and cropped land. The eastern part of Bangladesh is much more urbanized compared to the western part. After the partition of India in 1947 and particularly after the emergence of Bangladesh in 1971, the region east of Padma-Jamuna attracted development because of their natural endownments, such as fertile agricultural land, natural gas, hydroelectricity and easy transportation offered by the Meghna-Pabma-Jamuna systems. The location and development of urban centres have been strongly influenced by the north-south transportation axes and delimited by river barriers. The area east of the Jamuna-Padma rivers and west of the Meghna river functioned as an agricultural hinterland to the state capital of Dhaka.

Dhaka metropolitan area includes Narayanganj, Tongi and Demra. Settlements in the areas dominate in terms of area and investment. To quote the World Bank-urban economic activity is concentrated in Dhaka. About 60 percent of all establishments surveyed by the census of manufacturing industries are located

in Dhaka, while 47 percent of all manufacturing employment is also concentrated here. Jute processing and textile, the two principal industrial activities of Bangladesh are centered in Dhaka. Dhaka has also been the major beneficiary of public sector employment.

Chittagong, the second largest metropolitan city is less than half the size of Dhaka and is linked by rail, air, road and water to its hinterland extending from north to south upto the tea growing areas of Sylhet. Chittagong also has a wide range of growing industries, such as ship-building, steel mills, oil refinery, warehousing and manufacturing industries.

Khulna, the third metropolitan city has rapidly growing heavy industries such as ship-building, jute mills, newsprint factories, cotton, textiles and various consumer industries.

Every large town has squatter seettlements and slums with problems of high density and congestion and non-availability of community services, such as drinking water, sanitary arrangements and drainage. There are also the acutely congested road traffic and the lack of open space and park, education and health facilities. In most of the cities, marginal and informal settlements occupy large areas of land. Available data indicate that squatters represent 10.32 percent of the total population of Dhaka, 12.21 percent of Khulna and 2.90 percent of Chittagong.

During the 1960's, industrialization acted as a stimulus for urbanization but thereafter it declilned because of economic stagnation and continued under developed infrastructure.

Urban population growth and the sky rocketing prices of land and conventional building materials have brought about serious urban housing problems. The 1973 housing census indicated a housing shortage of some 47,000 units in Dhaka 4600 units in Chittagong and 9500 units in Khulna.

Many of the existing housing units are of poor materials and are lacking adequate public services. The growing housing deficit is reflected in congested occupancy per unit and inflated rents. In Chittagong rents have risen by 260 percent since 1974 compared to an increase of 200 percent in the consumer price index during the same period.

Another surrvey indicates that the percentage of the total urban population living in poor clusters is approaching 37 percent in Dhaka, 30 percent in Khulna and 16 percent in Chittagong. The unbelievably high population densities in these clusters upto 2000 persons per acre in Dhaka and Chittagong reflelcts the deterioration that has taken place in recent years. 70 percent of all urban houses are temporary structures of poor quality and 90 percent of those who live in these structurally poor houses belong to the low and lower middle income groups. 93 percent of the low income group, 83 percent of the lower middle income group and 82 percent of the middle income group do not have access to safe drinking water.

The Dhaka Metropolitan Area Integrated Urban Development project reports that at least 100,000 households lack adequate access to one or more basic engineering services out of the estimated total

of 170,000 households suffering from critical housing conditions inclulding over crowding and dilapidated or temporary dwelling structures.

In Bangladesh the largest percentage of housing is provided by the private sector (90 percent in Dhaka and 93 percent in all other urban areas). Government rental housing and housing built and sold by the government constitute only about 7 percent of total urban housing. An estimated distribution of the present housing stock in Bangladesh is presented in Table 2.3.

2.2 Rural settlement patterns

Shelterlessness in rural areas is less visible because the homeless can find space with neighbours or relations. Nevertheless 14 percent of all rural families do not own any bhita (homestead land). Housing conditions are poor with 80 percent of the houses made of poor materials (bamboo and straw) which deteriorate quickly. The majority of the rural population do not have access to safe drinking water (tubewells) and therefore obtain their water supply for drinking and other purposes from rivers, ponds, tanks and other surface water sources. Settlement patterns in rural areas are as follows:

(a) Nucleated settlements:

In the high flat land of the northern Piedmont and Barind regions, settlements tend to cluster along the main thoroughfares. The low rainfall increases as it moves eastwards. The northern part is irrigated by sub-soil water while the

Table 2.3 Distribution of Present Housing Stock by type
(percent)

Type of Housing	Dhaka	All Urban Areas
Squatter Housing	2	2
Private Rental Housing	41	33
Private Owner Occupied Housing	43	53
Government Rental Housing	7	5
Government Built, Owner Occupied Housing	3	2
Others (Boats, etc.)	4	5
	100	100

Source: Urban Sector Mission Memorandum,"Housing Typology and Mterials Use".

southern part depends entirely upon monsoon rain fall. The southeastern margin is irrigated by surface water and shallow tubewells. As a result of these conditions houses are built with mud and straw and have been so arranged to assume a regular village shape giving a nucleated pattern to the settlements. The houses are comparatively compact and the villages consist of 200 to 400 families each.

(b) Scattered settlements:

Most of the deltaic plain of the country particulrly the river valleys and low moist regions are exceptionally fertile. These areas are inundated during the monsoon but at the same time the soil fertility is renewed by silt and sediment making agricuture profitable. Therefore people hold on to these arreas and build their houses by raising the homestead land with earth. Transport and communication links are extremely difficult and it is only during the flood season that movement is possible by boat.

(c) Linear settlements:

Banks raised by silt deposits offer good opportunities for establishing settlements because they are normally protected from floods, water for domestic purposes is available and transport and communications are easily manageable. Although the river courses change, the settlements which grew along the levees remain. In the Moribund delta and in some areas the linear settlement pattern persists although there is no active river running by.

(d) Dispersed and isolated settlements:

The fertility of the islands of the Bay of Bengal has attracted flourishing settlements which thrive on very productive agriculture and fishing. However, the off-shore islands are subject to occasional calamities, such as cyclones with storms, surges and hurricanes.

The typical genesis of such an island is as follows. After the island emerges, a few years have to pass before it becomes ready for cultivation because it takes time for the soil profile to form. The first family arriving on the island digs a fresh water pond for domestic consumption and erects a dwelling on the raised bank. In time more families move in and build their houses in a similar fashion next to their agricultural land. Thus dispersed homesteads grow, ultimately resulting in the formation of small isolated settlements. The whole island then becomes inhabited with dispersed and isolated primary clulsters developing a unique pattern.

(e) Sparsely built homesteads in hilly areas:

Unlike the deltaic plain region, the eastern part of the country is composed of low hills with luxuriant evergreen vegetation. The unique settlement pattern here has been influenced almost entirely by topography. Agriculture is difficult in such terrain and agricultural land is severely limited. The hill slopes are prepared for cultivation by terracing. On the first surface of the hills and also on the gentle slopes, where ever possible, a shifting method of 'Jhoom' cultivation is used. Other economically promising occupations are non-existent.

(f) **Clustered and highly dense homesteads:**

In the exceptionally lower depressions such as the 'haors' of the north eastern micro-region, homesteads are built on artificially raised mounds, resulting in the formation of clusters of high population density. In this pattern of settlements, it is extremely difficult for the government to provide socio-cultural and health facilities at reasonable cost.

2.3 Land

Land is a valuable resource which represents an important base for socio-political power, income and employment. Under the East Bengal State Acquisition and the Tenancy Act in 1950, actual tillers of rural land became direct tenants of the government, giving them permanent, transferable rights. Ceiling for cultivable land was fixed at 100 bighas (33.30 acres) per family and excess land was to be acquired for settlement of cultivators with less than 3 acres. Subletting of land was prohibited but share cropping was allowed.

The ownership pattern of rural land has deteriorated over the years. 14.27 percent of rural flamilies are landless while only 23.75 percent have homesteads. 69 percent of rural families have holding below 3 acres. About 10 percent of the total land owned are under homestead. Small farmers are selling land to the rich, while the share croppers are becoming more dependent on rich landowners for agricutlural credit, fertilizer, seed and service. Tenancy reforms are urgently needed to protect the rights of share croppers and to ensure that they get a fair share of their

produce. At present share croppers get only 50 percent of the crop and where the owner pays current input costs, share croppers get 66 percent of the crop.

Land price has increased rapidly in recent times. In and around Dhaka it increased 60 to 50 percent faster than the consumer price index during 1974-1978, partly because of speculation and the scarcity of suitable, flood free land. It has also been fuelled by the investments of high income groups and by wage earners working abroad, both groups effectively pricing low income groups out of the land market. Under the present system of land tenure, land owned by government as *Khas* land is limited. Almost all land in the expansion areas are owned by private owners and the process of acquisition is highly complex.

CHAPTER – 3

The City of Dhaka

3.0 Historical background of Dhaka

Dhaka is a city of four centuries old and is one of the 12th biggest cities in the world of 17th century. In 1610, Islam Khan, the first subedar Governor of Bengal, declared Dhaka the capital of Bengal and named it Jahangirnagar after the name of Mughal Emperor Jahangir. Small administrative units called *Mahallas* were formed within the city leaded by sardars. Boats were the important mode of communication through canals flowing in and around the city making it clean by carrying waste into the river Buriganga. Upto 1712 a total of 17 Mughal Subedar Governors chaired the capital of Bengal. Dhaka lost the glory of capital in 1715 when Murshid Kuli Khan declared Murshidabad as the capital of Bengal. Dhaka city was a commercial centre during the Mughal period and was one of the 12 big commercial centres in the whole of Mughal Empire. People from Iran, Arab, Greece, England, France, Portugal and various other countries came to Dhaka for business purposes. When Murshidabad became the capital of Bengal, a Deputy Governor called Naib-E-Nazim was posted at Dhaka to rule East Bengal upto 1843.

Dhaka became the capital of East Bengal and Assam in 1905 when greater Bengal was divided. In 1911 both wings of Bengal were united again due to mass movements. This time Dhaka city was expanded beyond Fulbaria railway station and a large number of Government buildings, roads were constructed. The city became the capital of East Pakistan in 1947 after independance from British regime. In 1971 Dhaka again earned the glory of capital city after liberation war. Thus the city was developed

historically as an witnesss to ups and downs of different empires and political movements.

3.1 General development of Dhaka

Dhaka in the very early period of its history developed in an informal way. This informally planned part of the city, what we called old Dhaka, developed before the introduction of mechanized vehicles. Palanquins, horses and horsedrawn carriages were the principal means of urban transport and the city developed with narrow winding streets as thethen transportation system demanded. OLd Dhaka developed as mixed-use area with commercial and business activities lined along the roads while residential areas extended just beyond them. Concentration of commerce, business, industries and residences has turned old Dhaka into a heavily populated area.

Dhaka actually began to develop in a planned way during the later stages of the British colonial period. Its strategic location and its importance as a centre of trade and commerce necesitated the provision of required administrative machinery and urban facilities. The city centre at that time was focused at *Sadarghat*.

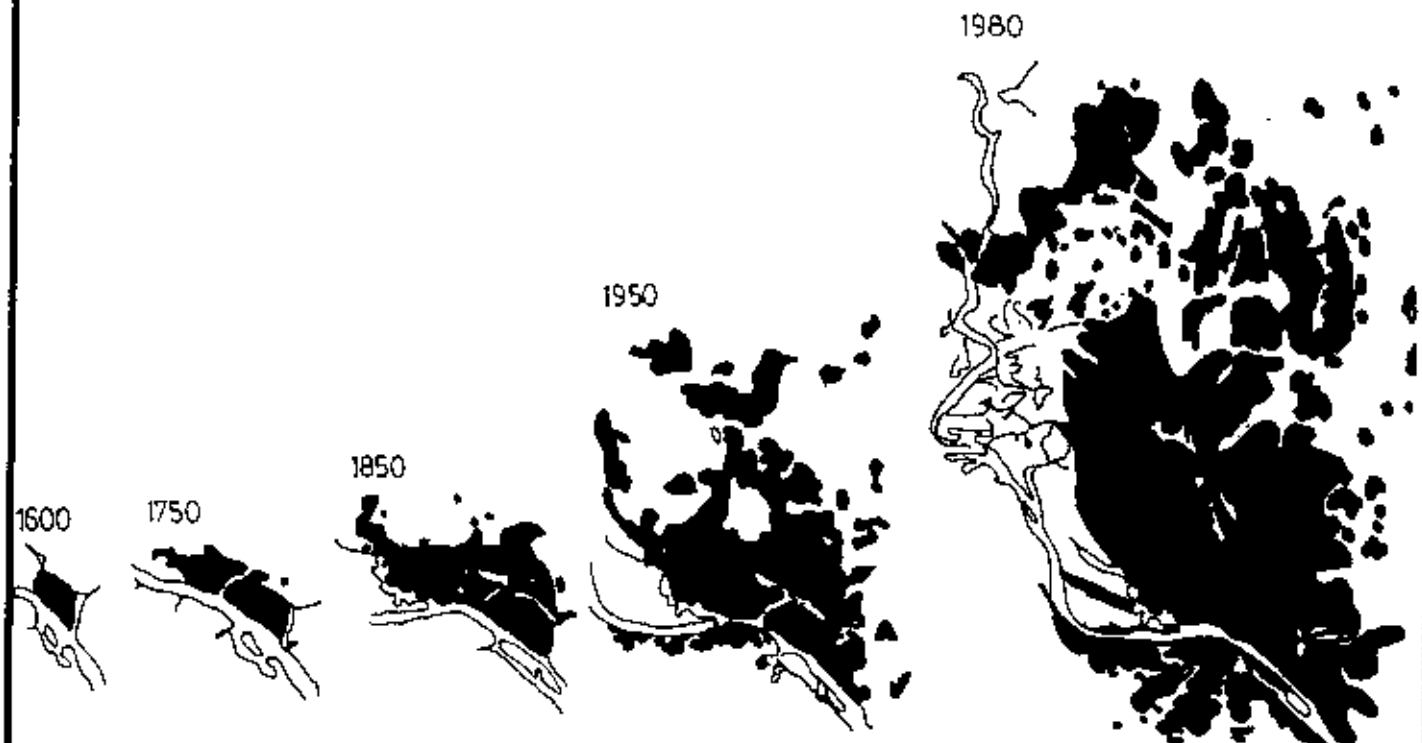
Development of Dhaka as a city began after 1947 during the Pakistan period. The principal communication and transportation routes developed and the new city developed from the old railway line onwards to the north. This railwlay demarcates old Dhaka from new Dhaka.

New Dhaka developed with the establishment of the Dacca Improvement Trust (DIT) now the Rajdhani Unnayan Kortipakhya (RAJUK). In the newer part of the city, activities were compartmentalised and the Master Plan prepared in 1958 was mainly followed. The new commercial centre of Motijheel, high-income residential area of Dhanmondi developed based on that Master plan. New Dhaka has well-developed roads and public facilities. The government administrative centres and other related public agencies, residential quarters of government employees, universities and large scale public parks and gardens occupy a great part of Motijheel, Ramna and Lalbagh police station.

The areas further north were developed during the 1960's. Large scale housing projects namely Mirpur housing estate and Mohammadpur housing estate were developed in the area of Mirpur and Mohammadpur for low-income as well as middle-income families. Gulshan and Banani were developed as high-class residential areas. The Uttara model town and Baridhara were developed by RAJUK. Beside the housing area of Uttara, the Zia International Airport is located in the same area which has been transferred from its former location in Tejgaon. Tejgaon was developed as an industrial area and to the west of Tejgaon is Sher-e-Bangla Nagar, where the new centre of Government, the Sangsad Bhaban is located (Fig. 3.1).

Even after the creation of Bangladesh it has never been possible on the part of the Government to make provisions for adequate housing facilities and job opportunities for the city residents or to the citiy migrants. As a result, large areas of unplanned

Fig. 31. THE GROWTH OF DHAKA (1600 - 1900)



THE DHAKA CITY AREA

0 1 2 3 4 miles

SOURCE : DMAIUP, Final Report Vol. 1

housing and squatter settlements have sprung up in the areas in between the planned areas and in the open areas in the northern part of Dhaka. Private housing developments are also covering the low, wet areas to the east and west. Houses are built by earth filling without the minimum community facilities. In this way large part of the low-lying areas, canals and water ways which act as natural drainage ways are disappearing due to unplanned housing and other develoopment activities.

3.2 Population trend

The population census covering Dhaka takes into account the Dhaka Municipal Corporation, Narayanganj Municipality, Tongi Municipality and the surrounding areas. According to the Bangladesh Bureau of Statistics the urban population of Dhaka showed a dramatical increase from 0.71 million in 1961 to 2.32 milllion in 1974 and 3.72 million in 1981.

Another study taken up by JICA showed that population of Dhaka increased from 0.41 million in 1951 to 3.44 million in 1981. Estimating the past trend of growth, the rate of increase has been approximately 3 percent or more for the Dhaka region (Table 3.1).

3.3 Topography of Dhaka

Bangladesh is generally described as a flat, alluvial plain. The land is floored with quaternary sediments deposited by the three great rivers. In the central northern part of the country there

Table 3.1 Characteristics of Landuse and Population change by Thana (1974-1981)

Thana (In Census)	Characteristics of Landuse (Population Change)	Growth Rate (annual)
(Old Dhaka)		(4.02%)
Sutrapur	High density area (population stagnant) Sprawl area (populaltion Increase)	4.12%
Kotwali	High density area (pop. decrease due to departure of residents) slum clearance (population decrease)	-2.43%
Lalbagh	High-middle density area (population increase) Sprawl in low area in the west (pop.increase)	10.05%
Ramna	Government District, Metropolitan Park, High class residential area (population stagnant), Sprawl area in the north (population increase).	4.60%
Dhanmondi	High-class residential area (population density low), Medium-class residential area (population stagnant), Slum colonies in green belt (population increase)	-1.43%
Motijheel	New CBD, medium-class housing area, Govt. living quarters, Housing progressing outside railway compound (population increase)	20.48%
Tejgaon	Govt. Offices, Govt. living quarters, industrial park, Slum colonies in all areas (population increase)	14.16%
Mohammadpur	Old medium-class housing area, housing construction in progress (population increase)	7.12%
Mirpur	Planned housing development area (medium low-income), Partially occupied by slum camps (population increase)	4.50%
Cantonment	Official living quarters and millitary facilities (population increase)	4.43%
Gulshan	New high-class housing under construction (population increase)	- 0.90%
Demra	Sprawl camps in the west Dhaka urban areas, Sprawl camps in the DND areas	15.74%

Source: JICA

are two major areas of pleistocene terrace sediments: the Madhupur tract and the Barind. These terraces stand as an island above the surrounding active flood plains of recent origin.

Dhaka is located at the southern tip of the Madhupur tract. The tract is a continuous block of 1500 sq. m. which rises to a height varying between 10 m and 20 m and is surrounded by the flood plains of the Buriganga and Balu rivers (Fig. 3.2 and 3.3).

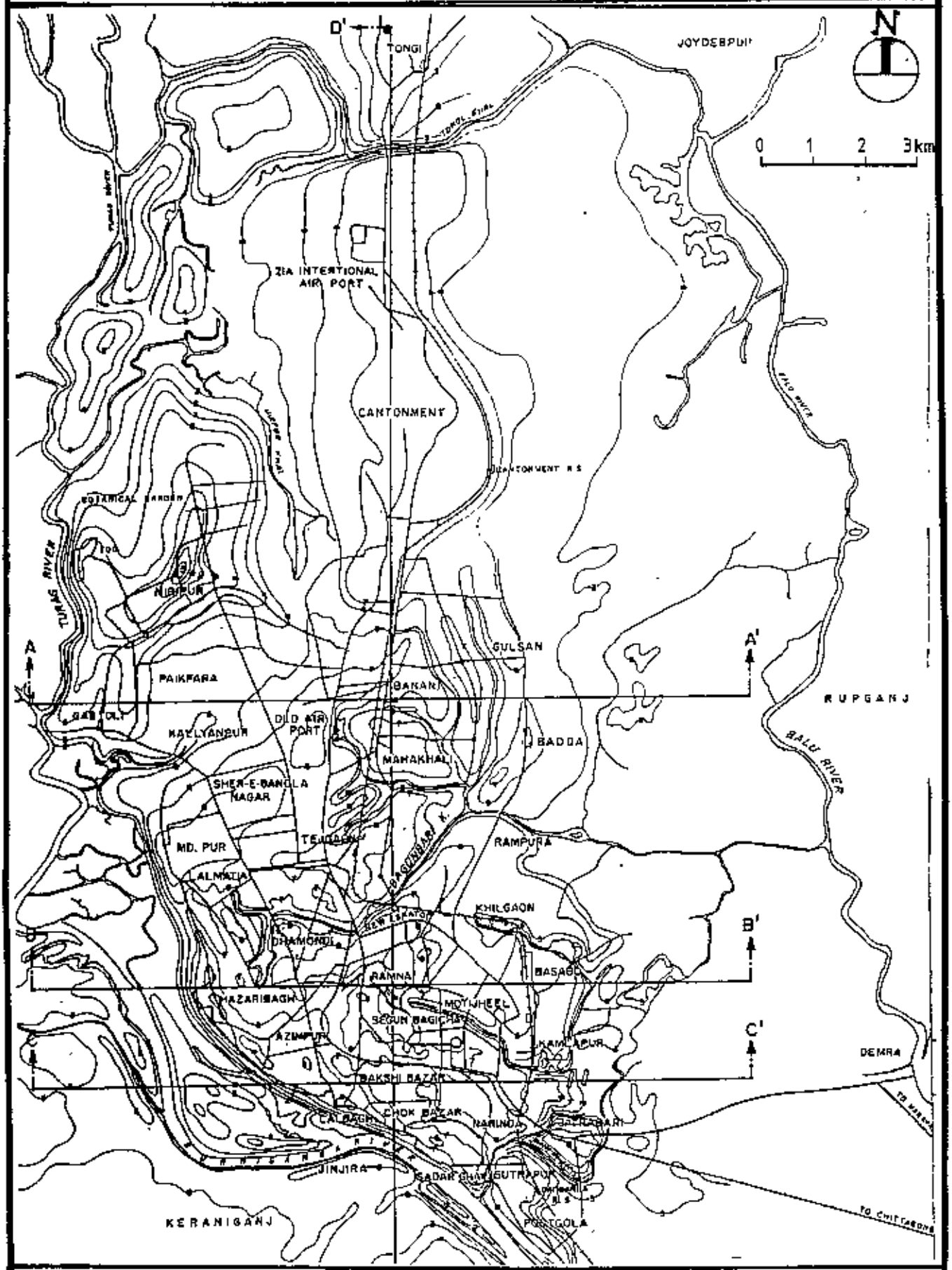
Large low lands surround Dhaka, the flood plains of Buriganga lies in the western and southern part and to the eastern part lies the flood plains of Balu rivers. Due to limited flood-free areas, Dhaka is now spreading into these low-lying flood plains by the use of land accretions.

