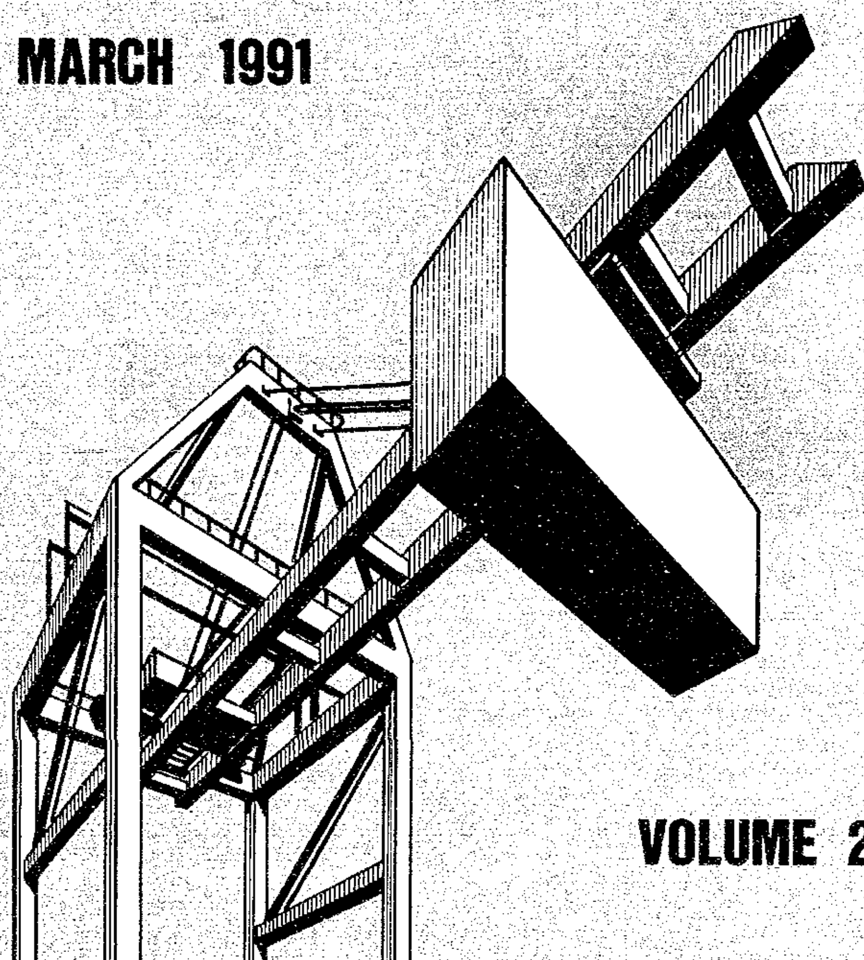
社会開発調査部報告書

No. 62

FINAL REPORT

FEASIBILITY STUDY ON DEVELOPMENT PROJECT OF CONTAINER TERMINAL AT DHAKA-NARAYANGANJ PORT IN THE PEOPLE'S REPUBLIC OF BANGLADESH

MARCH 1991



VOLUME 2 MASTER PLAN

JAPAN INTERNATIONAL COOPERATION AGENCY

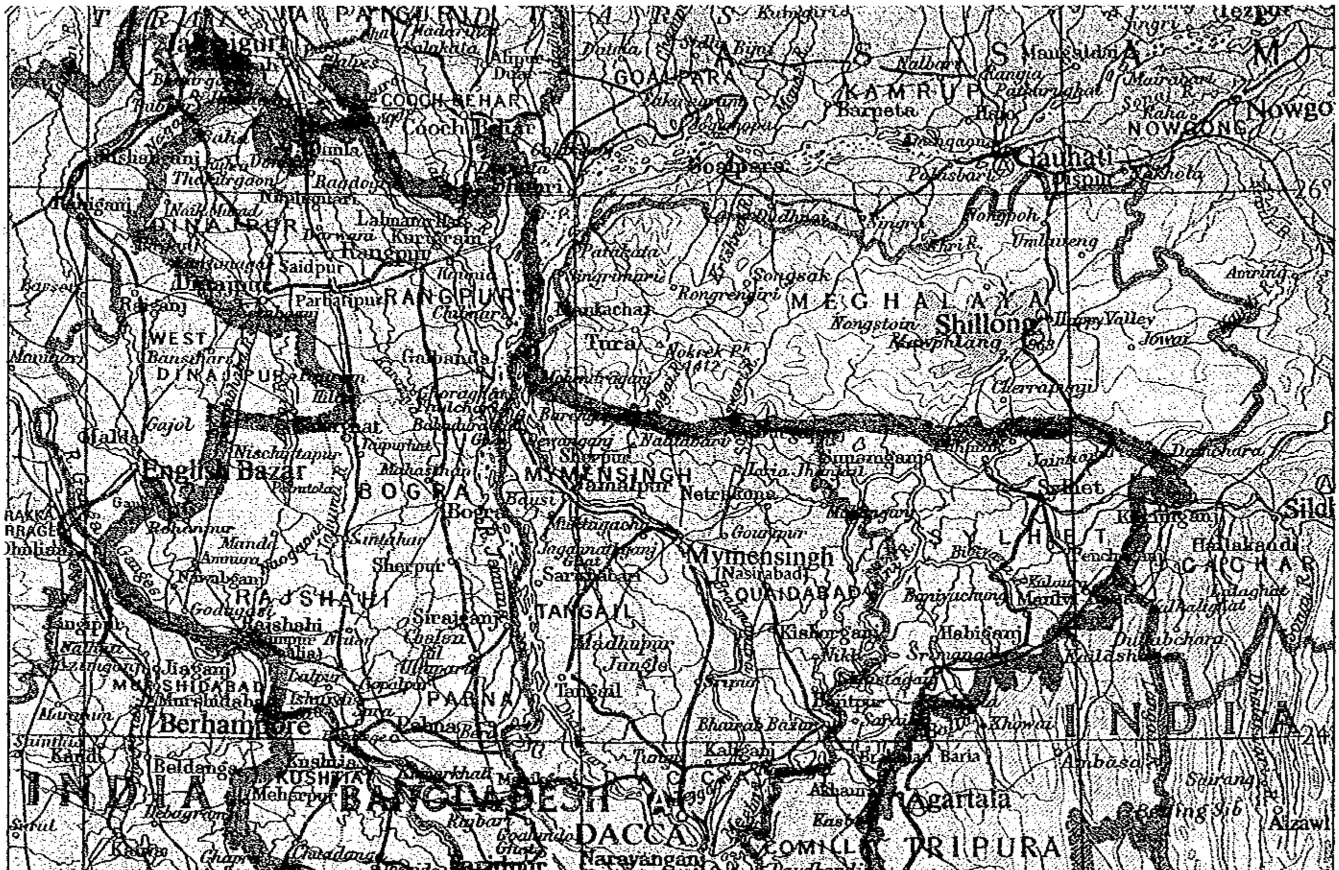
FEASIBILITY STUDY ON DEVELOPMENT PROJECT OF CONTAINER TERMINAL AT DHAKA-NARAYANGANJ PORT IN THE PEOPLE'S REPUBLIC OF BANGLADESH
VOLUME 2 MASTER PLAN
MARCH