3.4 Rivers in and around Dhaka

Dhaka drains directly and through drainage canals into the Turag river on the west, Tongi khal on the north, Balu and Sitalakhya rivers on the east and Buriganga river on the south. The Tongi khal connecting Turag and Balu rivers changes its flood direction according to hydraulic conditions of both the rivers. Waters of the Turag, Buriganga and Balu rivers are collelcted by Dhaleswari river and finally conveyed to the Bay of Bengal through the Meghna and Ganges-Padma rivers.

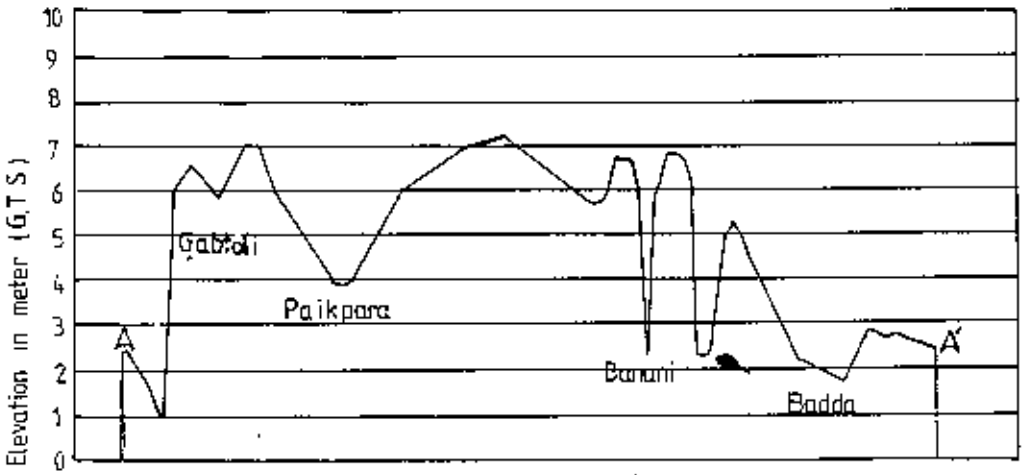
The water levels of the Turag, Buriganga and Balu rivers and Tongi khal are affected not only by discharges from the upstream rivers (namely the Dhaleswari, Bansi and Old Brahmaputra) but also by backwaters from the downstream rivers: the Dhaleswari, Sitalakhya, Meghna and Ganges - Padma rivers. In the dry season, they sustain tidal effects of the Bay of Bengal.

Fig. 3.2 Topography of Dhaka.

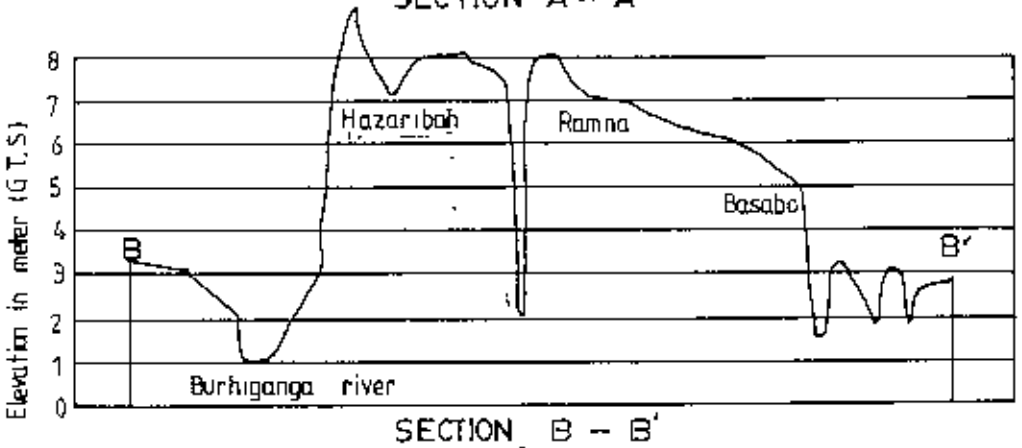


SOURCE :-JICA

Fig. 3.3. Cross Sectional Elevation



SECTION A – A'



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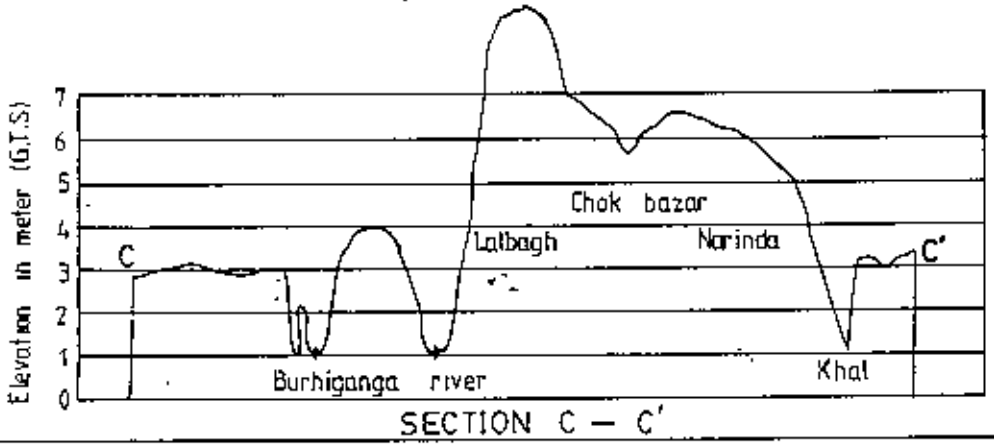

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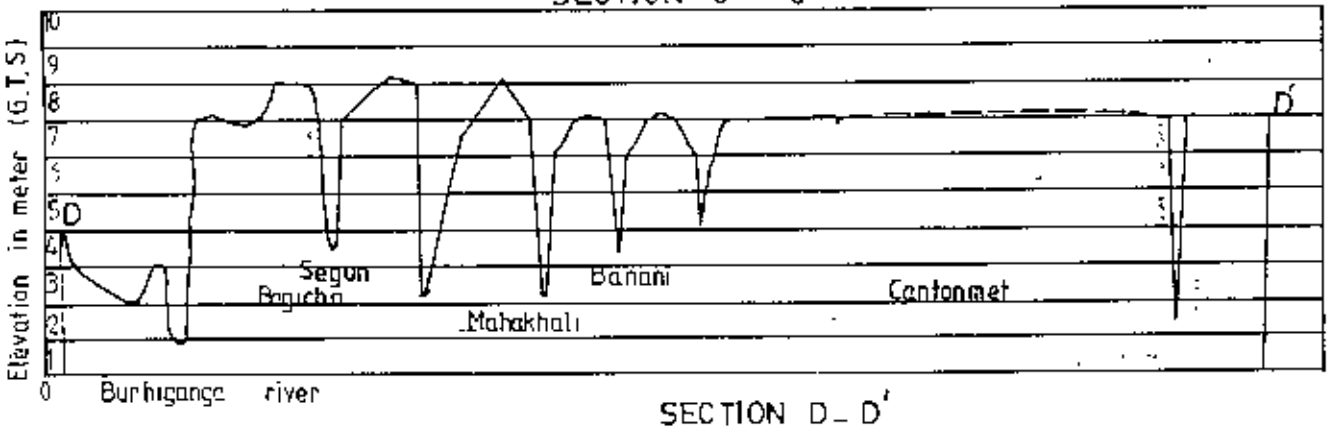


SECTION D – D'

SOURCE :- JICA

3.5 Water bodies inside Dhaka

Water bodies (other than rivers) such as ponds, lakes and canals are used not only for flood control but also for recreational and other purposes. There are many ponds, but the Dhanmondi Lake, Ramna Lake, Crescent Lake and Gulshan Lake are the only ones worth mentioning.

The Dhanmondi Lake is located in the midst of a high-class residential area and lies within a park. This is mainly used for recreational purposes. A large volume of sewage and wastage from tanneries are discharged into the lake. This pollutes the water and results in obnoxious odour.

The Ramna Lake is located in the heart of the city and is mainly used for recreational purposes. Here the domestic waste water inflow is controlled.

The Crescent Lake is manmade and has been designed as part of the Sangsad Bhaban. It is a famous visiting spot in the evening time.

The Gulshan Lake is a large one and the area around it is sparsely populated. During recent years the western portion of the area has been developed as a high-class residential area. The domestic waste water inflow is controlled and volulme of water storage is large.

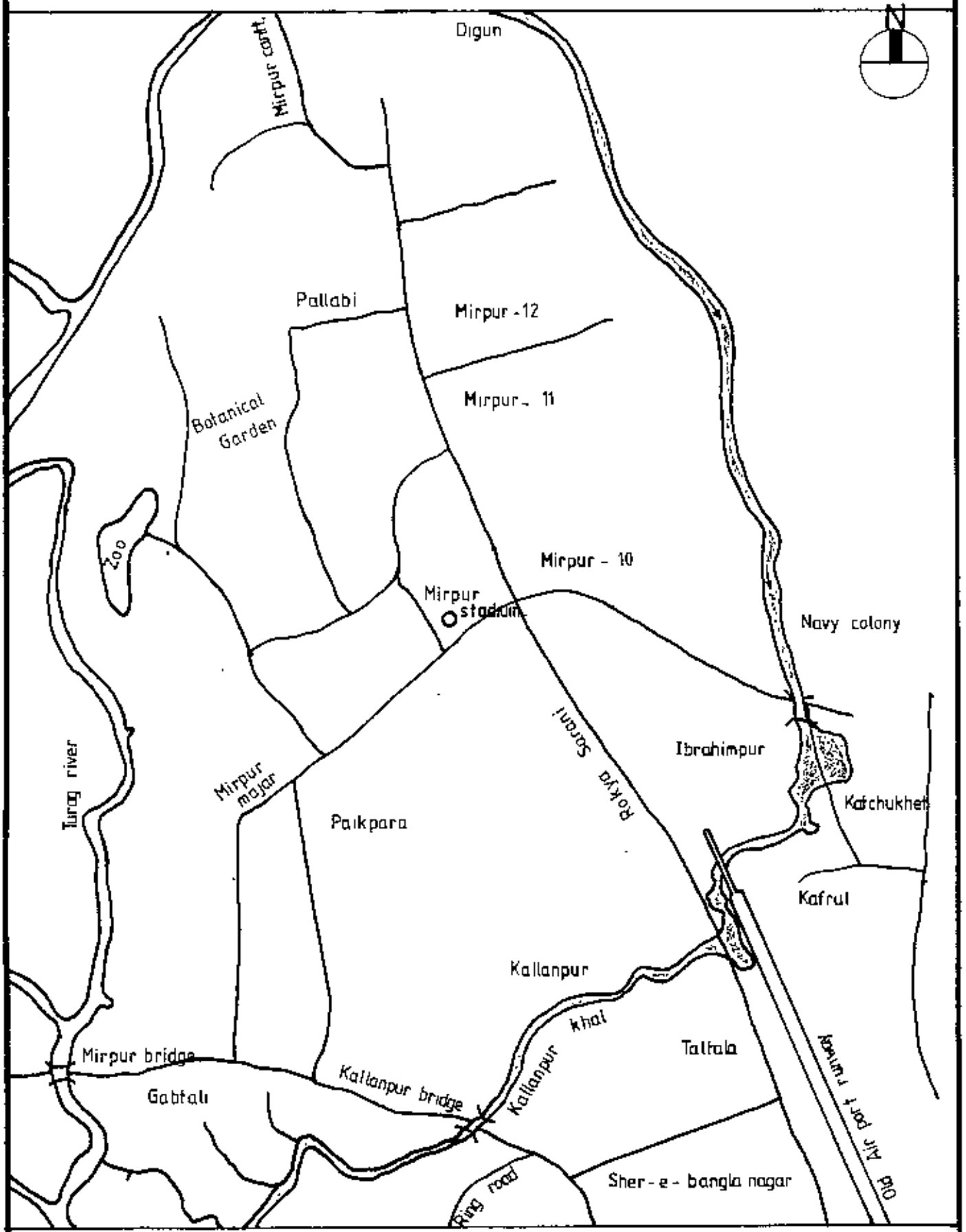
There are three groups of major drainage khals in the city:

(a) Digun Ibrahimpur Kallyanpur khal (Fig. 3.4a).

(b) Gulshan Banani Begunbari Dhaanmondi khal (Fig.3.4b).

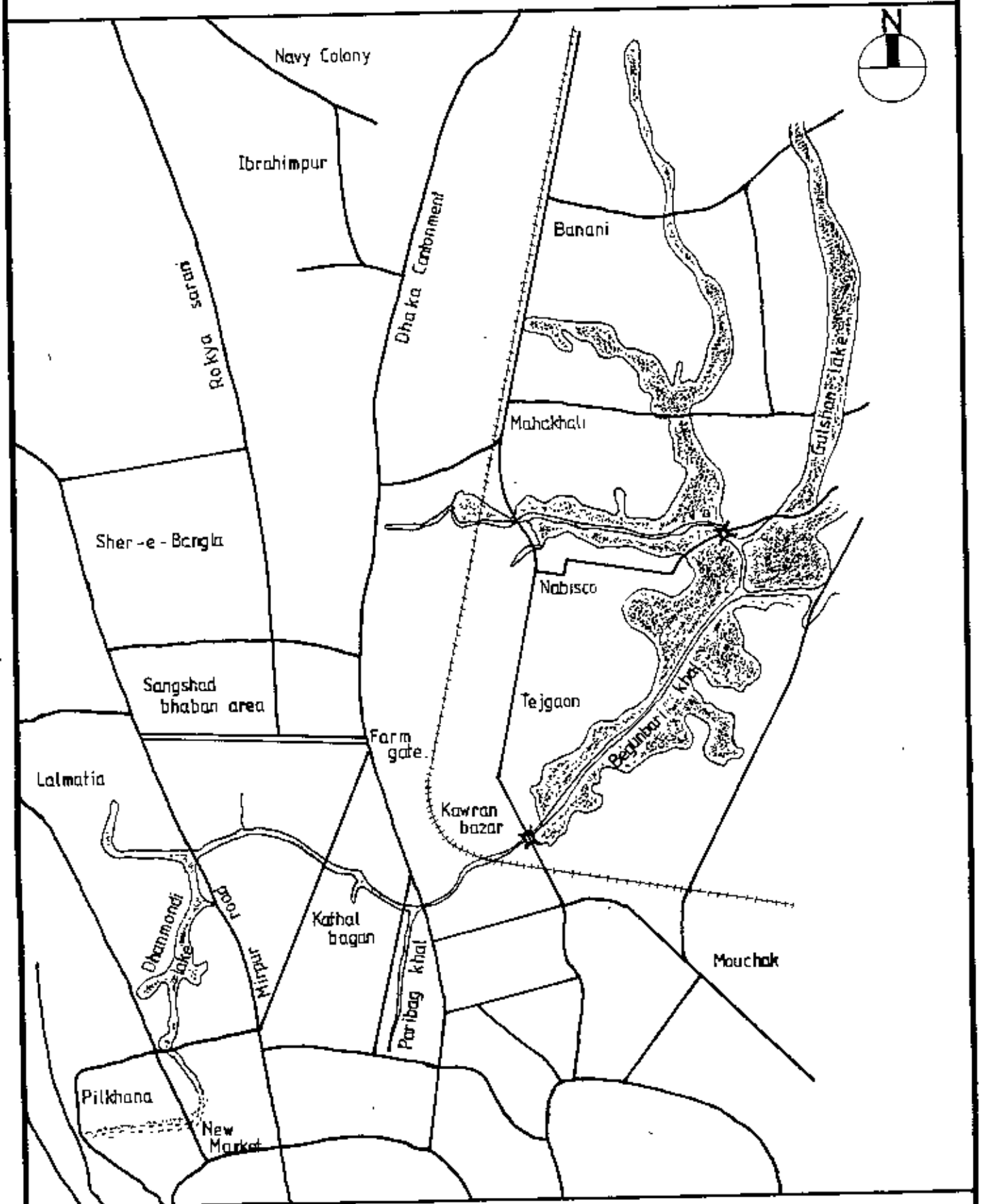
(c) Dholai Segunbagicha khal (Fig. 3.4c).

Fig-3.4a : Digun - Navy Colony - Ibrahimpur - Taltala & Kallayar-pur Khal.



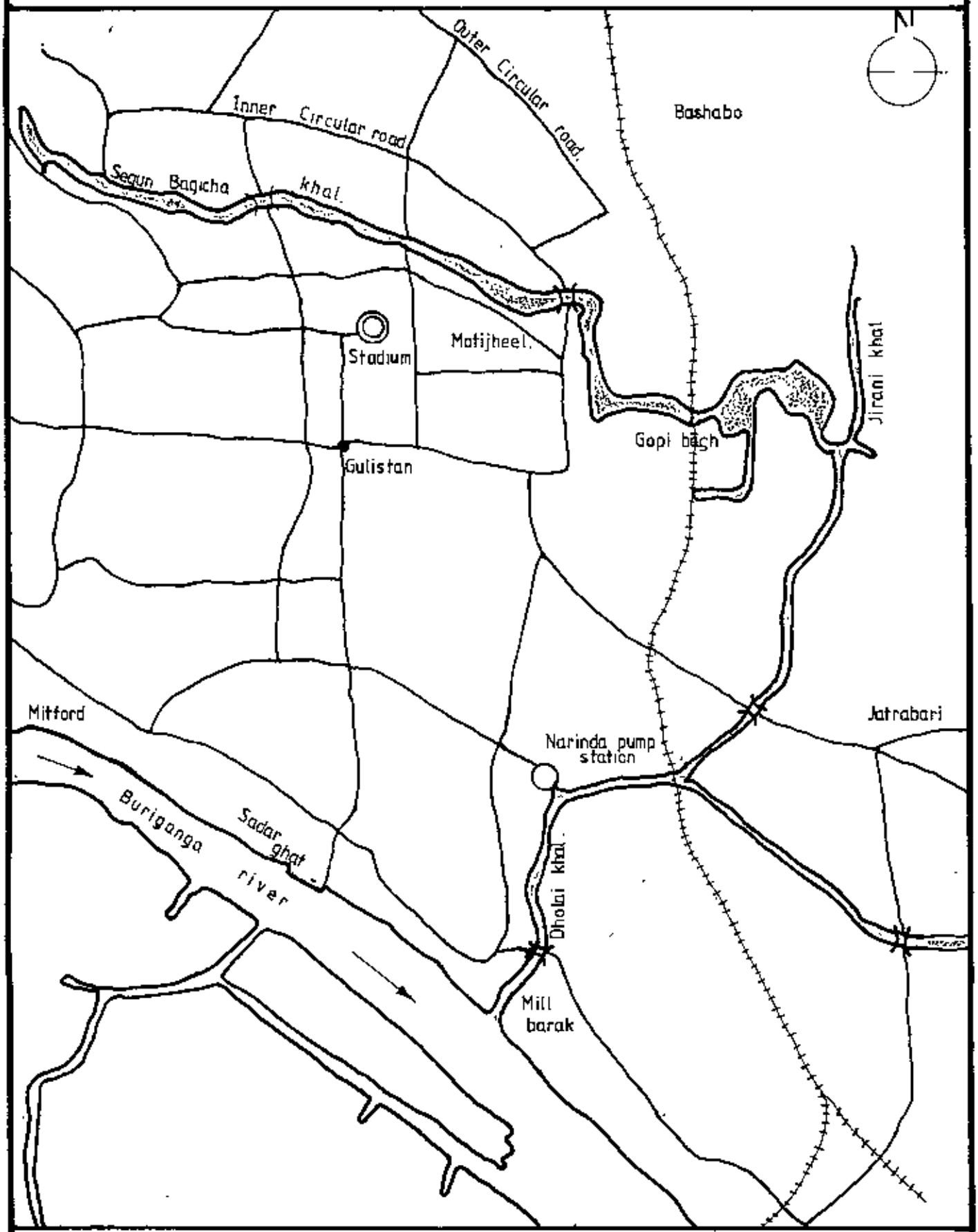
SOURCE :- INSTITUTE OF DIPLOMA ENGINEERS, BANGLADESH.

Fig. 3.4b : Gulshan - Banani - Mahakhali - Begunbari khal.



SOURCE : INSTITUTE OF DIPLOMA ENGINEERS, BANGLADESH.

Fig. 34c : Dholai – Segunbagicha - Arambagh - Gopibagh – Girani khal.



SOURCE : INSTITUTE OF DIPLOMA ENGINEERS BANGLADESH.

3.6 Climatic conditions

Dhaka has tropical monsoon climate and the distribution of temperature over the year characterises three distinct seasons: the cool, the warm and the monsoon. The average annual rainfall is about 2000 mm.

The warm season occurs in March and April. It is characterised by high temperatures, which occassionally exceeds 40°C. Frequent thunderstorms and cyclones range to about 90 km per hour. The range of humidity is generally low in this season.

The monsoon or rainy season extends over the months of May upto October. During this season 90 percent of the rainfall occurs. Storms are of high intensity and may be durable for several days. High temperatures (generally in the range of 40°C) coincide with high humidity (80 percent to 90 percent) and the sky is generally cloudy. Cyclonic storms of destructive nature are frequent during this season.

The cool and dry winter season begins from the month of November and continues upto the month of February. Occurances of rainfall is rare. Temperature is generally under 35°C and may drop to a minimum of about 5°C. The range of humidity is relatively low and the sky is mostly clear, blue.

CHAPTER – 4

Flood, Flood Control, Need for Urban Flood Control

4.0 Meaning of flood

Floods mean many thing to many people depending on the profession they are engaged in. To the poor village people who are caught in the swirling mud laden waters it represents terror and unlimited suffering through damage of homestead, loss of crop and livestock, and increased incidence of disease. To the urban people it means suffering in various ways e.g. through disruption of communication, deterioration of sanitation, rise in prices as movement of essential supplies is disturbed and loss of wages as factories are closed, movements are restricted and commerce and business activities are reduced. To the government flood means additional expenditure for rescue and relief, rehabilitation measures of damages to communication network and major set back in economic growth. Major metropolitan, if go under water for a prolonged duration and exceeding certain depth, the economy of the country may suffer tremendously as commercial and business activities almost come to a halt. Government of Banglaldesh almost every day cites flood as the main reason why the targeted economic growth in the past could not be achieved. To civil engineers who are responsible for design, operation and maintenance of flood protection means a professional challenge as well as nightmare when the structures are threathened or when the forecasts are upset by actual level of events.

4.1 Definition of flood

In Webster's new international dictionary a "flood" is defined as a great flow of water specially, a body of water, raising, swelling, and overflowing land not usually thus covered; a

deluge; a freshet; an inundation. Commonly it is considered to be phenomena associated with an unusually high stage or flow over land or coastal area which results in severe detrimental effect. Nishat (1990) distinguished between flood and inundation. According to him when an area goes under water and remains so for sometime it may be called inundation but when this inundation causes damage to property and life, disrupts communication and bring harmful effects to not only human being but also to flora and fauna, it becomes flood.

4.2 Causes of flood

Floods are mainly caused by excessive precipitation which drains into the river causing spilling over the banks into adjacent areas. The situation is made worsed due to constriction of cross-section of rivers and canals caused by siltation of river beds, inadequate drainage, backwater effect at junctions of tributaries.

In Bangladesh heavy monsoon rainfall coupled with its location at the lower most reaches of three mighty rivers, which drain a vast wet basin and low altitude of major parts of the country among others make floods an annual phenomenon here. Floods occur due to different causes, which can generally be classified as natural and man made.

4.2.1 Natural causes

(a) Precipitation:

Maximum rainfall occurs during the monsoon which has been recorded as 90 percent to 95 percent of annual rainfall. Approximately 300 mm to 400 mm of rainfall is received during the June - August period and 150 mm to 300 mm in September and October.

(i) Direct precipitation - Since the city is located within the typical monsoon climate zones, it receives an approximate averagee rainfall of 2000 mm which sometimes exceeds the capacity of the existing drainage facilities and causes flooding.

(ii) Inflow from surrounding areas - In the past the city was criss-crossed by numerous lakes and canals, which provided an excellent means of communication as well as a very natural drainage system. Due to rising population pressure and scarcity of buildable land within the city, the low-lying areas and canals are being filled up. Excessive precipitation over the surrounding flood plains causes accumulation of water, the excess water flows towards the city and thus causes flood.

(b) High discharge of rivers:

The water levels in the rivers surrounding Dhaka are affected not only by discharges from the Padma, the Brahmaputra river and local rainfall but at time it is affected by the backflow of

waater from the Dhalelswari and Sitalakhya rivers and the river Meghna, when these are seriously affected by heavy rainfall in the northeastern part of Bangladesh and high tide in the Bay of Bengal at the same time.

(c) Siltation of river beds:

Large silt loads in Himalayas tributories leads to siltation or aggradation and increasing flood levels. The main stem of the river systems in general shows no such aggradation, as the velocity of the main stem and larger floods scour out the silts deposited in earliar years. So no major changes are recorded over the years.

But, as the Ganges and Jamuna flows over the flat deltaic plain of Bangladesh, the flowing velocity counts down and allows for the deposition of the silt. Extensive siltation causes blockages and thus overspilling of the river.

(d) Inability of the surrouuding area to drain of quickly:

The low-lying flood plains are used for agricultlural activities during the dry season of winter. But the growing development activities increase impervious areas and hampers the natural drainage pattern.

4.2.2 Man made causes

Man made activities sometimes contribute to occurance of flood. Steps taken to minimize flood may be rendered ineffective due to various causes. These are in generally:

(a) Inadequate drainage facilities:

Floods may result from inadequate existing drainage facilities and their improper operations and maintenances. Some of the reasons for poor drainage are mentioned below:

(i) Insufficiency of drainage pipes: Insufficient diameter of drainage pipes cannot drainout high water level of heavy rainfall.

(ii) Low drainout capacity of existing drainage pipes: Most of the existing pipes have very low drainout of discharge capacities to handle habitual storm rainfall.

(iii) Blockage and clogging of existing drainage pipes: This problem takes place just about everywhere due to dumped garbages and sediment deposits in open drains or inspection pits.

(iv) Disregard of drainage lines during construction of utilities: When proper care is not taken during construction of roads, laying out of water supply lines and telephone cables, etc. it may dissect of the drainage line.

(v) Illegal connection of household waste water line to storm line: Illegal connection of housoehold waste water line to storm line decreases the discharge capacity.

(vi) Problems at the pumping station: There is only one pumping station in the city at Narinda. This station cannot be fully operated due to mechanical problems.

(b) Encroachment of the water way:

Filling and damming of water courses for housing and other development activities and insufficient water ways under bridges, undersized and improperly designed culverts at roads and rail way crossing creates bottlenecks.

(c) Filling of low-lying areas, canals, ponds etc.:

Filling-up of low-lying areas, canals or ponds prevents the natural surface detention storage. The existence of these water bodies not only control floods but also serve the purpose of recreation and other activities.

(d) Rapid urbanization:

Rapid urbanization increases development activities, which in turn increases the impervious areas, increasing population in recent years.

(e) Low-priority given to flood control measures:

Low-priority given to flood control and drainage programmes, in turn leads to slow implementation of projects and poor maintenance of existing drainage facilities. Poor maintenance of drainage canals results in a reduced flood capacities causing flood.

(f) Awareness of the citizens:

If the city residents are not aware of the results of garbages dumped in drainage lines or the haphazard and uncontrolled

development activities etc. will lead to disruptions of the smooth flow of city life.

4.3 Flood control

Any effort, aimed to control or modify the water flow causing flood, called structural measure, or aimed to reduce flood damage and suffering, called non-structural measure, can be termed as flood control measure. Thus by "flood control" in real terms we mean "protection" as well as "reduction of losses". In our country "flood control" is a general term. Rather "flood-damage mitigation" would have been the proper term which has already been adopted in Australian practice (Linsley and Franzini, 1979) to emphasize that absolute control over floods is rarely feasible either physically or economically. Aim of flood control, flood management or flood mitigationn is to reduce flood damage to a minimum consistent with the cost involved.

4.4 Different types of flood control measures

All flood control activities can be categorized into **structural** and **non-structural** flood control measures. Non-structural flood control measures mitigate flood damages by modifying damage susceptibility of property in the flood plain or by modifying the loss burden. In contrast, the more well known structural flood control measure, such as reservoirs, dams, flood by pass, flood walls, levees and detention basins mitigate flood damages by modifying the characteristics of the flood. Non-structural flood control measures are further characterized by the relative

simplicity or design and construction technology and the small scale, local level at which these measures reduce the flood hazard.

The different measures for flood control are briefly described as follows:

(a) Water control measures:

By these measures flood waters are either controlled or flood water resistant materials and products are used to minimize or reduce damage to facilities.

(b) Land use control measures:

The development of land lilable to flooding is restricted by either direct regulation or by indirect in documents to develop elsewhere. This may inclulde removal of existing development.

(c) Financial measures:

These measures may involve a redistribution of the costs of flood damage from those directly affected to other sectors of the community. Grants and loans to flood damage victims are an obvious example of community aid.

4.4.1 Structural measures

The steps that require hydraulic structures or any other sort of channel and catchment modification to alleviate the flood damage are known as structural measures. Their primary objective is to reduce or to regulate the discharge or stage of the rivers and

if not so, to protect the area by putting up a physical baarrier to protect the land from being inundated. The conventional structural approach for flood control works adopts one or more of the following methods (Kuiper, 1965; Linsley and Franzini, 1979):

- storing water in reservoirs for release at controlled rates during the passage of a flood or after the threat of flooding has passed.
- improving flow conveyance by channel improvements so that flood stages can be reduced.
- reducing the rate of run-off from lands by catchment treatment.
- confining the river to a definite course by building levees/embankments/dikes or flood wall.

4.4.2 Non-structural measures

Non-structural measures are administrative as well as technical measures aimed at the alleviation of flood losses which does not involve modifications of flood flows. The different non-structural measures are:

- Flood Forecasting and Emergency Warning.
- Flood Plain Zoning.
- Evacuation and Shelter Management.
- Flood Fighting.

4.4.3 Embankments and flood walls

One of the oldest and most widely used methods of flood control is to create a barrier preventing overflow called embankments or dikes Embankments act as barriers between a stream and the area to be protected by confining flood water within the river.

Embankments and flood walls are essentially longitudinal dams erected roughly parallel to the river. Embankments are also known as dikes and levees. The functional aspects of both embankments and flood walls are same. The difference is that the embankments are usually massive earthen structures while the flood walls are generally compact concrete structures. A special case of embankment, when it encircles an area completely, is known as a polder. This is generally done when the concerned area is vulnerable to flooding from all directions.

However, embankments are with mixed blessings. Embankments tend to produce a number of undesirable side effects:

Firstly, the confining of flood flows within embankments lead to a rise of flood levels in the channel. This exposes downstream areas and strip between the channel and embankment to higher floods.

Secondly, the river channels have to transport more sediments than before embankments were constructed. In most case this leads to a rise of the river bed. The continuous aggradation of river beds undermines the effectiveness of embankments.

Thirdly, embanking may produce an increased meandering or shifting of the river channels because of increased flood velocities in embanked channels. This contributes to frequent erosion of embankments. Thus, embankments have to be continuously repaired.

Fourthly, if adequate measures are not planned in advance embankments may lead to the problem of interior drainage. In some embanked areas there is an acute shortage of water in the beginning of the dry season.

Fifthly, embankments obstruct the flow of silts into fields. In some areas of Bangladesh there are also reports of moisture deficiency and hardening of the soil.

Sixthly, embankments may adversely affect the production of fish and dislocate the traditional nevigational routes.

Seventhly, the change in natural hydrology in certain areas may also create health hazards to the human as well as the livestock population.

Finally, the embankment fosters increased flood plain occupancy. When a flood of greater magnitude compared to design flood occurs, much greater damage is done than if no embankment had been constructed at all.

4.5 Need of urban flood control in Bangladesh

The flood control/mitigation projects undertaken so far in Bangladesh are mainlly aimed at agricultural development. Flood protection measures benefit all the three main crops viz. Aus, Aman and Boro depending on locality (Ahmed and Nishat, 1987). Flood control project besides preventing occurrence of flood also aim at improvement of drainage and if possible providing irrigation facilities in the protected area. However, all design parameters are chosen in consideration to agriculture only (Ahmed, 1987).

Flood control for urban areas did not receive any attention possibly because the main focus had been on rural areas. But recent devastating floods in 1987 and 1988 have drawn the attention of the researchers and planners to this aspect of flood problem. Hastily flood control plan for the Dhaka city area has been prepared and is being implemented on piecemeal basis (Nishat and Monowar, 1989).

Urban development plans need to take into consideration protection from flooding and provision for adequate drainage. Cities often expand and can bring fringe areas within city limit where problems can be more acute. This is observed in Dhaka when the low lying areas are prone to flooding every year while the relatively high areas are only periodically subjected to flooding, however the flooding was so extensive that only about 58 square kilometers of the total 260 square kilometers were left

unsubmerged (JICA, 1990). Efforts for flood control for urban areas if not properly designed may have compounded environmental health hazards due to the lack of consideration for an adequate drainage, thus resulting in polluted water remaining stagnant in low lying land for long periods of time. The lack of coordination in collection and disposal of solid waste may also contribute to localized flooding through clogging of drains. Similarly inadequate and ineffective excreta management results in high levels of exposure to water borne pathogen during floods. Clear need thus emerged to integrate flood protection works with other infrastructure investments and environmental improvement measures to maximize benefit for the flood protection plan for urban areas (JICA, 1990).

The flood control measures which need to be undertaken for urban areas should take into account many other considerations in addition to those for rural areas. Considering the losses and sufferings in various sectors due to flood in a city, the level of protection, submergence tolerance etc. must be different for urban flood control works. Submergence of Dhaka or Chittagong or Khulna i.e. a major metropolis can cause disruption to international as well as intranational trade, business, commerce, industrial production etc. As such speical attempts to protect urban areas is being significant.

CHAPTER - 5

Experience with Flood Control Projects at Home and Abroad

5.0 Bangkok flood control and drainage system

5.0.1 Introduction

The location of Bangkok is on the lower *Chao Phraya* river delta with flat ground elevation of 0 - 1.5m MSL. This area is naturally flood prone and the urbanization area is rapidly expanding into the flood-plain on both sides of the river. The rapid development of urbanization has caused many changes to hydraulic characteristics of this region such as the reduction of natural flood storage by land filling at construction sites, reduction of drainage capacity by filling up of drainage canals for road construction, squattering and illegal land acquisition at the banks of the drainage canal and changes of flow directions due to the land subsidence caused by overpumping of ground water.

The changes due to urbanization aggravates the flooding problems by increasing the peak level and prolonging the flood duration. Although the people who had originally lived along the riverside were accustomed to the flooding and they were prepared for it and thus resulting in no substantial damages. However, those who are new-comers and those who 'live away from the waterways are unaware of the flood-prone characteristics of the region and are exposed to a very high risk of damage.

It has been observed that flooding occured quite often in the past decade as in 1978, 1980 and 1983. The damages in these years are in the order of thousand million bhat. Particularly in 1983, only direct damages were about 6600 million bhat. As

the land subsidence and urban development continue, the damage would be increased every year if no proper flood protection were implemented.

5.0.2 Cause of flooding

(a) Natural factors:

(i) Direct precipitation

The heavy rainfalls are regular in this region due to the southwest monsoon during May to October and heavy rainfall due to depression storm from the South China Sea during August to October. Rainfalls due to depresion storm normally have high intensities e.g. 53mm/hr at 2 year return-period. The urban discharges presently exceed the capacity of drainage in many areaas of the city.

(ii) Inflow from surrounding area

The rainfalls over the flood plains surrounding Bangkok city concentrate into the canals and flow toward the river which lies accross the city. This large flood plains produced a sizable flow and increase the risk of the bank-overflows of the drainage canals. However, the King's dike on the east bank, and the southern railway on the west bank are effective in blocking the inflow to city. Good drainage system and pumping are required to drain city water to the river.

(iii) River over-flow and tidal affects

The flood peak in the *Chao Phraya* river from the north normally passes the *Chao Phraya* dam in mid October and reaches Bangkok in

Novembmer. The estimated peak level at *Pak Kred* will be at 2.70m MSL at 3600 cms at 100 year return period.

The tide in the *Chao phraya* river is highest from November to Decemer. Thus the water level in the lower part of the *Chao phraya* river is highest at the beginning of November. The peak level of 2.10 mm MSL at 3500 cms backup flow-rate has been estimated at 100 year return period.

At present on the east bank, roads serving as dike along the *Chao Phraya* river can protect over spillage of flood water in the city except unusual high water level in the river. On the west bank, flood wter can flow through along and over spill into the city. Thus flooding in this area is greatly influenced by river and tide.

(b) Man made factors:

The secondary factors of flood are due to the change in landuse and changes of the characteristics of the ground surface. Important factors are:

(i) Poor or insufficient internal drainage.

(ii) Rapid changes of land-use without adequate counter measures to prevent urban impoundments.

(iii) Land subsidence.

5.0.3 Method of flood protection

(a) River basin development:

In order to reduce the risk of river overspills many counter measures can be taken. Reservoirs could be constructed to store river flow in the rainy season. The river cross-section can be enlarged and bends can be replaced by short-cuts in order to increase the flow capacity in the *Chao Phraya* river specially in the vicinity of Bangkok.

(b) City protection:

The protection of city from flooding can be classified as land and water oriented systems which can be defined as follows:

(i) Polder or land oriented system.

The concept of polder or land oriented system accepts the high water levels resulting from the floods outside the polder areas, so flood protection is achieved by creating isolated areas by construction of dikes surrounding each area. The local impoundments due to the direct precipitation will be dealt with by drainage pumps. This system can be laidout to suit the land-use planning. At inter-sections of dikes and water courses (e.g. canals, drains) gate structures are required. The gravity drainage is possible only when the water level outside is lower.

The land oriented projects are for example: Flood Control and Drainage Project (City Core), Flood Protection/Drainage Project in eastern Suburban Bangkok (Eastern Suburbs), Improvement of

Canal' Connecting Khlong Taweee Wattana and Khlong Khoon Ratpinidjai to alleviate flood damage to the West Bank of the *Chao Phraya* river (Tawee Wattana) and Master Plan for Flood Protection and Drainage of Thonburi and Samut Prakan West (West Master Plan).

(ii) Diversion or water oriented system.

Diversion in combination with appropriate control structures should lower the flood level within and also to some extent outside the protected area. The main elements for this approach are means to divert the water combined with structural elements which allow flood management.

The water oriented approaches are seen in the Flood Routing and Control alternatives of *Chao Phraya* river for Bangkok (Flood Routing) and Bangkok Flood Protection (*Chao Phraya* 2).

5.0.4 Existing flood control and drainage facilities

Before 1983 flood, the flood control and drainage facilities were limited. The existing facilities are the work done by the Sub-committee of the National Flood Protection Commitee chaired by Professor Anat Arbhabhirama.

Since the study emphasizes on tidal effects on flood control and drainage system, only facilities along the Chao Phraya river such as dikes and pumping are described excluding those for internal drainage.