FINAL REPORT

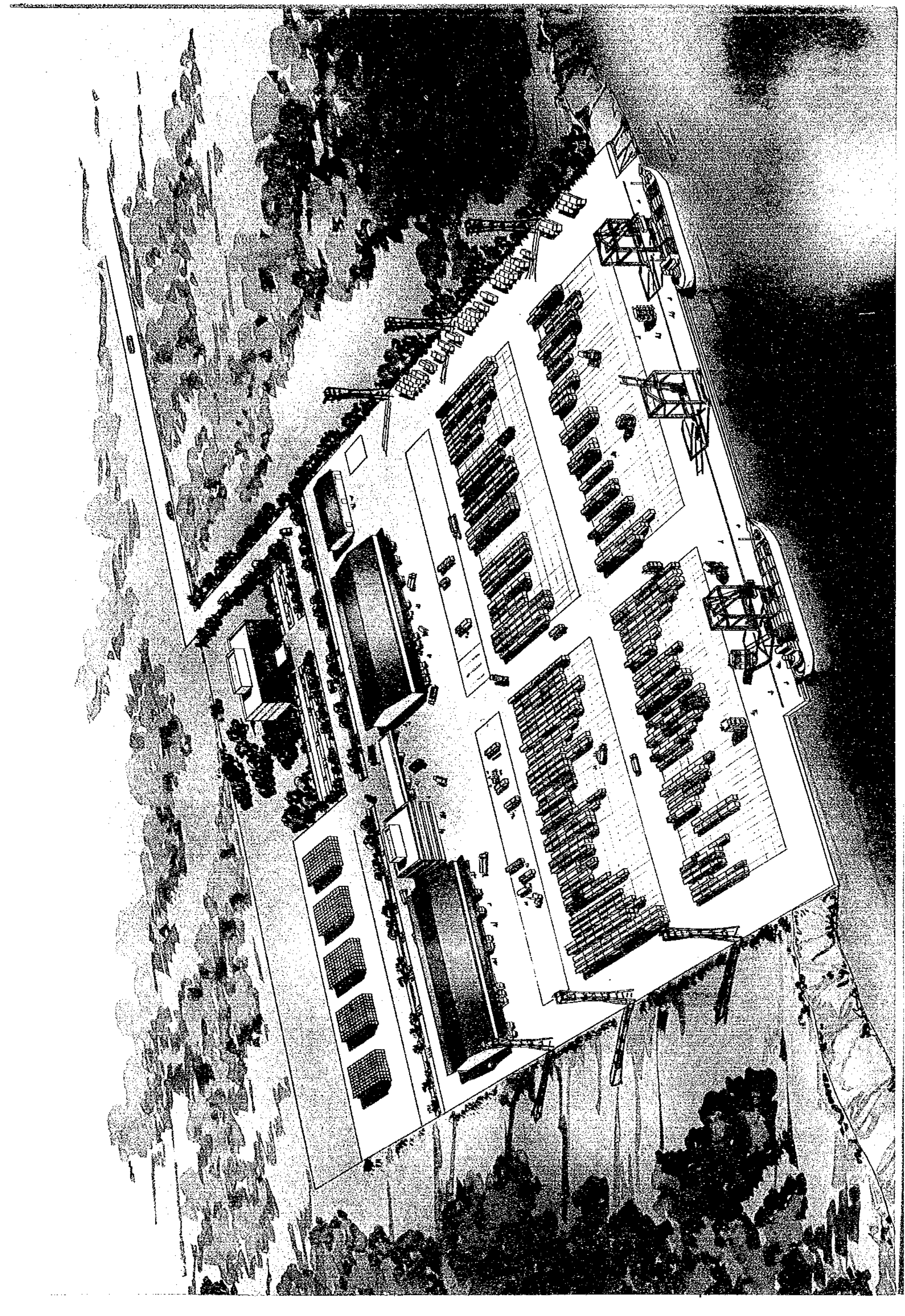
FEASIBILITY STUDY ON DEVELOPMENT PROJECT OF CONTAINER TERMINAL AT DHAKA-NARAYANGANJ PORT IN THE PEOPLE'S REPUBLIC OF BANGLADESH

MARCH 1991

VOLUME 2 MASTER PLAN



BANGLADESH
INDIA
BURMA
MEGHALAYA
TRIPURA
DACCA
Calcutta
Chittagong
Cox's Bazar
Shillong
Gauhati
Mymensingh
Comilla
Barisal
Khulna
Agartala
Sylhet
Narayanganj
Chandpur
Noakhali
Faridpur
Krishnagar
Burdwan
Nabadwip
Berhampore
English Bazar
Dinajpur
Rangpur
Bogra
Rajshahi
Pabna
Tangail
Jessore
Patuakhali
Bakarganj
Cooch Behar
Goalpara
Kamrup
Nowgong
Cachar
Dhubri
Tura
Saidpur
Kushtia
Madaripur
Maijdi
Sandwip
Hatia I.
Kutubdia I.
Maiskhal I.
Rabnabad
MOUTHS OF THE GANGA (GANGES)
Continuation on the same scale
88°
90°
92°



ABBREVIATION

ADB	Asian Development Bank
AH	Area of High Water Level
AL	Area of Low Water Level
AVE	Average
BIWTA	Bangladesh Inland Water Transport Authority
BIWTC	Bangladesh Inland Water Transport Authority
BR	Bangladesh Railway
BRTA	Bangladesh Road Transport Authority
BSC	Bangladesh Shipping Corporation
BWDB	Bangladesh Water Development Board
BWP	Bangladesh Meteorological Department
CFC	Conversion Factor for Consumption
CFS	Container Freight Station
CPA	Chittagong Port Authority
CT	Container Terminal
CY	Container Yard
C.B.R	California Bearing Ratio
C.D	Chart Datum
D.W.T.	Dead weight Ton
EIRR	Economic internal rate of return
FCL	Full Container Load
FFYP	Forth Five Year Plan
FIRR	Financial Internal Rate of Return
GDP	Gross Domestic Products
GVW	Gross Vehicle Weight
G.L	Ground Level
H.A.T	Highest Astronomical Tide
H.H.W.L	Highest High Water Level
H.W.L	High Water Level
ICD	Inland Container Depot
IWT	Inland Waterway Transport
LCL	Less Than Container Load
LOA	Length Over All
L.A.T	Lowest Astronomical Tide
L.W.L	Low Water Level