Diking is required along the river because the elevations of the river banks are low as shown in Fig.5.1 in comparison with the maximum flood levels along the river. Fig. 5.2 shows the existing diking which makes use of the existing highways or newly constructed roads: about 12 roads serve as the diking for the eastern side and about 9 roads serves for western side. The diking on the western side is opened at certain locations of large canals which cannot be blocked, therefore, cannot at present be completely protected from flooding by high water in the river. Five polders on the western side shown in Fig. 5.2 provide local protection of these area, they are:

(i) Thonburi Khlong San Polder,

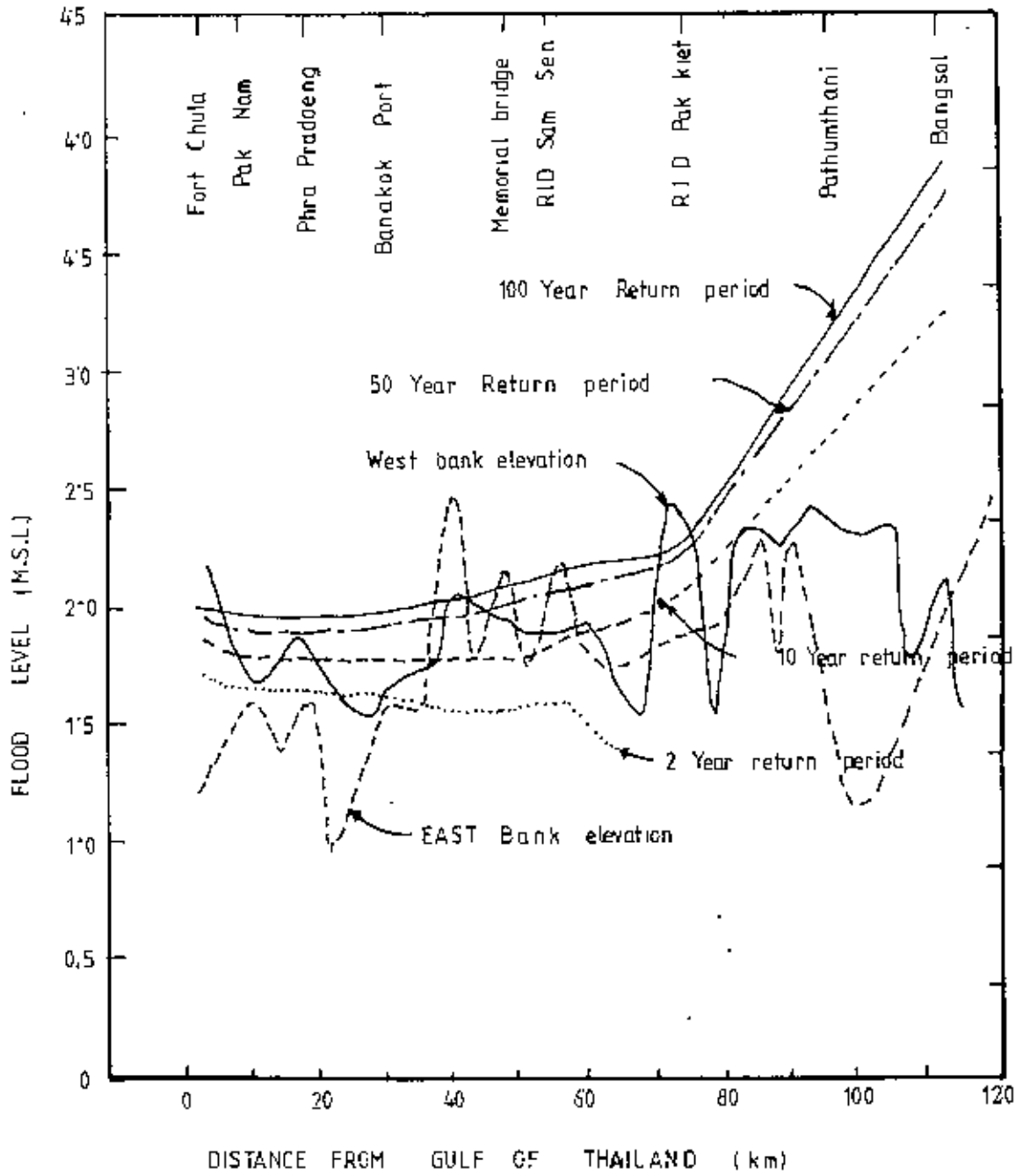
(ii) Bangkok Yai Polder,

iii) Bangkok Noi Polder,

(iv) Taling Chan Polder, and

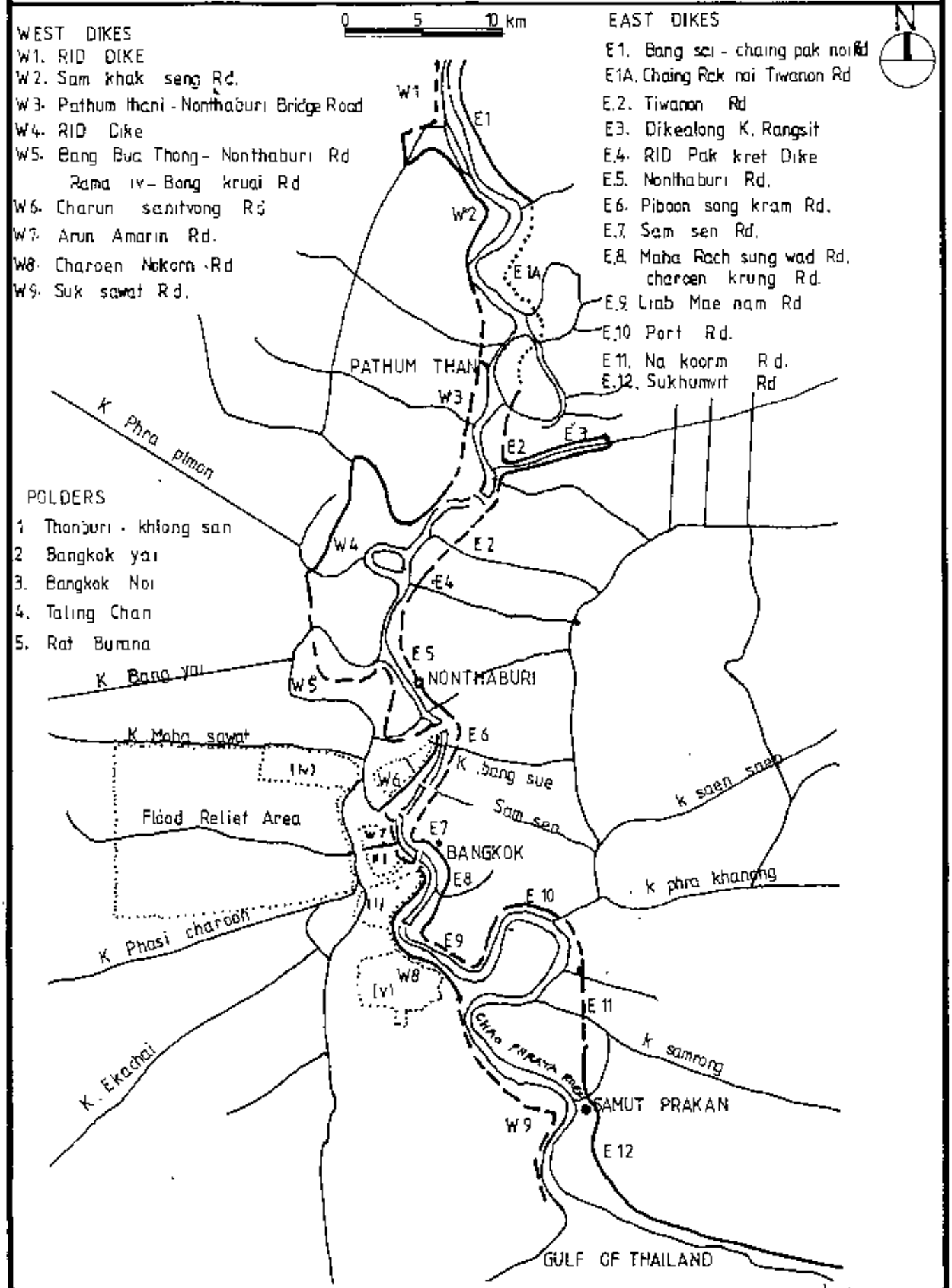
(v) Rat Burana Polder as well as Flood Relief Area.

Fig. 5.1 Maximun Flood Levels along the Chao Phraya River from Bangsai to Fort Chula for Various Return Periods



SOURCE :- Bangkok flood control and drainage system prof. Suphat Vongvisesso mjai.

Fig. 5.2 Dikes along the Chao Phraya River and 5 Polders on the West



SOURCE:- Bangkok flood control and drainage system prof. Suphat Vongvisessomjai,

5.1 Dhaka-Narayanganj-Demra project

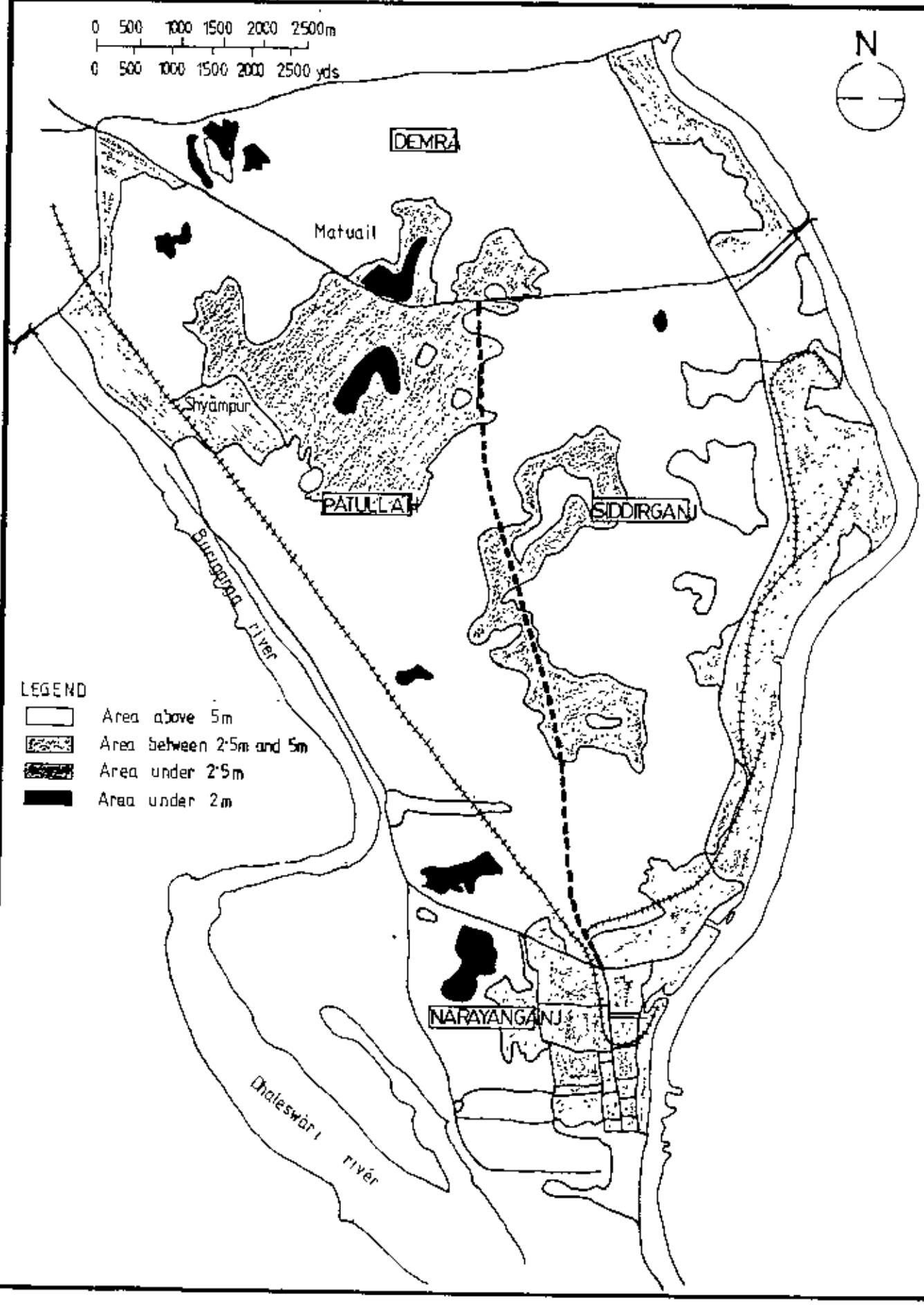
5.1.1 Introduction

The Dhaka-Narayangonj-Demra (DND) area is bounded by metalled roads and flood walls. As the area was developed for irrigation it is drained and largely flood-free. Because of its proximity to the city and because it is relatively flood free the DND has developed quite rapidly during the last decade, particularly in the northwest corner. Currently RAJUK is preparing a development plan for the area and further substantial development is anticipated over the next decade. The development of the DND will see Narayangonj further becoming part of Dhaka.

5.1.2 Physical features

The area covers a total of 56.79 sq.km and is of a triangular shape. North of the area is bounded by the Demra road, Dhaka-Narayangonj highway bounds the area on the western side and Demra to Narayangonj highway bounds the area on the east. The two joins together in the south of the area to form the triangular shape. The area was subject to annual flooding prior to the construction of the road-cum-embankment in the mid 1960's that encompass the area. With the construction of road-cum-embankment in the mid 1960's the area became generally flood free with good agricultural potential. Apart from a small in the south and built up areas on the northwest, generally the better part of DND has an elevation of less than 5m. Large areas in the centre and east are below 2.50m (Fig. 5.3).

Fig. 5.3 Land Height of DND Area



SOURCE :– JICA

The entire DND area is criss-crossed by irrigation canals, the pump station in the peripheral roads pump water in and out as the area demands. One central spine of Dhaka-Katchpur highway cuts across the DND area and other than that, the rest of the roads are unplanned and sporadic.

5.1.3 Existing development

The DND area is in between Dhaka and Narayangonj. This fact in the past had initiated development pressures both from Dhaka and Narayangonj side. The high cost of land and high densification around the CBD area of Dhaka has spilled developments over the northern part of the DND. All along the three major highways around the DND, sporadic development has taken place. Around the northwest of DND area there is a large settlement the Jatrabari area. On the southern tip of the area the land adjacent to the Narayanganj west is also developed to an extent. There are village settlements of small and large sizes throughout the DND in general. Commercial enterprises such as brick fields, building materials transhipment points have grown along the western highway. Dhaka WASA has a large area designated as sewage treatment area also in the west. Medium density settlements have grown all along the high way housing commutres working either in Dhaka or Narayangonj. Table 5.1 and Fig. 5.4 show the existing land use pattern.

Table 5.1 Existing landuse of DND (1990)

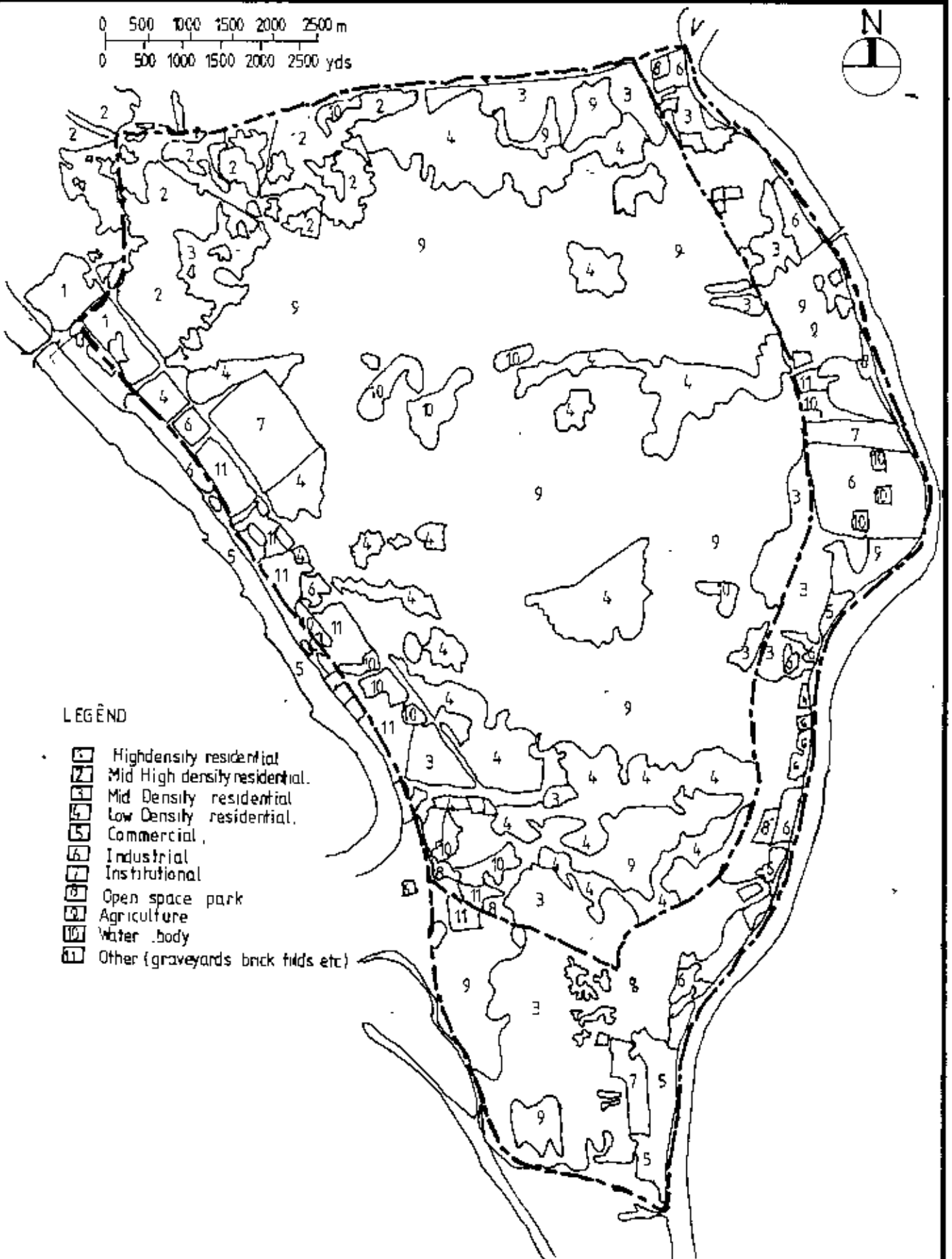
Total area	5679 hectores	(100%)
Residential	1864	(33%)
Commercial	56	(1%)
Industrial	196	(3%)
Institutional	59	(1%)
Agricultural	3173	(56%)
Water bodies	3322	(6%)
Built-up area	2176	(38%)

Table 5.2 Future Landuse of DND (2010)

Total area	5679 hectores	(100%)
Residential	2463	(43%)
Commercial	172	(3%)
Industrial	482	(8%)
Institutional	1153	(20%)
Agricultural	532	(9%)
Water bodies	877	(15%)
Built-up area	4270	(75%)

Source: Feasibility study on Greater Dhaka Protection Project of Bangladesh Flood Action Plan No. 8A, Draft Final Report, JICA, May 1992.

Fig. 5.4 Existing Landuse of DND Area



SOURCE :- JICA

5.1.4 Proposed development

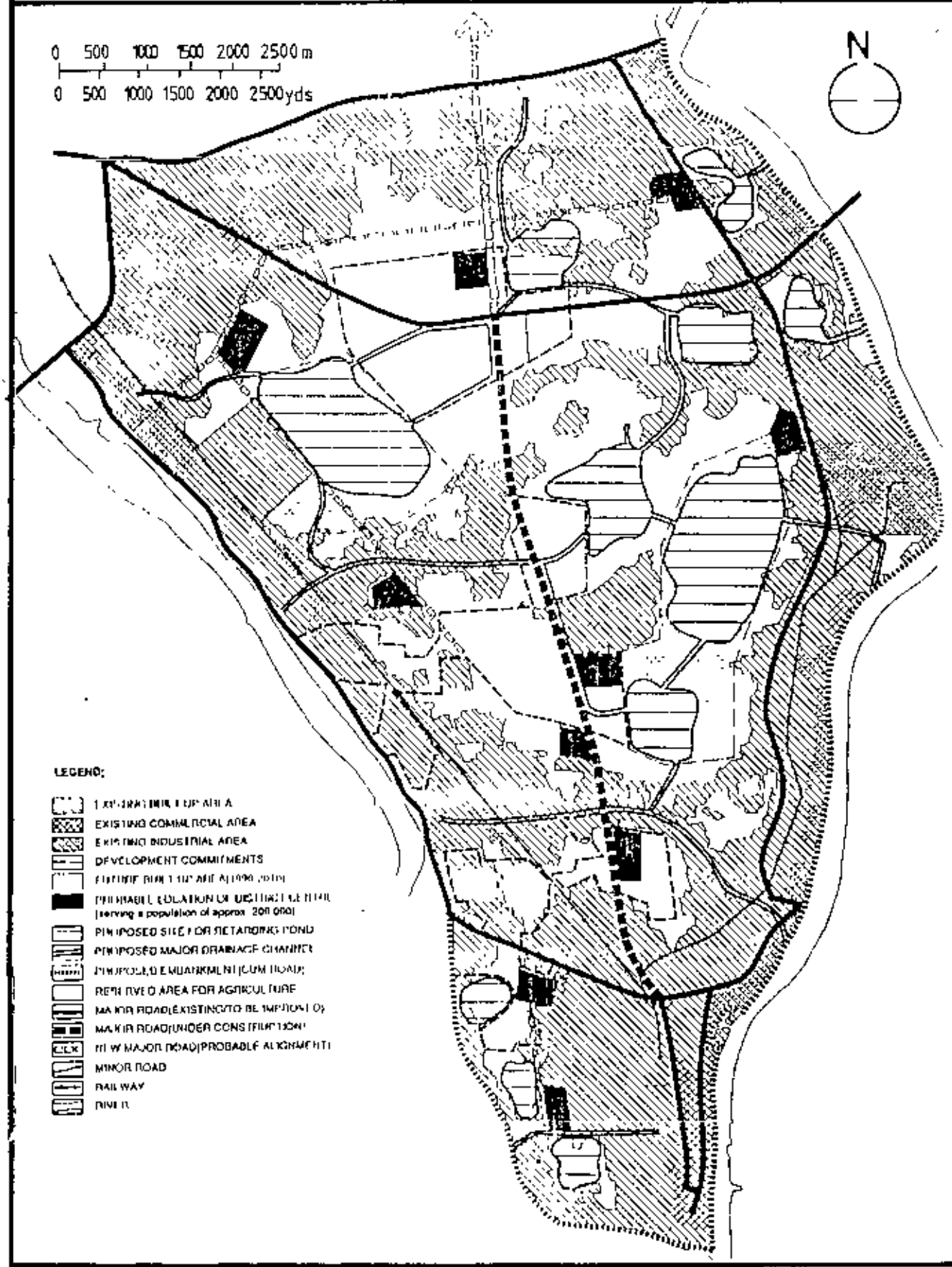
There are a good number of RAJUK projects in the pipe line designated for DND area. There are at least four settlements to be developed by the RAJUK out of which one in the south namely Panchaboti is in an advanced stage of land acquisition.

Unplanned developments are sure to continue in the future with the existing metropolice becoming more dense day by day. The floods in 1988 which inundated a better part of Dhaka could not penetrate the DND area. This itself has provided a moral boost to the would be developers of DND area and it is reasonable to assume development of further settlements in the area at an accelerated rate in the coming decade. RAJUK has drawn up a schematic master plan of DND area, showing roads and settlement areas. This plaan is on the process of Government approval.

5.1.5 Population and landuse

The total population of DND in 1990 was calculated at 449,000 by JICA study team. The larger part of the 1990 population is concentrated along the boundary roads and also in the northeast and the south of the area. However, new areas of development either sporadic or planned will be in the central area. The new areas of development are largely expected during the next decade. If alternate urban areas in the Dhaka conurbation develops at a slow pace then the DND area will have to bear the maximum pressure of development. Table 5.2 and Fig. 5.5 show an indicative landuse pattern at the year 2010.

Fig. 5.5 Indicative Landuse Map of DND (2010)



SOURCE : JICA

CHAPTER – 6

The Study Areas

6.0 Origin and scope of GDFCD project

In the wake of the devastating flood of 1988, the Government of Bangladesh constituted a Committee for flood control and drainage of greater Dhaka. vide order No. NPB/CG-1/8-16/88-428 dated 24.10.1988 with Minister for Planning as its chairman and comprised of thirteen members from related Government offices (Appendix - I). The organization pattern of the committee is placed at (Appendix - II). The terms of reference of the committee were:

(a) To prepare a flood control plan for greater Dhaka Metropolitan areas, Mirpur, Tongi and Narayangonj.

(b) The committee will also consider the following:

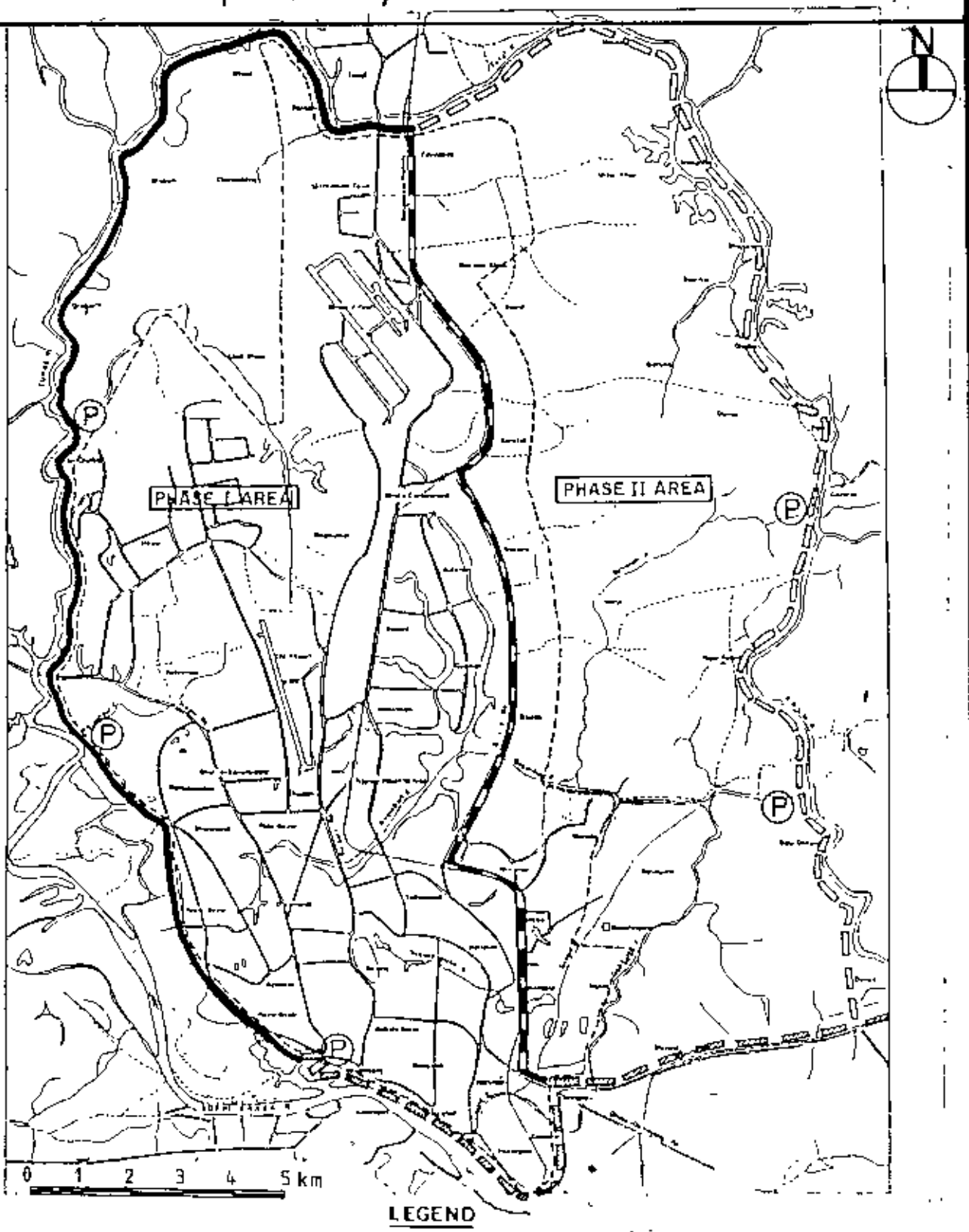
(i) Establishing link roads around Dhaka-Narayangonj, Tongi-Savar- Mirpur and neighbouring industrial areas.

(ii) Formation of lakes within Dhaka city to facilitate drainage.

(iii) Nodernization of Dhaka's swerage system.

In March, 1989 the report on flood control and drainage of greater Dhaka prepared by the committee was officially approved by the Government. The committee proposed a phased programme of the Greater Dhaka Flood Control and Drainage (GDFCD) project, after considering the existing conditions of greater Dhaka city, previous studies and projects, ongoing projects and existing plans. As shown in Fig. 6.1 the phase-I programme is proposed for most of the existing urbanized areas and the western part of

Fig. 6.1 Greater Dhaka Flood Control and Drainage Scheme. Proposed by Committee.



SOURCE:- Report on Flood Control and Drainage of Greater Dhaka by Committee in Jan, 1989.

the greater Dhaka city that are surrounded by the Buriganga river, Turag river, Tongi khal, National railway, DIT road etc. The remaining eastern part of the greater Dhaka city will be protected by the phase-II programme.

The proposed 13 projects for the phase-I programme and 3 projects for the phase-II programme are listed in Table 6.1 and 6.2 and illustrated in Fig. 6.2. The typical design of flood protection embankments and walls are given in Fig. 6.3.

6.1 Alignment of GDFCD embankment

From the examination of geo-physical conditions of Dhaka as it exists now the committee observed that there is a big stretch of low lying area on the western side from *Tongi* bridge alongside the *Turag* river upto *Shirnir Tek* creating a big gap through which river water enter Dhaka. Unless this gap is closed by embankments no flood control scheme for greater Dhaka can be effected.

The committee proposed that an embankment be constructed from *Tongi* railway bridge towards west along the east bank of river *Turag* upto botanical garden and then to *Shirnir Tek*. The length of the embankment would be about 17.62 km. The embankment should be provided with 5 sluice gates totalling 15 pipes of 4 feet diameter each with gates at the outside end for opening or closing as the water level situation would dictate. These sluices are estimated to be adequate enough to drain out the rain water from the poldered area until the water level on the river side reach a pre-determined of danger level. Till such time as

Table 6.1 Greater Dhaka Flood Control and Drainage Projejct (Phase - I) proposed by the Committee

	Project	Agency	Cost (Million Tk.)
1.	17.62 km embankment from Tongi railway bridge up to Shirnir Tek with 5 sluice gates	BWDB	785.00
2.	2.27 km embankment and flood protection wall from Shirnir Tek upto Mirpur bridge	DMC	95.38
3.	0.77 km road construction from Shirnir Tek upto Mirpur Mazar	RAJUK	47.50
4.	4.25 km embankment from Mirpur bridge upto Satmasjid road	DMC	176.14
5.	5.78 km embankment from Satmasjid road upto Kellar Morh	DMC	341.11
6.	7.20 km flood protection wall from Kellar Morh upto Friendship Bridge	DMC	
7.	29.40 km flood protection wall around Dhaka-Narayanganj-Demra Project	RHD	118.80
8.	1.40 km new road construction from Kamlapur upto Saidabad Bus Terminal	RAJUK	107.44
9.	2.50 km road raising of Rampura road	DMC	22.97
10.	6.0 km road raising of Pragati Sarani road with temporary gates	RAJUK	46.00
11.	Flood protection bund around Zia International Airport	CAAB	77.20
12.	Cleaning of 13-khals/Canals of the city	DWASA	252.00
13.	Repair and restoration of sewerage in Dhaka city	DWASA	16.80
	Total		2086.34

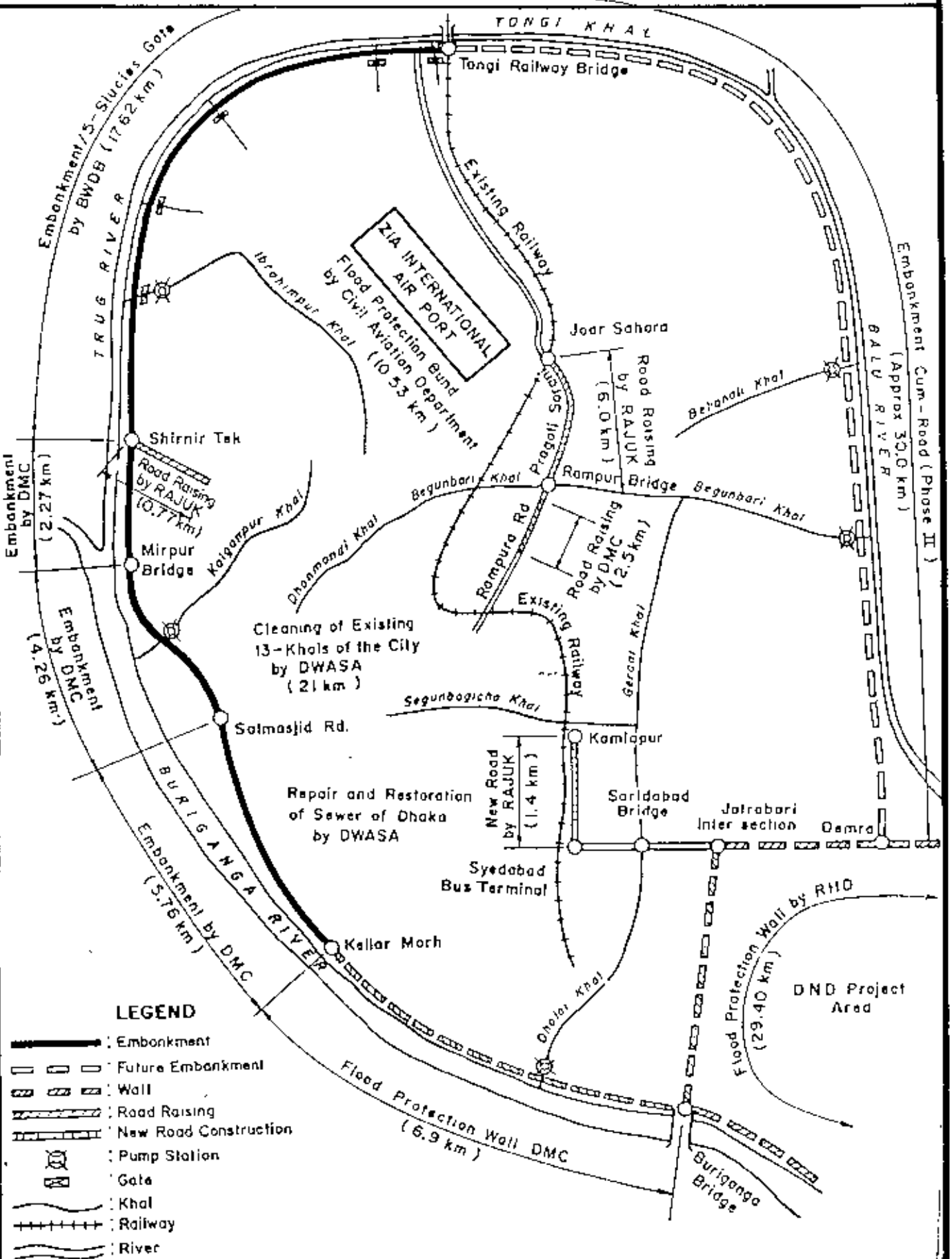
Source: Updating study on storm water drainage system improvement project in Dhaka city, Main Report, JICA, February 1990.

Table 6.2 Greater Dhaka Flood Control and Drainage Project (Phase-II) proposed by the Committee

	Project	Agency	Cost (Million Tk.)
1.	The proposed self-financing road from Demra DND to Tongi bridge should be realigned to follow the western bank of the Balu river. This should be a by-pass road. In designing this by-pass road/dam, the eastern part should be raised to prevent flooding. On the inside at a lower level, a minimum of four lane road should be built. Similarly on the north-western side of the city from Tongi bridge to Shirnir Tek a similar design should be considered. A proper survey should be carried out and the technical aspects for the above work should be taken into consideration.		1500.00
2.	A four lane road should be built along the inside part of the western flood embankment (from Tongi bridge to Shirnir Tek)		100.00
3.	Installation of 5 pumping stations		2000.00
	Total		3600.00

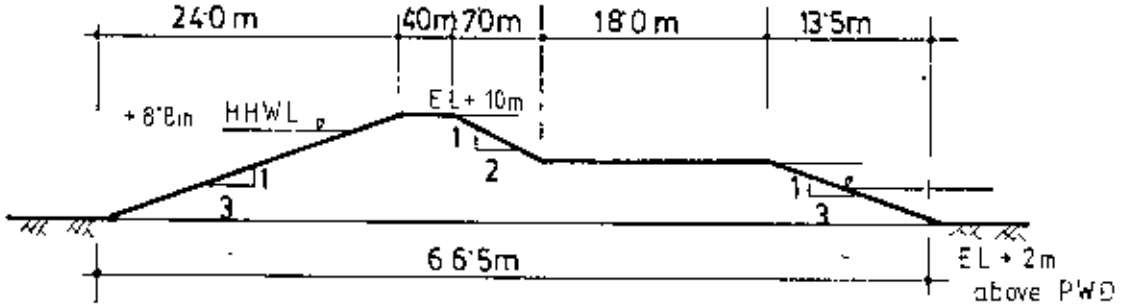
Source: Updating study on storm water drainage system improvement project in Dhaka city, Main Report, JICA, February 1990.

Fig. 6.2 Proposed Projects in GDFCD Project

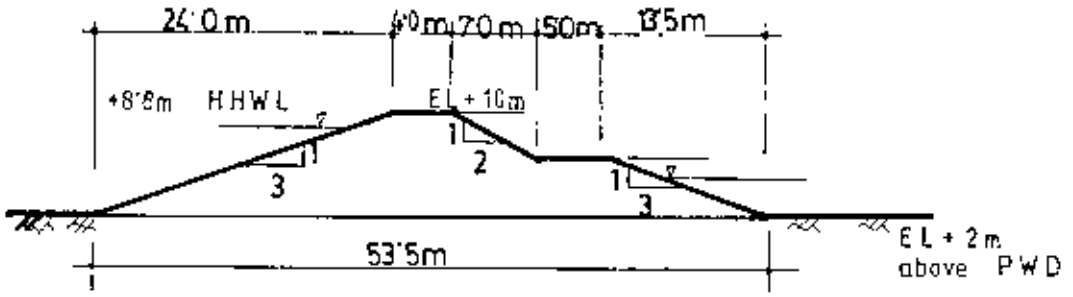


SOURCE:- Report on Flood Control and Drainage of Greater Dhaka by Committee in jan 1989

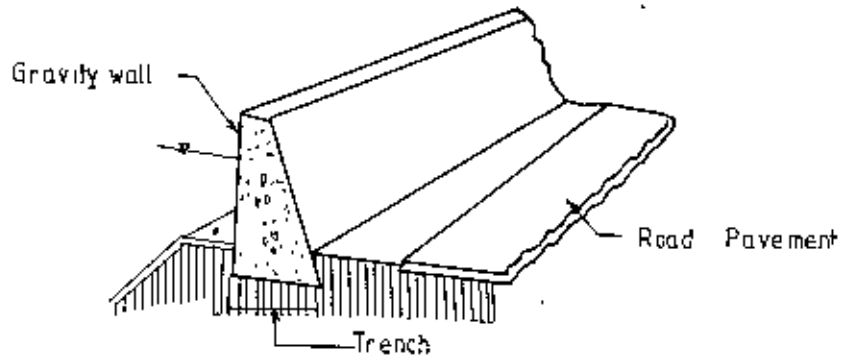
Fig. 6.3 Typical Design of Flood Protection Embankment and Wall of GDFCD Project

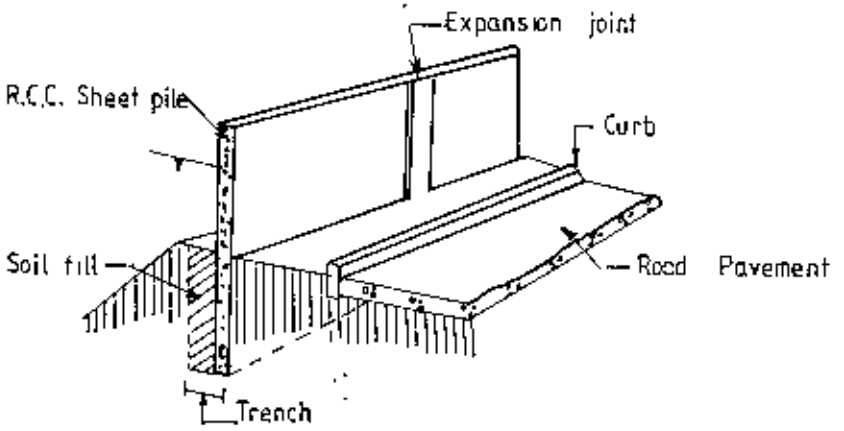


TYPICAL SECTION(INCLUDING 4 LANE HIGHWAY)



TYPICAL SECTION (ONLY EMBANKMENT)





SOURCE:- Report on Flood Control and Drainage of Greater Dhaka by Committee in Jan. 1989

permanent pump stations are built there should be 350 standby pumps of 2 cusecs each to pump out rain water during heavy shower inside the poldered area. The land to be acquired for this embankment-cum-road is estimated to be 120.58 hectares and for earth collection to be 86.28 hectares totalling 206.86 hectares. The total cost of the work is estimated Tk.470 million. The work has to be done by the water development board. The committee proposed to raise the existing *Aarmaikal* road by Dhaka Municipal Corporation from *Shirmar Tek* towards south upto Beauty cinema hall and to build flood protection wall towards west upto Parbat cinema hall on the northern side of Mirpur bridge. The total length of road to be raised is 2.25 km. The cost is estimated at Tk.15 million. From the southern side of Mirpur bridge there exists a dam of BWDB which went under water by 3 to 4 feet. The committee recommended that the same must be raised by 3 metres for which a sum of Tk.10.40 million would be required.

From the southern point of BWDB embankment, the committee proposed that this is to be extended towards south east upto *Shiya Mosque* at *Tajmahal* road via Baitul Aman and Mohammadpur housing society. The length of the proposed embankment extension would be approximately 1 km. For this land has to be acquired. The proposed extension from BWDB embankment to *Shiya Mosque* with a crest width of 4 metre and an average height of 5 metre would cost approximately Tk.33.1 million. In this embankment provision should also be made for pump station which would require Tk.2.50 million approximately. The work has to be done

by the Dhaka Municipal Corporation.

The portion of the *Shamoli* ring road from *Shiya Mosque* towards south upto *Satmosjid* is to be constructed. The proposed 300 metres road-cum-embankment from Shiya Mosque to Satmosjid road with a crest width of 7 meters would cost about Tk.11.50 million. The work has to be done by the DMC.

The committee observed that it is not possible to construct flood protection embankment along with west bank of Dhaka city from Satmosjid road down upto Dhaka-Narayanganj-Demra (DND) embankment because of extremely dense population, habitation and construction. Moreover, raising of road would be extremely costly disrupting the traffic on the narrow road and it may not also be possible to implement. At the same time if flood protection is provided only along the line of Satmosjid road a lot of areas on the western side of Satmosjid road right down the Buriganga river will remain threatened to flood. The committee, therefore, proposed construction of flood protection wall from Satmosjid road towards west upto 1000 feet to the river bank and then along with the Buriganga river upto Buriganga bridge and to connect DND. At *Dholai khal* drainage point a regulator-cum-pumping station will have to be constructed. The cost will be approximately Tk.40 million. The road from *Sutrapur* towards south east upto *Postogola* will have to be rraised by DMC and a flood protection wall will need to be constructed from *Sutrapur* upto the *Narinda* DPHE pump house. The cost of the work is estimated to be Tk.38 million. A portion of *Rampura* road was

submerged under water during the 1988 flood. About 1.5 km of the road went under water with an average of 0.50 meter depth. This portion of *Rampura* road needs to be raised above the high flood level. The cost of the proposed raising of 1.50 km. road having an average width of 26 meters by 0.50 meter would be Tk.21.50 million approximately. This work is to be done by DMC.

The Civil Aviation Department is to construct a flood protection bund around ZIA International Airport to save the same from inundation due to flood. The estimated cost of the work is approximately Tk.75.00 million including CDST and cost for installation of pumping station.

The estimatmed cost for clearing existing 12 khals/canals inside the city by Public Health Engineering department by removing the obstruction there on to ensure natural flow of water so that the city area remains free of water logging is Tk.15 million.

Dhaka WASA has also prepared an estimate amounting to Tk.16.80 million for repair and restoration of the internal sewerage system of the city area which were damaged by the 1988 flood.

On the western side of the city there is a proposal by Roads and Highways department to construct a road from *Demra* DND to *Tongi* bridge. The committee strongly feels that the road should be realigned to follow the western banks of the *Balu* river connecting DND to *Tongi* bridge. In designing this by pass road/dam, the eastern part should be raised to prevent flooding. On the inside, at a lower level, a minimum of four lane road should be built. Similarly on the north, north-western side of

the city from Tongi to Shirnir Tek similar design should be followed for a four lane road leading to Mirpur bridge. The committee feels that the embankment-cum-road from Demra to Tongi railway bridge would require longer time. Therefore, an interim plan should be prepared to protect the city from flooding. The existing *Progoti Sarani* covers the entire length of road from *Joar Sahara* towards south upto *Rampura* bridge. It will require temporary flood control structure to be constructed on the upstream side of the Rampura bridge and closure of the existing culverts or bridges on *Progoti Sarani* and also on the railway line from *Tongi* upto *Progoti Sarani*.

6.2 Change in alignment and design

During execution of phase-I projects several changes in design and alignment of the embankment were made due to resistance from local people. The changes are:

(i) Instead of raising of Karamikal road from Shirnir Tek to Beauty cinema hall and construction of flood walls from Beauty cinema hall to Parbat cinema hall, construction of embankment on low areas and flood wall on high land was undertaken from Shirnir Tek to Mirpur bridge.