MPA	Mongla Port Authority
MT	Metric Ton
M.H.W.N	Mean High Water Neap
M.H.W.S	Mean High Water Level
M.L	Mean Level
M.L.W.N	Mean Low Water Neap
M.L.W.S	Mean Low Water Spring
P.C PILE	Prestressed Concrete Pile
P.W.D	Public Works Datum
RHD	Road and Highways Department
SCF	Standard Conversion Factor
SPT	Standard Penetration Test
TEU	Twenty Equivalent Unit

EXCHANGE RATE

US$ = TK 34.06 = ¥ 140.50

CONTENTS (PART I)

List of Tables (Part I)

List of Figures (Part I)

PART I MASTER PLAN

CHAPTER 1 OUTLINE OF BANGLADESH

1.1 Historical Background

The People's Republic of Bangladesh emerged as the 139th Nation of the World following a brief but bloody war of liberation with Pakistan on December 16, 1971.

The country has a long history that is briefly outlined in the following section.

The history of Bengal was relatively obscure until 3rd century BC when it became a part of the vast Mauryan Empire, inherited and ruled by Emperor Ashoka, one of the classical figures of Indian history.

Following his death the empire went into rapid decline and eventual collapse in 184 BC. After a long interval it was the Guptas who reunited northern India. However, Gupta rule came to an end at the hands of the invading Huns and 6th century AD Sasanaka founded the Ganda Empire in Bengal. Within the next couple of centuries northern India broke up into several fragments with Bengal achieving a separate political identity.

Internal conflicts, however, continued until Gopala, a tribal chief, emerged as an elected leader and became the founding figure of the Pala Dynasty (8th to 12th century AD). In 805 AD, with the death of Deva Pal, the Pala Dynasty was considerably weakened and their prosperous empire invited successive invasions from the East, West and South. However, it was the southern Senas who replaced the Palas as rulers in Bengal. Their rule was rather short-lived as the Muslim invaders from Delhi set Bengal as their target.

With only a 17-man strong cavalry, Ikhtiaruddin Muhammad Bakhtiar Khilji captured Bengal in 1199 and brought the region under the rule of the Sultanate of Delhi. During the administration of the rulers of Afghan origin, the city of Gaur, in particular, emerged as a cosmopolitan metropolis.

In 1526, the Moghul Dynasty was firmly established in Delhi by Babur. It was not until 1576 that the Moghuls managed to take control of Bengal.

Gaur remained the centre of power in Bengal until it was replaced by Dhaka in 1608. Under the patronage of the Moghuls, art and literature flourished, overland trade expanded and Bengal was opened to world maritime trade.

With the development of international maritime trade and commerce came the Portuguese and the French, followed by the English under the banner of the East India Company. The internal strife and the intrigues that characterized the provinces ruled by the Nawabs-Nazims in this region helped Robert Clive to overthrow Siraj-Ud-Daula, the young Nawabs of Bengal in 1756 at the battle of Plassey. This was just the beginning of the eventual establishment of the British Raj in India for nearly two hundred years after the fall of the Moghuls in Delhi at their hands.

At the close of WW II in 1945, European colonialism faced stiff opposition and resistance in their various colonies. India was no exception and its independence became imminent in the face of the nonviolent movement led by Mahatma Gandhi.

However, rifts appeared between the Indian Muslims and Hindus, and when the freedom of India was achieved in August 1947, it was partitioned into India with a Hindu majority, and East and West Pakistan with Muslim majority.

However, the Muslims in East Pakistan, who outnumbered the Muslims in West Pakistan, expressed their dissatisfaction at the imposition of Urdu as the state language by the father of the nation, Muhammad Ali Jinna. Their expression of dissatisfaction continued and culminated in the Language Movement of February 1952 when some students were killed by the police. This event not only sparked off greater violence but also helped in the revival of Bengali nationalism.