(ii) Embankment was constructed from Satmosjid road to Kellar morh and flood wall was constructed from Kellar morh to Maitri Setu alongside Buriganga river. Whereas the proposal was to construct embankment upto *Maitri Setu* (Bangladesh-China

Friendship Bridge over river Buriganga) along the bank of river Buriganja. Again for a portion behind Mitford hospital no wall could be constructed due to obstruction from shop owners over the area.

(iii) The road-cum-embankment was extended from Shirnir Tek to Mirpur Majar and the existing kutcha road from Shirnir Tek to Mirpur Majar was converted to a four lane road.
Again due to resistance from local people road raising from Sutrapur to Postogola was suspended.

6.3 Selection of study areas

Due to financial limitations and time constraint the whole of the fringe areas covered by the embankment could not be considered for the present study. Again the study was confined within the area only where earth embankment have been constructed and the areas covered with protection walls have not been considered in this study. Three typical areas were selected for field survey along the whole length of earth embankment starting from Tongi railway bridge upto Kellar morh at old Dhaka. The basis for selection of the study areas are mainly population density and level of development. Starting from low density less developed area upto high density developed area have been considered in the process of selection of the study area. It may be noted that north of *Uttara* have not yet developed whereas *Lalbagh* area is situated at the old part of the city with years of record of development. Again *Mohammadpur* area have started developing from middle of this century. Every care have been taken so that the

study areas represent the characteristics of the whole fringe areas of the embankment.

6.3.1 North part of Uttara, along Turag river.

This part of the study area is at the northwest side of Dhaka city. The area covers high lands used for agricutural purposes, scattered settlements of purely village nature are noticed. The area is of a very low density of population. Boat is mainly used for transportation through river and canal network over the area. Due to construction of embankment bicycle, rickshaw and other light mechanised vehicles have started plying using the embankment as road, linking the adjacent areas. Huge areas have been purchased by housing societies along the embankment for development into residential plots. There is every chance that this part of the fringe area would be merged with the planned residential zone of *Uttara* and urban facilities would be extended upto the embankment.

6.3.2 Around Sat-Gambuj Mosque, Mohammadpur.

This area is mainly low lying agricultural land close to city centre. Before construction of the embankment the area remained under water for most period of the year. Since the area is very near to city it has developed quickly after construction of the embankment. A medium density settlement is undergoing to be a very high density locality since the urban facilities are available within a short distance. The expansion of city along

this direction was not possible before construction of the embankment due to flood water and as such the vast land was used for one time cultivation over the year. After construction of the embankment unimaginable development have taken place over the area attracting people due to short distance from city centre and good communication link. Within a short period the area is going to be a densely populated residential area.

6.3.3 Northern part of Kellar Morh, Lalbagh.

This area is situated at the old part of Dhaka city having a very high density of settlements. Close to the river Buriganga this part of the city have developed during the early period of Mughal regime. Density of population over this area was increasing day by day but the area could not expand due to risk of flood. Due to construction of the embankment the area is saved from flood risk and the embankment have provided the oppurtunity to link the area with city centre. People of the locality have started constructing bamboo bridges upto the embankment to use it as road link to city. Before construction of the embankment they used boat as the mode of transportation. Instead of kutcha houses they are now constructing pucca structures as the river water can not inundate the area. Within short period of time the whole of the low lying areas and ditches would be filled up for construction of houses, shops etc.

CHAPTER – 7

Observations and Conclusions

7.0 Changes in trend of housing, settlement & landuse.

(a) Definite change in population movemnt, landuse and settlement pattern have been noticed due to construction of greater Dhaka town protection embankment. 22.3 percent of the population who move in the fringe areas traversed by the embankment have come from outside the Dhaka city area. The rest 77.7 percent stayed within the city area before coming to this area (Table 7.1).

(b) 73.7 percent of the people surveyed opined that the main reason for coming to this area is, basically due to construction of the emankment as a result of which the area have been saved from flooding and there is no risk of flood (Table 7.2).

(c) The trend of landuse indicates increse in residential use and a decrease in agricultural land. Again vacant land and water bodies are in a decreasing trend. A little rise in commercial landuse is also observed (Fig. 7.1).

(d) Sharp rise in semi-pucca/C.I. sheet house construction is noticed. Also pucca structures are increasing in appreciable number (Fig. 7.2).

(e) 91 percent of the people surveyed in the area opined that land value have increased due to construction of the embankment. The main factors influencing the land market is that the area have been saved from annual flooding due to construction of the embankment and the private developers have started filling of low areas for housing business. Residential plots are being sold to prospective buyers at higher rates.

Table 7.1 Population movement

People moved from	Percentage
Within Dhaka city	77.70
Outside Dhaka city	22.30

Table 7.2 Reason behind movement to fringe areas

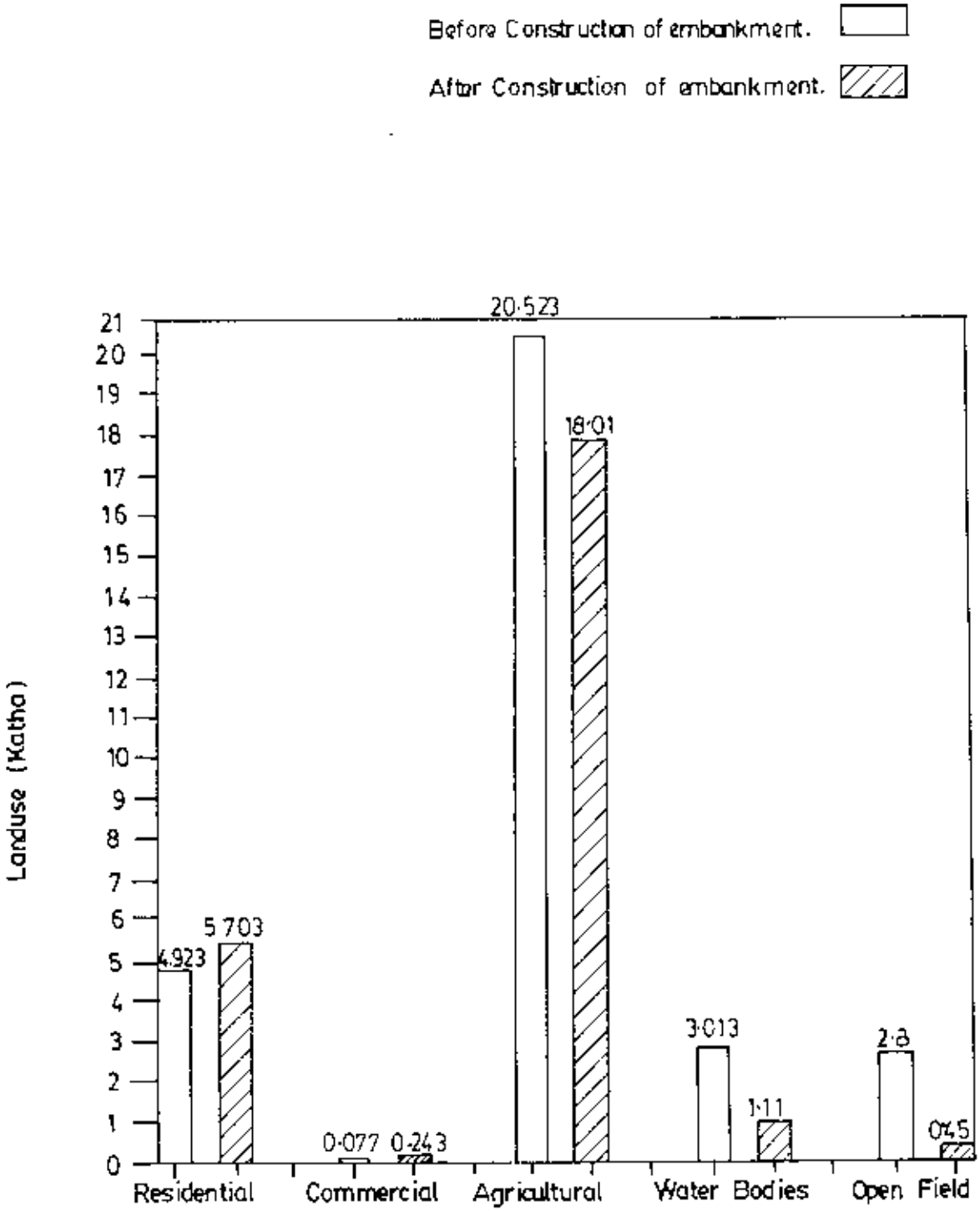
Reason	Percentage
Flood free area	73.70
Good for residence	68.70
Good communication link	68.30

Table 7.3 Forecast of settlement in respect to density

Density of settlement	Percentage
High	58.30
Medium	39.30
Low	2.30

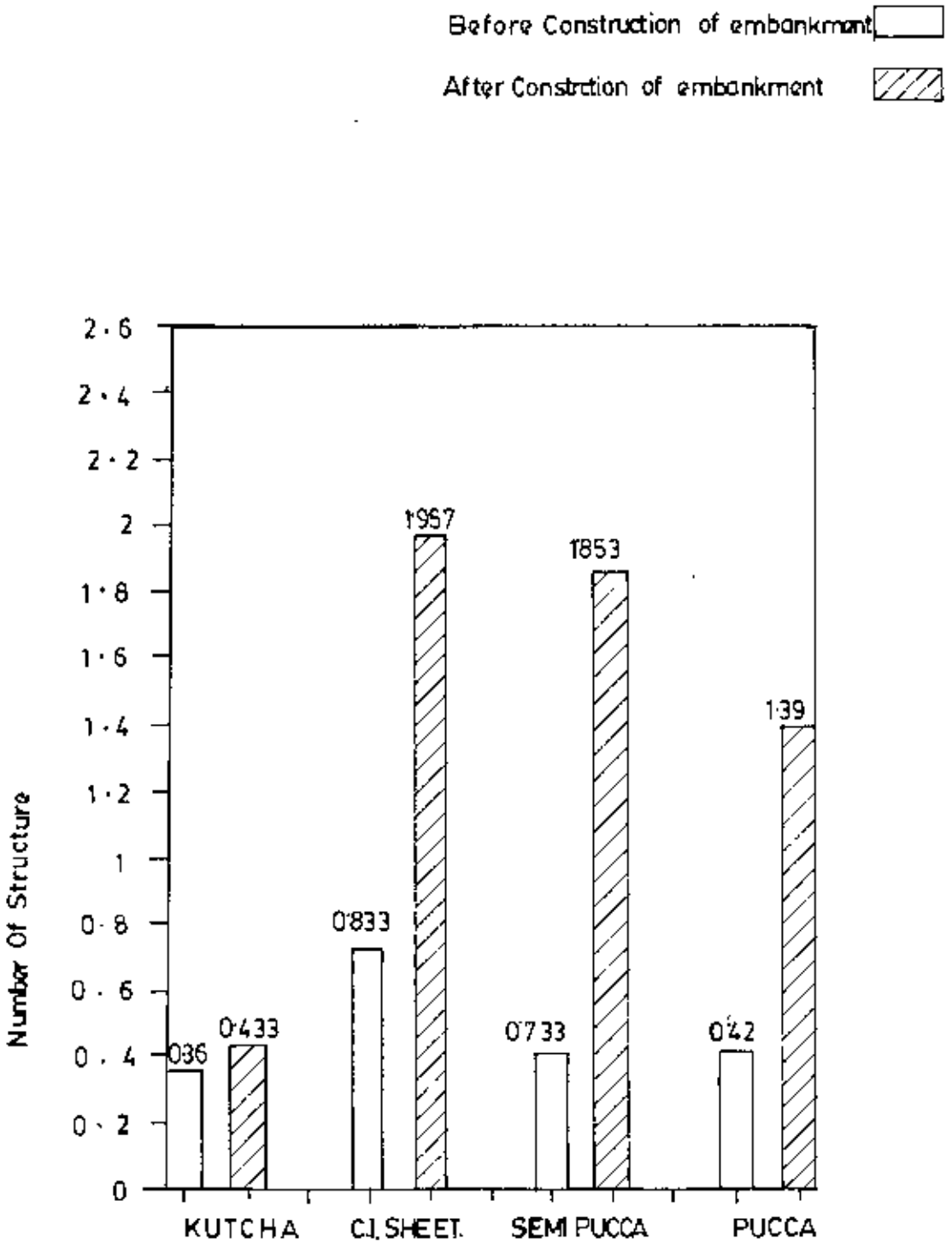
Source: Questionnaire survey (1992)

Fig. 7.1 Barchart for Land Use Pattern



SOURCE :- FIELD SURVEY, 1992

Fig. 7.2 Barchart For Housing Pattern



SOURCE : FIELD SURVEY, 1992

(f) It is predicted that the areas would be developed as residential areas with a high density of settlement of medium income group of peoples (Table 7.3 and 7.4). Low income group are unable to make any place in these areas due to high cost of land and again high income group are not interested to settle since the areas are not developing in a planned way and service facilities are not sufficient. Of course commercial uses like shops, markets and others like mosques, schools, etc. are going to be established in a slow motion.

(g) Due to construction of the embankment in the low-lying areas mode of transport of the inhabitants of the area have shown certain change. Number of people using boats before construction of the embankment have decreased due to the embankment. On the other hand use of mechanised transport have increased by converting the embankment as road (Table 7.5).

(h) The change in landuse is mainly from agricultural use to residential use. Temporary settlements of landless and low income peoples have developed at many places throughout the fringe areas of the embankment. But ultimately they would be forced out by settlers of high income groups.

(i) Survey findings suggest that 74.0 percent of the inhabitants have their own land and out of the landowners 44.3 percent inherited and rest 29.3 percent purchased the land. Around the fringe areas of the embankment 75.7 percent lives in own houses and rest 24.3 percent lives in rented houses (Table 7.6, 7.7 and 7.8).

Table 7.4 Forecast of settlement in respect to income

Income group	Percentage
High	41.70
Medium	56.70
Low	1.70

Table 7.5 Change in pattern of transportation by mode

Transport mode	Before Embankment	After Embankment
On foot	98%	99.30%
Boat	43%	12.30%
Bicycle	81%	93.70%
Rickshaw	54%	71.00%
Motorcycle	25%	36.30%

Table 7.6 Land ownership around the Embankment

Land Ownership	Percentage
Own land	74
Not owner	26

Source: Questionnaire surrvey (1992)

Table 7.7 Type of land ownership

Type	Percentage
Purchased	29.30
Inherited	44.30
Lease from Govt.	00.30
Total	74.00

Table 7.8 House Ownership

House Ownership	Percentage
Own house	75.70
Rented house	24.30

Table 7.9 Factors influencing forecast of landuse

Factors	Percentage infavour
Flood free area	73.70
Development of communication link	73.00
Development of Residential Plots	70.00
Attention of housing societies	51.00

Source: Questionnaire survey (1992)

(j) It is forecasted that the areas would be developed into purely of residential nature and the main reason for that is the construction of flood protection embankment (Table 7.9). Before construction of the embankment these low-lying areas were used for agricultural purposes. For most period over the year those land remained under water. After construction of the embankment flood water cannot enter the areas and thus the land have become suitable for other uses. Due to scarcity of land in the city and high demand for residential plots, people have started filling low lying areas and saved from floods. Also the embankment being used as road, the communication link over the areas have developed. Road network is growing in an unplanned way. Also other facilities like market, educational institutions etc. are not developing sufficiently. Thus the area is developing as a whole in a hapazard manner.

7.1 Observations

(a) In the past Dhaka city was criss-crossed by numerous canals and waterways, which provided for an excellent means of communication as well as a very natural drainage system. Most of these canals and waterbodies have disappeared due to high rate of development activities. These khals and low lying areas have been choked up by encoarchment. Filling deposition of city garbage, construction of housing projects, roads etc. in low-lying areas have decreased the water retention capacity of the city. Dhaka city has developed partly in planned way but mostly in an unplanned way. In both cases provisions, construction or maintenance of proper drainage system has not been kept in mind. It may be observed that if the present rate of development continues, the khals or low-lying areas of the city will disappear and the city will have to face serious consequences. As such a planned drainage network is to be activated for smooth draining out of rainwater, otherwise there may be internal flooding of the city during excessive rains.

(b) There is no effective control of landuse and development for Dhaka city. Laws relating to planning are not strictly enforced. There is an urgent and immediate need for a guided and comprehensive land policy which should outline the landuse programme of the city. In this regard there is a clear need to make assessment of the existing landuse planning and policies being implemented or enforced within the metropolitan area of Dhaka. It is needed that an alternative landuse plan be prepared immediately in order to make optimum utilization of land within

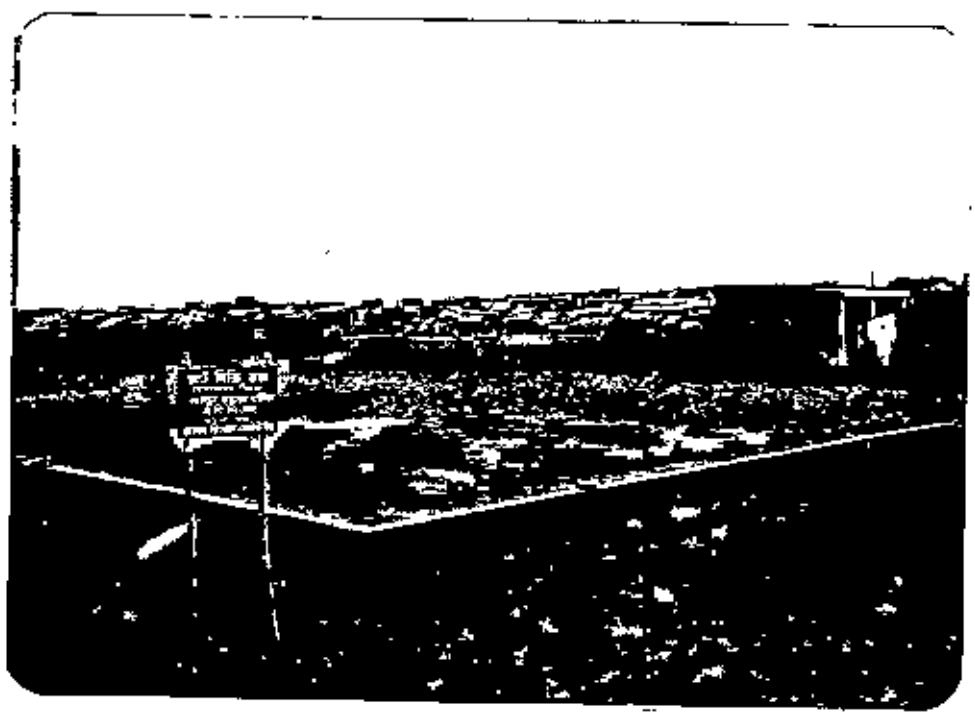
Dhaka and to ensure preservation of valuable agricultural land, the swampy areas, khals and canals for protection against flood. Also RAJUK in co-ordination with other development agencies for Dhaka city should go for an integrated area development plan for the vast fringe areas of the city.

(c) The absence of defined and well-regulated land and housing policies has contributed to the unplanned and scattered location of development activities and the high price and scarcity of buildable land within the city. This has effectively priced out the low-income peole from the housing market. People, who cannot afford the high price of buildable land within the city, make compromise by building houses in low-lying areas by land-fill elevation.

(d) Lack of an effective landuse plan and restrictive measures have given rise to urban sprawl. While areas within the city lie vacant, unused or underused, areas like that of Bashabo, Madartek, Rampura, Gulshan, Mirpur etc. which were previously low-lying drainage plains are fast disappearing. Private developers are filling up these land and selling them to prospective home builders. These fortune-seeking developers are not aware of the environmental hazards and hydraulic imbalance created due to filling up of these natural drainage systems.

(e) Since the Dhaka city flood protection was a political commitment and the construction of the embankment was taken up without extensive feasibility studies, a comprehensive study is thus needed. The total cost of the construction and the annual

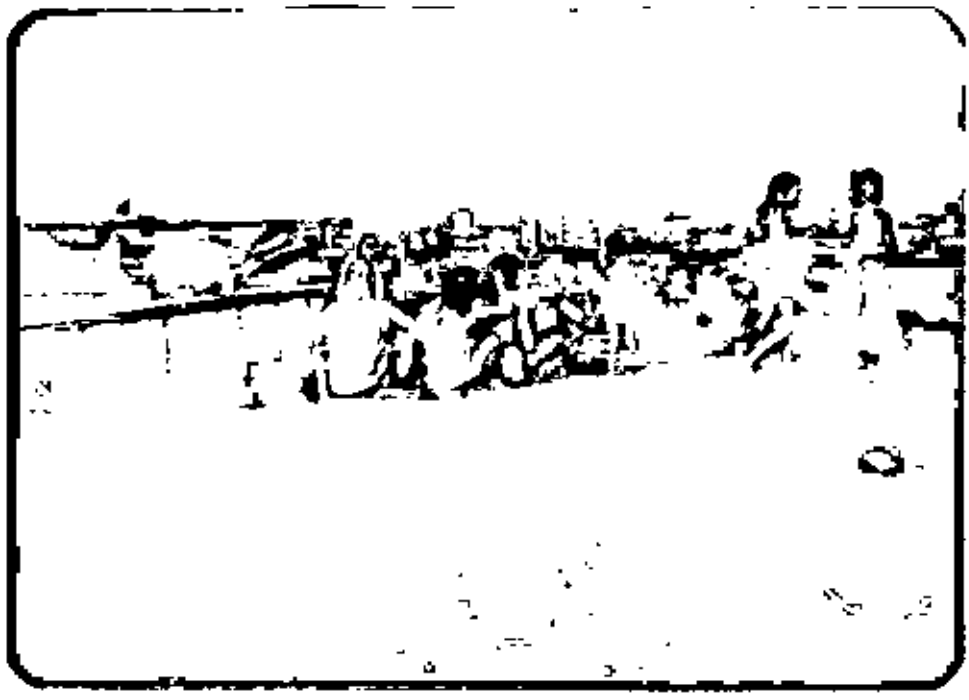
1. RESIDENTIAL PLOTS FOR SALE:



Plots ready for sale at south side of
Satgambuj mosque, Mohammadpur.

2. SETTLEMENT ON EMBANKMENT:

Temporary houses built on embankment, Mohammadpur.



Settlers enjoying the environment.

3. ERECTING STRUCTURES ON EMBANKMENT:

Constructing bamboo houses at fringe areas of embankment, Mohammadpur.

Kutcha and Semipucca houses built at areas adjacent to embankment Mohammadpur.

maintenance cost is to be taken into consideration for mobilization of resources for this purpose. Another important need is for an economic benefit/cost evaluation of the projects both for confirming the economic justifiction for the project as planned, including the selected embankment routing as well as for indentifying/quantifying the losses which would accrue to human economic activities outside the protected area, due to extra flooding which will occur outside at the cost of protecting the region inside.

(f) Due to construction of the embankment the on rush of flood water from surrounding areas of the city have been blocked, thus the big volume of water will have an effect on the surrounding areas causing higher floods than before. This have not been considered in the construction of the embankment. Dredging of the rivers surrounding the city and thus increasing the retention capacity of the rivers are essential. Again re-excavation and restoration of the natural drainways, khals, water bodies within the city and control of water movement through sufficient number of pumping stations, sluice gates are needed. Otherwise covering the city with embankment may create water logging and the flood control embankment may be a curse on the city dwellers. This is to be seriously considered whether just stopping the flood water to enter the city is important or the improvement of drainage system is important.

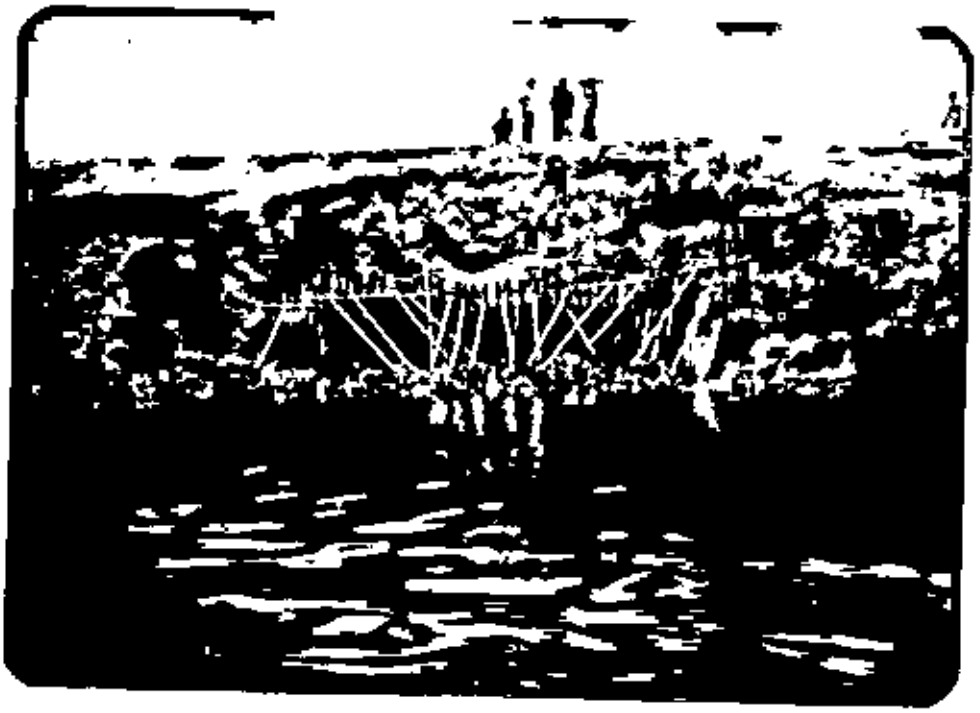
(g) It has been observed that serious erosions have occured at many places and rain cuts have developed along the whole length

4. EMBANKMENT FAILURE:

Embankment side failure at north of Kellar morh, Lalbagh.

Embankment top settled at Kellar morh, Lalbagh.

5. PROTECTION OF EMBANKMENT:



Bamboo pallasiding to protect sides of embankment at Kellar morh, Lalbagh.

of the embankment. Also at many places the embankment have settled down mainly where it crossed deep canals, waterways. There is a need to ensure that the designs and construction procedures for the embankment including compaction measures will enable these structures to withstand peak flooding pressures, including erosion and wave as well as hydraulic pressures.

(h) It is difficult to prevent encroachment on to flood protection embankment. In addition to those affected by embankment construction there are a greater number attracted to the embankment from adjacent slum and squatter areas. The embankment offer a rent-free, flood-free oppurtunity close to place of work. Settlement whether urban or rural in character has detrimental effects on the embankment. Construction cuts into the embankment's profile and removal of vegetation cover together with associated development of footpaths brings about erosion. It is clearly impossible to remove people sheltering on the embankment immediately after flooding and also particularly difficult to resist the claims of those who move onto the embankment as a result of being affected by embankment construction.

(i) Resettlement of the people affected by the construction of the embankment should be given priority. Acquisition of land for construction of the embankment and also for resettlement of those affected should be done simultaneously so that they can be rehabilitated quickly.

6. EMBANKMENT BEING USED AS LINKROAD:

Bamboo bridges constructed to link the embankment , Lalbagh.

Embankment top levelled for use of pedestrians at Lalbagh area.

(j) It may be noted that in the second phase of Greater Dhaka Flood Control and Drainage Project there is provision for a four lane road on the inside to a lower level from Demra to Tongi bridge along the embankment. Similarly on the northwestern side of the city from Tongi bridge to Shirnir Tek a four lane road along the inside part of the embankment have been proposed. The concerned authority should go for a peripherial road system around Dhaka city by connecting Demra with Tongi and again from Tongi upto Buriganga bridge along the length of the embankment. A detailed survey in this regard should be carried out and its feasibility should be studied since this embankment-cum-road system will require additional land acquisition by the Government.

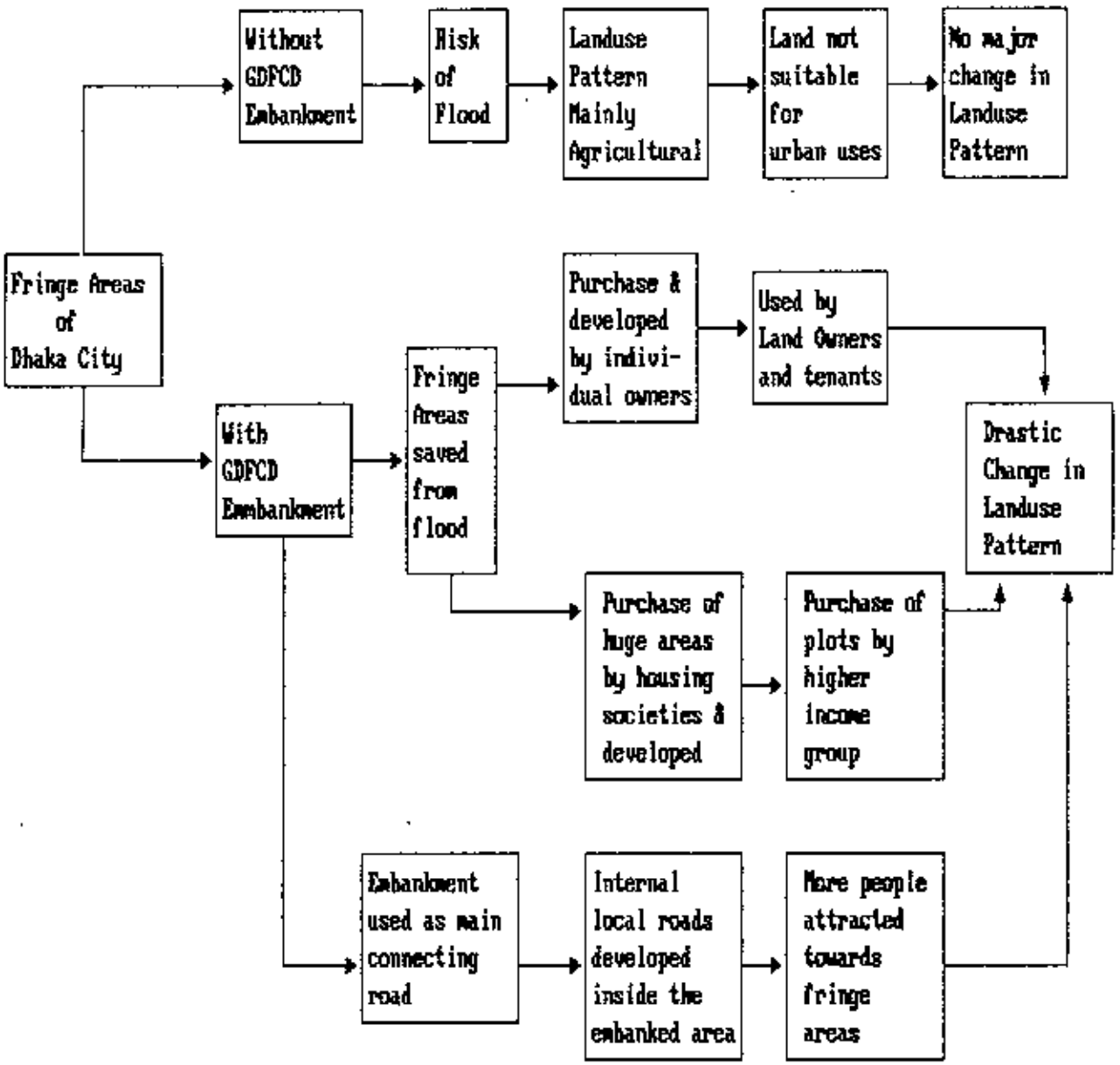
7.2 The Model.

Within the limited scope of this study it is not possible to build definite model for forecasting future landuse pattern in the area, since a lot of variables are involved in deciding the future landuse pattern and as all of them were not considered in this study. As for example the Government policy regarding landuse planning over the area is a vital factor which has not yet been framed. Other factors like socio-economic conditions, political situation, housing sector investments etc are important in influencing the speed of development of the areas. Again the second phase of the project have not yet been completed and as such the total impact of the Greater Dhaka Town Protection Embankment cannot be ascertained at this stage. Although there are many limitations, an attempt have been made here to develop a framework for forecasting future landuse pattern in the fringe areas of the embankment.

Two ideal situations have been considered in developing the framework. One without any flood protection measure and the other with flood protection embankment constructed around the fringe areas. The study findings suggest that during the pre-embankment stage no appreciable change in landuse pattern was noticed despite heavy demand for land in the city and the fringe low-lying areas were used mainly for agriculture or fishing purposes. The areas remained flooded for most part of the year and were not suitable for urban uses. Consequently with the construction of flood protection embankment the fringe areas have been saved from annual flooding and rapid change in landuse

pattern have taken place. Large areas have been purchased by housing societies to develop them for residential purposes. Individual land owners are filling their land to construct houses either for their own living or for renting them out. It is interesting to note that, internal road network is developing using the embankment as the main connecting road to the city. Other urban facilities are developing day by day. Those who are purchasing residential plots from housing societies, although are not constructing houses now, the fringe areas are going to be developed into residential zones within a short time. For this, a guided landuse plan is urgently needed. Otherwise the areas may turn into unplanned, congested localities. Again the way the low-lying areas are being filled up may create serious drainage problems in future over the areas. Some of the deep area, ditches etc. may be kept reserved as retention basins. Considering all the aspect for optimum utilisation of the embankment, the change in landuse pattern from mainly agricultural type to residential and other urban uses should be guided properly.

FRAMEWORK TO FORECAST FUTURE LANDUSE PATTERN IN FRINGE AREAS TRAVERSED BY EMBANKMENT



APPENDICES

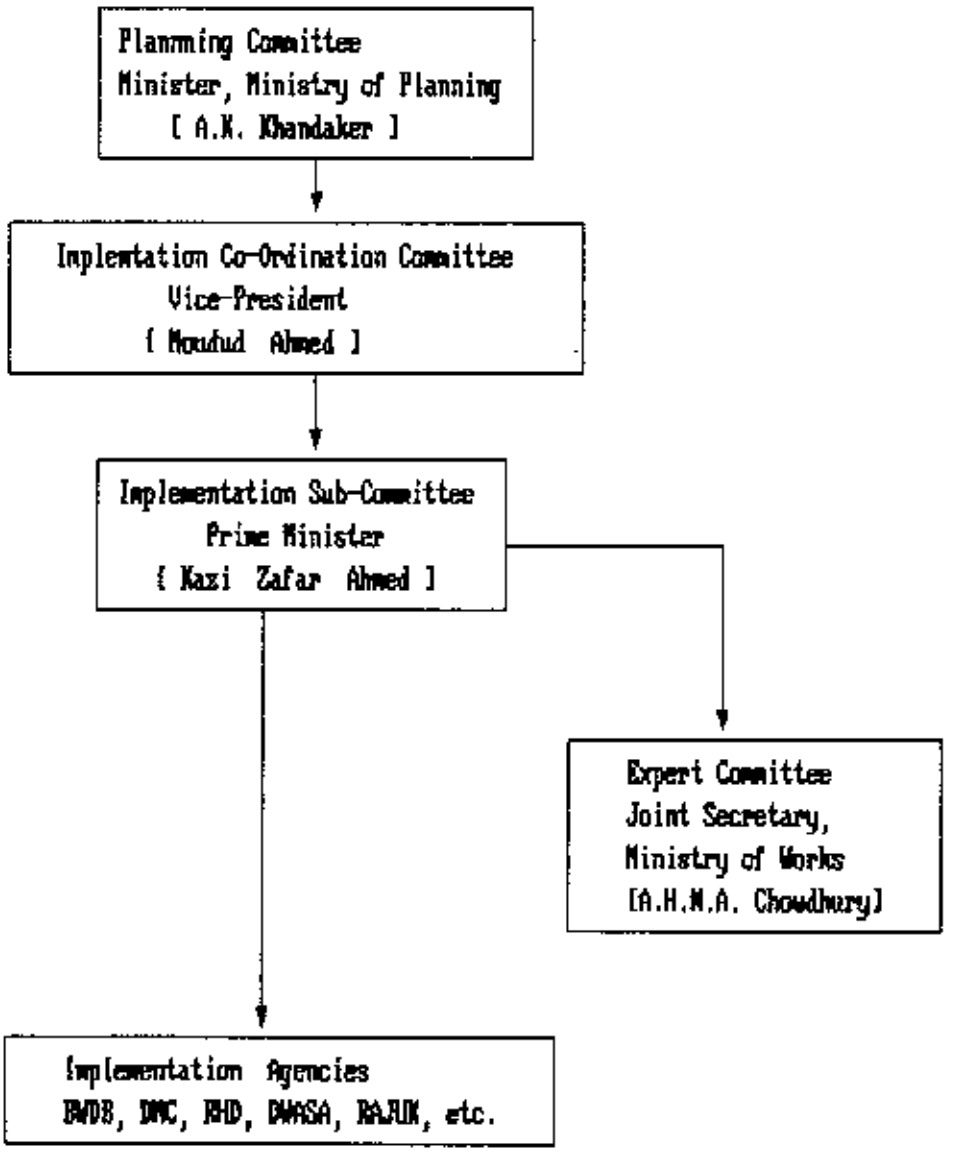
APPENDIX - I

COMMITTEE FOR FLOOD CONTROL AND DRAINAGE OF GREATER DHAKA

01.	Air Vice Marshal (Retd.) A.K. Khandaker	Minister for Planning.
02.	Col. (Retd.) M.A. Malek	Administrator, Dhaka Municipal Corporation.
03.	Mr. Husain Ahmed	Secretary, Local Government Division.
04.	Kazi Fazlur Rahman	Member, Planning Commission.
05.	Mr. Golam Kibria	Secretary, Finance Division.
06.	Mr. Nazimuddin Ahmed	Secretary, Road & Road Transport Division.
07.	Dr. Ekram Hossain	Secretary, Planning Division.
08.	Dr. Enam Ahmed Chowdhury	Secretary, External Resources Division.
09.	Syed Shamim Ahsan	Secretary, Irrigation, Water Resources & Flood Control.
10.	Maj.Gen.Mohammed Mahbubur Rahman, PSC	Engineer-in-Chief, Bangladesh Army.
11.	Mr. Ayubur Rahman Chowdhury	Addl.Secretary-in-Charge, Ministry of Works.
12.	Mr. Amzad Hossain Khan	Chairman, Water Development Board.
13.	Mr. M.M. Rahmatullah	Chairman, RAJUK.
14.	Brigd.(Retd.) Chowdhury Khalequzzaman	Chairman, Dhaka WASA.

APPENDIX -II

ORGANIZATION CHART OF FLOOD CONTROL AND DRAINAGE OF GREATER DHAKA



81. Planning Committee consisted of 14 members was established on October 24, 1988.
82. Implementation Co-Ordination Committee consisted of 22 members was established on January 08, 1989.
83. Implementation Sub-Committee is consisted of 10 members and related agencies.
84. Expert Committee on Flood Control Issues headed by the Prime Minister was established on August 24, 1989 instead of the above Committee. This new Committee is consisted of 30 government officials and related agency.

REVIEW OF STUDIES AND PROJECTS FOR FLOOD CONTROL OF DHAKA CITY.

For flood protection and drainage of Dhaka city and its surrounding areas, several studies have been undertaken and several plans have been proposed by DPHE, BWDB and other agencies until 1987. However, most of the proposals have not been officially accepted mainly due to financial constraints. Major studies among them are discussed below:

(a) Master plan and feasibility report for storm drainage and flood control for the city of Dhaka, DPHE, 1968:

The first full scale study on flood protection and internal drainage of Dhaka city known as 'The Snell Report' was under taken in 1968 and a Master Plan was prepared covering 75 sq.km. area. This Master Plan proposed:

(i) Protection of Dhaka city by means of dike encircling the area when the surrounding rivers has very high water levels.

(ii) An effective internal drainage system within the dike to drain-off storm water to locations where it may be discharged to natural drainage systems. Storm water were to be discharged by pumping at peak periods of rainfall and also provide retention reservoirs to reduce pumping requirements.

It was estimated to cost about Tk.200 million. However, this plan did not receive final approval.

(b) The Halcrow scheme, 1970:

The second study was carried out by Sir William Halcrow and partners in 1970. This scheme was revised after liberation war and new boundaries were conceived in the light of Dhaka having become capital of an independent country. The proposed empoldered area was increased to 250 sq.km.

The basic concept of the Halcrow scheme was to construct a dam along side the four rivers surrounding the city of Dhaka, and to form a number of potected or poldered areas, each approximately the size of the Dhaka-Narayangonj-Demra(DND) polder within a primary embankment. A number of pumping stations were to facilitate the drainage from the polders. The primary embankment was to cater for a one in a 500 year return period. The cost of the scheme was estimated to be Tk.0.36 billion, and was projected to be carried out into three phases.

Bangladesh Water Development Board (BWDB) prepared a cost estimate of phase I and II at Tk.410 million in 1975. The Department of Public Health Engineering (DPHE) also prepared a separate plan for the internal drainage system costing Tk.130 million in 1976. No fund was however allocated for these projects. In 1976, DPHE prepared a crash programme for removing water logging from Dhaka city and completed the works in 1980 at a cost of Tk.66 millions.

In 1978, DPHE reviewed the Master plan of 1968 and prepared a programme for flood control and drainage works at a cost of Tk.2880 million. The plan was not approved.

During 1980 following the crash programme another drainage plan namely interim scheme for removing water logging within Dhaka Metropolitan was taken up at a cost of Tk.190 million and was completed in 1983. In 1985, DPHE prepared a revised crash programme for construction of storm water drainage in water logged area of Dhaka Metropolis and is now ongoing.