This state of affairs continued until 1971 when on March 25th the Pakistan Army unleashed its firepower on the innocent and unarmed population of East Pakistan and caused one of the worst genocides in the history of mankind. This sparked off the freedom movement of Bangladesh under its leader Sheikh Mujibur Rahman who was languishing in jail in West Pakistan. Through the gallantry of the valiant freedom fighters "the Mukti Bahini" and the Indian Defence units, Bangladesh won its independence on December 16, 1971, and Sheikh Mujibur Rahman, on his release from jail in Pakistan returned to his homeland and took over the reins of government of the People's Republic of Bangladesh.

The Bangladesh people have a long history of their lineage which is as follows:

Driven by the invading Aryans, a group of Dravidians settled in this land, which was followed by Aryan settlement. The Arab Muslims started arriving in the 9th century AD to be followed by the Persians, the Turks, Afghans and the Moghuls. Different races and nationalities from the neighboring areas came and settled in this region. Over the centuries, these diverse group of people mingled together to attain the present homogeneous cultural and ethnic entity.

1.2 Geographical Feature

Bangladesh is bounded by India on the north and west and by Myanmar and India on the east. In the south, the country has a long shoreline that opens onto the Bay of Bengal.

The location of the country is in the north-eastern section of south Asia between 20 degrees 34' and 26 degrees 38' north latitude and 88 degrees 01' and 92 degrees 41' east longitude.

The area of the country is about 143,999 sq km (about 55,598 sq miles) with about 5.4 percent of the area occupied by rivers. The actual land area of this country is about 136,167 sq km.

Table 1.1 Area of Bangladesh by region

(Unit:sq.miles)

Region (Former district)	Total area	River area	Reserve forest area	Effective land area
Bandarban	1,738	7	1,654	77
Chittagong	2,879	314	682	1,883
Chittagong hill tract	3,351	14	2,915	422
Comilla	2,549	95		2,453
Noakhali	2,108	425		1,683
Sylhet	4,911	112	483	4,316
Dhaka	2,884	207	91	2,586
Faridopur	2,657	182		2,475
Jamalpur	1,293	48	13	1,232
Mymensingh	3,733	85	123	3,525
Tangail	1,314	64	99	1,151
Barisal	2,818	550		2,268
Jessore	2,538	60		2,478
Khulna	4,698	120	327	4,251
Kushtia	1,328	66		1,262
Patuakhali	1,581	303		1,278
Bogra	1,501	33		1,468
Dinajpur	2,535	28		2,507
Pabna	1,827	100		1,727
Rajshahi	3,651	67		3,584
Rangpur	3,705	144		3,561
Bangladesh	55,598	3,024	6,387	46,187

The country has a tropical climate, which is classified into two distinct seasons: the dry season and the monsoon season. Annual rainfall varies from 1,100 mm to 3,500 mm with 80 percent of the total rainfall occurring during the monsoon season.

Bangladesh is predominantly a deltaic region, formed by alluvial sediments borne by 3 rivers: the Brahamaputra-Jamuna, the Padma (Ganges) and the Meghna.

With the exception of the Chittagong Hill Tracts, the Madhupur and the Barind Tract, the country is made up of low-lying alluvial plain.

These conditions sometimes lead to devastating floods, which damage the national economy of the country.

These floods recur once every three or five years.

Although these floods and the heavy rainfall are often considered a hindrance to development, the abundance of water is one of the major resources for agriculture and industry in the country.

1.3 Population

According to the Statistical Yearbook of Bangladesh 1989, the population of Bangladesh was estimated at about 108 million people with a population density of 748 persons per sq km in 1988.

About 11.5 percent of the population was concentrated in the Dhaka district, which has the highest density in Bangladesh, with 1,657 persons per sq km in 1988.

The percentage of the labour force to the total population in this country was 30.8 percent with a total labour force of 30.9 million people in 1988.

In the Dhaka District, the labour force was 4,233 thousand persons, about 36.7 percent of total population of the district in 1988.

The population growth rates of Bangladesh as a whole and the Dhaka District between the census years of 1974 and 1981 were 2.35 percent and 4.0 percent per annum, respectively.

Reduction of the population growth rate is one of the major policies of the government.

A projected population growth rate of 1.8 percent per year was considered for the Third Five-Year Plan (TFYP).

Fig. 1.1 and Table 1.2 show the estimated population of Bangladesh from 1974 to 1988. Table 1.3 shows the population in the census years from 1951 to 1981 and Table 1.4 shows the estimated labour force of Bangladesh between 1981 and 1988.