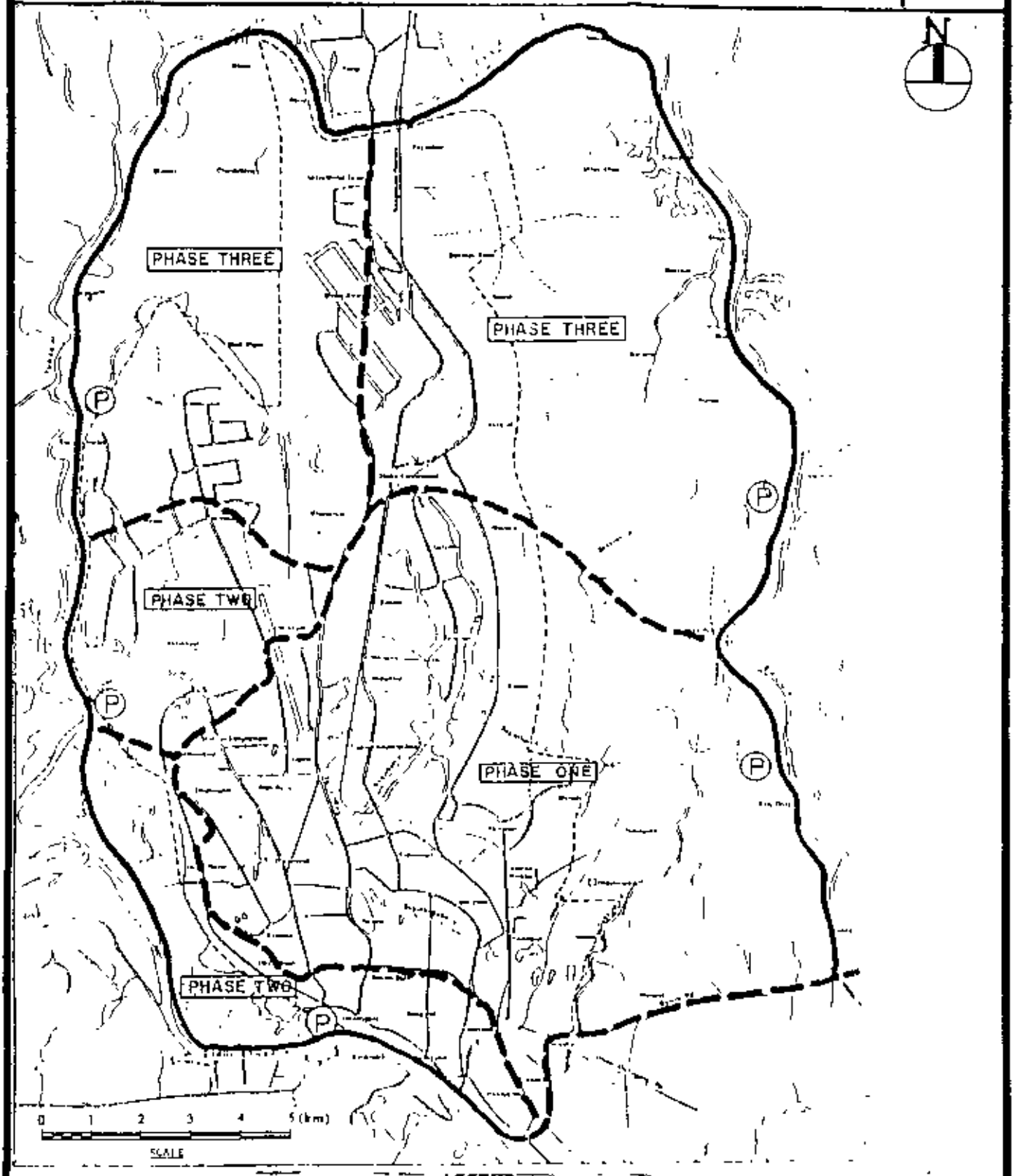
(c) Dhaka Metropolitan Area Integrated Urban Development Project (DMAIUDP), Planning Commission, ADB, UNDP, 1981:

Under joint financing from the ADB and UNDP, a study on the Dhaka Metropolitan Area Integrated Urban Development was completed in 1981. While no detailed flood control and drainage plans were prepared in this study, the study examined landuse patterns, future potential for expansion and urbanization and priority investment needs. The study recommended an urban development strategy directing the expansion towards the northern high areas rather than the eastern and western flood plains which require large scale flood protection and drainage works.

(d) Jansen Study, 1988:

The plan suggested by the Dutch expert T.G.H. Jansen was almost the same as that proposed by Halcrow and Partners. The plan consisted of Tk.4500 millions flood protection component and Tk.11000 millions internal drainage system development component. The protection of greater Dhaka city was proposed by construction of embankment along Buriganga, Turag, Balu and Tongi khal in three phases (Fig. Appendix - I).

Fig. App.1 Flood Protection scheme recommended by Dutch Expert.



SOURCE:- Recommendations to the Committee on Greater Dhaka Flood Control by T.G.H. Japan in Nov. 1988.

(e) Dholai khal Rehabilitation and Area Development Project:

In October 1986, the World Bank had undertaken the Dholai khal Rehabilitation Project with the objectives as noted below:

(i) Improvement of drainage system in the old part of Dhaka city.
(ii) Improvement of communication facilities in the old area.
(iii) Provision of new commercial activities along the side of improved Dholai khal.
(iv) Provision of improved health and sanitation conditions.

For the above purpose (i) The rehabilitation measures of the project suggested by the consultants consist of the following major components:

- Construction of a pump station with sluice gates and storage basin.
- Rehabilitation of Dholai khal.
- Rehabilitation of Debdulai and Gerani khals.

(f) JICA Study:

In October, 1987 Japan International Co-Operation Agency (JICA) conducted a study on storm water drainage system improvement project in Dhaka city in collaboration with officials of the Government of Bangladesh. The study proposed a three phase programme for drainage improvement for Dhaka city with a total area of 137.5 sq. km. The study urged the immediate implementation of the highest priority programme of phase-I which cost Tk.2.61 billion covering an area of 31.30 sq.km.

In 1988 after Dhaka suffered the worst flood in its history, the Government of Bangladesh requested the Government of Japan to re-evaluate and up-date its previous JICA study taking into account the results of related projects which began after the 1988 flood as well as the information gained from the flood itself. The scope of work for the updating study was agreed upon between the ERD, Ministry of Planning, Government of Bangladesh and the JICA on June, 1989.

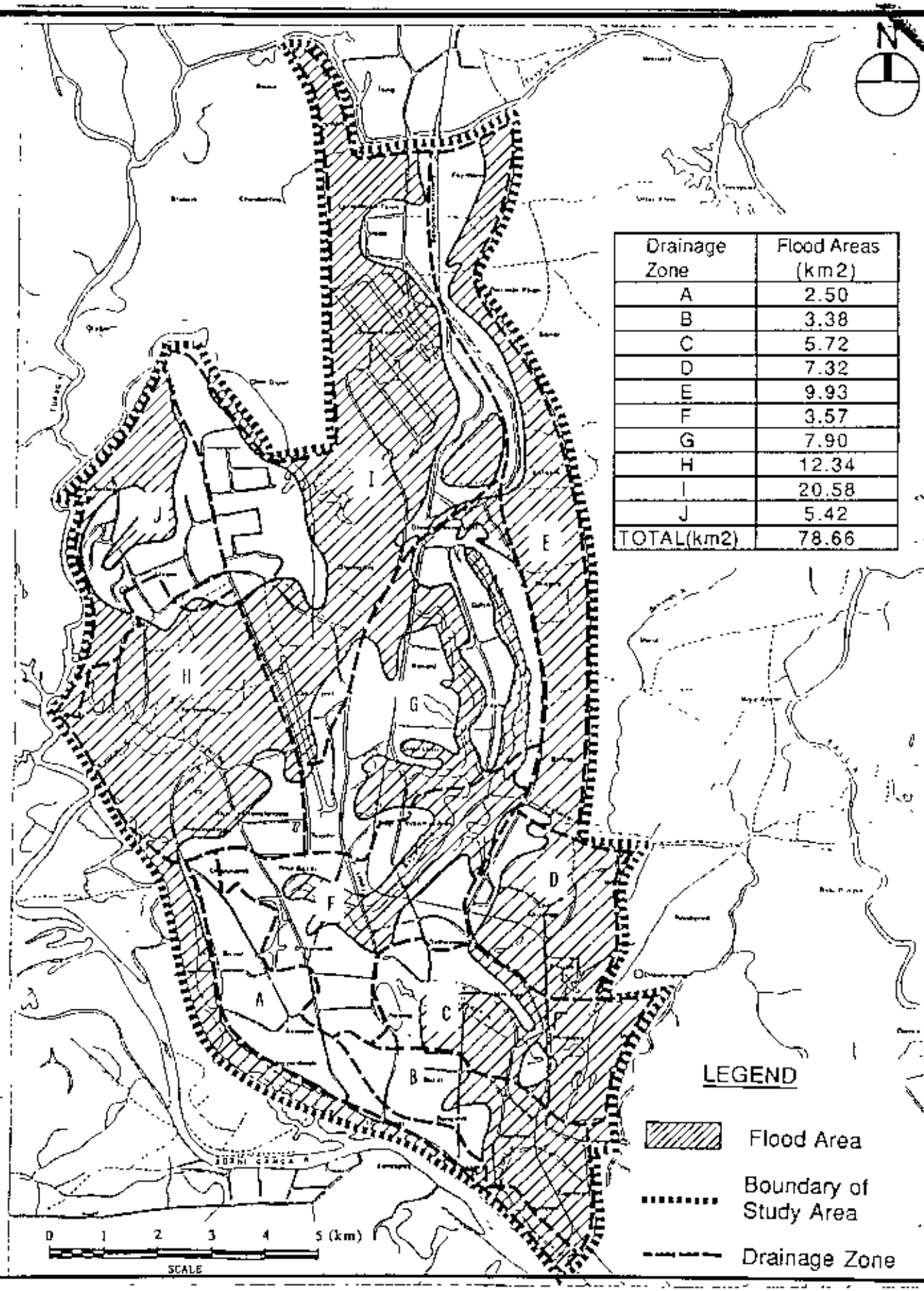
The JICA study divided the greater Dhaka are into 10 drainage zones A, B, C, D, E, F, G, H, I and J for the flood protection and internal drainage plan. It recommended for strict enforement of control to prevent any reduction of minimum khal and canal area, as reduced khal area would cause water flows to be impeded. The proposed phase I and II plans comprised 7 control gates, 2 pump stations, 36.35 km of khal improvement, 17 km. of drainage pipes and total project cost of Tk.4478.70 million (Fig. Appendix-2).

(g) Initial Environmental Examination for Dhaka flood protection project, Department of Environment, Ministry of Environment and Forests, Government of Bangladesh, October 1989:

The initial Environmental Examination (IEE) for the Dhaka Flood Protection Project (DFPP) is essentially a reconaissance level Environmental Impact Assessment (EIA). It

(i) presents a brief discussion of the EIA process and its role on the planning and implementation of development projects,

Fig. App.2 Drainage Zones of Dhaka.



Drainage Zone	Flood Areas (km2)
A	2.50
B	3.38
C	5.72
D	7.32
E	9.93
F	3.57
G	7.90
H	12.34
I	20.58
J	5.42
TOTAL(km2)	78.66

SOURCE – JICA.

(ii) delineates the significant environmental issues believed to be involved.

(iii) concludes that an EIA study is needed and presents a recommended plan by which Department of Environment (DOE) would prepare and EIA report.

The tentatively indicated conclusions of IEE made thus for noted three matters of urgency, as follows:

(i) There is a need to ensure that the designs and construction procedures for the ditch and walls which have been/will be built, including dike constructions compaction measures, will enable these structures to withstand peak flooding pressures, including erosion and wave as well as hydraulic pressures.

(ii) Because the existing system of storm drainage in Dhaka city is already very poor and cause many environmental problems, even without the DFPP, it is recommended that further construction of the dike/wall system between Mirpur bridge and Buriganga bridge be stopped until the governmental authorities responsible for drainage can show clearly and definitely that the system of dikes/wall and appurtenances (gates, pumps etc.) will not further impede the already serious drainage situation.

(iii) Related to (ii) above, construction of pumping system should not be started until the drainage issue has clearly been resolved.

The various environmental issues to be examined by the proposed EIA study are summerised in Appendix Table - I. Appendix Table - 2 has been prepared to summerize the tentative IEE findings and to indicate the questions which need to be answered by the proposed EIA and associated feasibility type studies.

(h) Pre-feasibility study for flood control in Bangladesh, French Engineering Consortium, Bangladesh Water Development Board in association with SETS, 1989:

Following the catastropic 1987 and 1988 flood in Bangladesh, the French Government has appealed for a world aid programme in favour of flood control in Bangladessh and has decided to finance a prefeasibility study for an overall and lasting flood protection for the country.

The flood protection pre-feasibility study consists of the confinement of the rivers and distributaries between embankments erected with more or less important set-back distances to the river banks. This pre-feasibility study shows that flood control in Bangladesh can be considered possible by systematic embankment of the major rivers, their main tributaries and their distributories.

The main features proposed for the flood control scheme are as follows:

- Embankments along the three major rivers, the Brahmaputra-Jamuna, the Ganges-Padma and the Meghna.

APPENDIX TABLE 1: SUMMARY OF PROPOSED EIA TASKS FOR EVALUATING SIGNIFICANT ENVIRONMENTAL ISSUES.

	EIA Task	Participating Govt. Agency (in addition to DOE)	October - December, 1989	Scheduling Jan.-June, 1990	Follow-up
01.	Integrity of Engineering Design Construction for Dikes/walls.	WDB	(DCE) Data collection & evaluation	Complete	-
02.	Dike Location/Routing.	WDB	DCE	Complete task	-
03.	Severance Problems.	To be selected.	DCE/plan field surveys	Complete task	Continuing study to implement needed env. projects measures.
04.	Resettlement.	To be selelcted.	DCE/plan field surveys	Complete task	,,
05.	City Drainage.	WASA, WDB, DMC.	Preparation interior drai -nage plant.	Complete task	,,
06.	City Sewerage.	WASA	,,	,, ,,	,,
07.	In-city Flood Level Control/Economic Analysis	WDB	DCE	Preliminary Analysis	Continuing Analysis
07.1	Economic Savings in Potential Area	-	-	,,	,,
07.2	Extra Damage outside Protection Area.	-	-	,,	,,
07.3	Provisions for ofsetting/ Compensating for Extra Damages.	-	-	,,	,,
07.4	Benefit/Cost Analysis.	-	-	,,	,,
08.	Other Adverse Effects.	DMC and others.	DCE	Complete task	-
09.	Project Enhancement Potentials:				
09.1	Land Reeclamation.	DMC and others.	DCE	Complete task	-
09.2	Highway Transport.	Dept. of Highways.	DCE	,,	-
09.3	Environmental Aesthetics.	Dept. of Forests.	DCE	,,	-
10.	Project Operational Maintenance.	WDB	DCE	,,	-
11.	Construction Stage.	WDB	DCE	,,	Monitoring of Construction.
12.	Disaster Management Plan	WDB	DCE	,,	-

TABLE APPENDIX - 2: SUMMARY OF INITIAL COMMENTS ON ENVIRONMENTAL ISSUES

Sl. No.	Environmental Issue	Indicated Initial Comment Based on Reconnaisance Level (IEE) study
01.	Integrity of Engineering Design Construction for Dikes/Walls.	Needs checking.
02.	Dike Location Routing.	More or less already fixed, hence is significant as related to resulting environmental consequences.
03.	Severance Problems.	Needs Evaluation (no information yet available on how this problem is to be managed).
04.	Resettlement.	"
05.	City Storm Drainage.	City drainage is severe problem with without project, hence need to be sure project does not make situation worse.
06.	City Sewerage.	No major problem expected.
07.	In-city Flood Level Control/Economic Analyses.	
	07.1 Economic Savings in Potential Area.	Need Evaluation/little information so far availa-ble/benefits should be large compared to costs.
	07.2 Extra Damage outside Protection Area.	"
	07.3 Provisions for ofsetting/ Compensating for Losses.	Need to take care of those damaged by the project, specially the urban poor.
	07.4 Benefit/Cost Analysis.	Need Evaluation/little information so far availa-ble/benefits should be large compared to costs.
08.	Other Adverse Effects.	Needs Evaluation/no major problems anticipated.
09.	Project Enhancement Potentials.	Needs Evaluation.
	09.1 Land Reclamation.	Need to arrange for appropriate use of land reclamation potentials.
	09.2 Highway Transport.	Objective is to take optimal advantage of roads to be made available by dikes.
	09.3 Environmental Aesthetics.	Objective is to take advantage of opportunity for enhancing environmental aesthetics.
10.	Project Opertional Maintenance.	Needs case study to ensure that project will result in optimal economic-cum-environmental benefits.
11.	Construction Stage.	Monitoring needed to ensure contractors will observe appropriate environmental protection requirements.
12.	Disaster Management Plan.	Important in case of dike failure of floods over 100 year design flood.

- Embankments along the main tributories, the Teesta, Dharla, Dudkumar, Atrai, Kangsa, Titas and Gumti rivers in order to counter the floods in these rivers and the backwater effect due to high stages in the major rivers, when existing.

- Embankments along certain main distributories the old Brahmaputra, the Dhaleswari and the Arial Kha in order to alluviate the discharge flowing in the major rivers.

The pre-feasibility study was entrusted on January 04, 1989 to a group called the French Engineering Consortium (FEC) comprising five French Engineering consulting firms :

- BCEOM
- COMPAGNIE NATIONALE DU RHONE
- COYNE ET BELLIER
- ELECTRICITE DE FRANCE INTERNATIONAL
- SOGREAH

However, from the very beginning the study was conducted in close association and with co-operation from Bangladesh experts. Six experts from the Bangladesh Water Development Board (BWDB) were associated with the experts of the FEC and the consortium ensured the co-operation of Bangladesh Engineering and Technical Services of Dhaka (BETS). An interministerial Bangladesh-France steering committee ensured the permanent technical and administrative follow-up of the study.

(i) Feasibility study on greater Dhaka Protection Project of Bangladesh Flood Action Plan No.8A, JICA, 1992:

Three areas have been selected for the feasibility study. Those are greater Dhaka east, DND and Narayanganj west. Though they constitute a continuous zone along the eastern side of the metropolitan area, they have different characteristics and are at different stage of urban development. The purpose of the feasibility study is to determine which parts of each area are likely to be developed within the flood protection plan period and when, so as to provide a more detailed picture than the master plan for use in determining the feasibility of flood protection proposals. Showing the areas most likely to be developed for urban use permits a better delineation of land needed for flood protection measures. This land needs to be protected from further development prior to acquisition. The feasibility study also outlines development control measures needed, discusses land acquisition, management, cost recovery issues and makes an initial assessment of suitable uses for retarding areas.

APPENDIX - IV

QUESTIONNAIRE ON DHAKA CITY FLOOD PROTECTION EMBANKMENT

Department of Urban and
Regional Planning, BUET, Dhaka.

[For Research Purpose Only]

Date : _____

Name of person interviewed: _____

Address: _____

CARD NUMBER-1

SAMPLE NUMBER : ☐☐☐ 1-3

AREA : ☐ 4

1-Aaround Sat Gombuj Masjid, Mohammadpur.

2-Along Turag River, Northern side of Uttara.

3-Around north of Kellar Morh, Lalbagh.

---

1. Do you own the land ? ☐ 5
   1 - Yes
   2 - No

2. If yes, how did you own the land ? ☐ 6
   1 - Purchased
   2 - Inherited
   3 - Lease from Govt.
   4 - Not applicable (if answer is no)

3. How long do you own the land ?
   Months ☐☐ 7-8
   Years ☐☐ 9-10

4. Are you living in a rented house at this place ? ☐ 11
   1 - Yes
   2 - No

5. If yes, when did you hire the house ? ☐ 12
   1 - Before 1988 flood
   2 - After 1988 flood
   3 - Not applicable (if answer is no)

6. Where were you staying before hiring this house/coming to this place ? ☐ 13
   1 - Within Dhaka city
   2 - Outside Dhaka city

7. Indicate the reasons behind coming to this place.
   1 - Yes
   2 - No

Less house rent	☐ 14
Availability of land at lower rate	☐ 15
More job oppurtunities	☐ 16
Good communication facilities	☐ 17
Good living environment	☐ 18
Free from flood risk	☐ 19

08. State the land use pattern of your plot in katha:

	Before Embankment	After Embankment
Residential	☐☐ 20-21	☐☐ 22-23
Commercial/Industrial	☐☐ 24-25	☐☐ 26-27
Agricultural	☐☐ 28-29	☐☐ 30-31
Ditch/Water bodies	☐☐ 32-33	☐☐ 34-35
Open field	☐☐ 36-37	☐☐ 38-39

09. Indicate any change in your locality after construction of the embankment in respect of the following :
1 - Yes
2 - No

Settlement pattern	☐ 40
Land use	☐ 41
House type	☐ 42
Transport facilities	☐ 43
Land value	☐ 44
New Migrants	☐ 45

10. Type and number of structures in your plot :

	Before Embankment	After Embankment
Kutcha	☐ 46	☐ 47
Tin shed	☐ 48	☐ 49
Semi-pucca	☐ 50	☐ 51
Pucca	☐ 52	☐ 53

11. Mode of transport for movement from your plot/house:
1 - Yes
2 - No

	Before Embankment	After Embankment
On foot	☐ 54	☐ 55
Boat	☐ 56	☐ 57
Bi-cycle	☐ 58	☐ 59
Rickshaw	☐ 60	☐ 61
Car	☐ 62	☐ 63

12. Did the embankment play any role in improving the transportation system for the area ?

1 - Yes
2 - No ☐ 64

13. The effects of the embankment on the area in your opinion are:

1 - Yes
2 - No

Filling of low land	☐ 65
More flood free area	☐ 66
Problem in drainage	☐ 67
Development of residential area	☐ 68
Expansion of city area	☐ 69
Development of housing business	☐ 70
Problem in safety and security	☐ 71

14. Did the value of land in the area have increased due to construction of the embankment ?

1 - Yes
2 - No

☐ 72

15. If yes, the reasons are :

1 - Yes
2 - No
3 - Not Applicable (if answer is no)

Free from risk of flood	☐ 73
Improvement of communication facilities	☐ 74
Land suitable for residential uses	☐ 75
Demand for land adjacent to city	☐ 76
Purchase by land developers in large quantities	☐ 77

CARD NUMBER-2

16. Have you purchased or sold any land in this area ?

		Month		Year				Amount of Land Katha		Price Per Bigha Million Taka			
Before Embankment	Purchased												5-15
	Sold												16-26
After Embankment	Purchased												27-37
	Sold												38-48

17. Forecast the future land use pattern in this area :

1 - Yes
2 - No

Residential	☐ 49
Commercial/Industrial	☐ 50
Agricultural	☐ 51
Others	☐ 52

18. Factors influencing your forecast are :

1 - Yes
2 - No

Flood free area	53
Good communication links	54
More attention of housing societies	55
Availability of labourers	56
Construction of more pucca structures	57
Development of residential plots	58

19. What income group of settlement do you forecast for this area ? 59

1 - High
2 - Medium
3 - Low

20. Forecast about the density of setttlement in this area ? 60

1 - High
2 - Medium
3 - Low

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