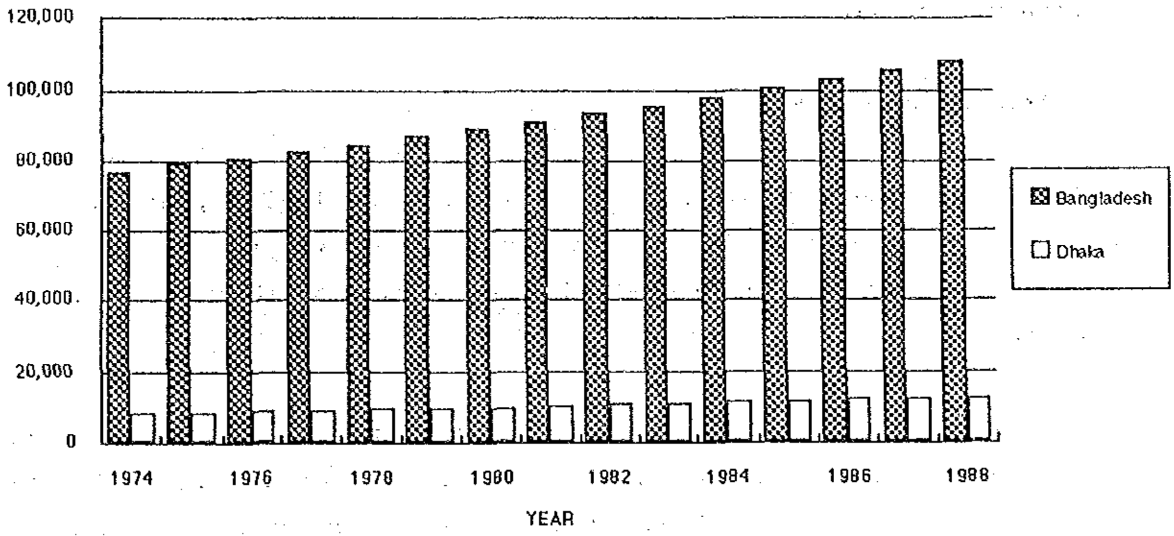


Fig. 1.1 Estimated Population

Table 1.2 Estimated population of Bangladesh

Unit:(Thousand)

Year	Bangladesh	Dhaka	Others
1974	77,031	8,327	68,704
1975	78,961	8,586	70,375
1976	80,815	8,785	72,030
1977	82,713	9,039	73,674
1978	84,655	9,304	75,351
1979	86,643	9,574	77,069
1980	88,677	9,853	78,824
1981	90,894	10,448	80,446
1982	93,199	10,713	82,486
1983	95,563	10,985	84,578
1984	97,986	11,263	86,723
1985	100,468	11,548	88,920
1986	102,860	11,829	91,031
1987	105,280	12,101	93,179
1988	107,756	12,380	95,376

Source:Statistical Yearbook of Bangladesh

Table 1.3 Population in Census Year

(Thousand)

Year	Population
1901	28,928
1911	31,555
1921	33,254
1931	35,604
1941	41,997
1951	44,166
1961	55,223
1974	76,398
1981	89,912

Source:Statistical Yearbook of Bangladesh.

Table 1.4 Labour Force

(Unit:Thousand)

Year	Dhaka District	Total
1981	3,246	25,907
1984-85	3,641	29,510
1985-86	4,233	30,919

Source:Statistical Yearbook Bangladesh.

1.4 Economic Profile

1.4.1 Transition of GDP

The Gross Domestic Product of Bangladesh in 1987/88, at 1984/85 constant prices, reached 450,237 million Taka and its growth rate between 1976/77 and 1987/88 grew steadily at a rate of about 3.5 percent per annum.

The basic economic sector in this country is the agricultural sector, whose share of GDP is declining. The growth rate of the agricultural sector in GDP between 1976/77 and 1987/88 was approximately 1.9 percent per year, which is the second-lowest growth rate of the country's major economic sectors.

The highest growth rate sector in GDP is the power, gas, water & sanitation sector, with about 15.4 percent per annum, and the lowest is the trade service sector, with about -0.1 percent per annum.

The estimated GDP per capita in 1987/88, at 1984/85 constant prices, was about 4,277 Taka and its growth rate between 1976/77 and 1987/88 was about 1.37 percent per annum.

Fig.1.2 and Table 1.5 show the transition of GDP between 1976/77 and 1989/88.

Ratio of GDP by district is shown in Table 1.6.

GDP per capita between 1976/77 and 1987/88 is shown in Table 1.7.

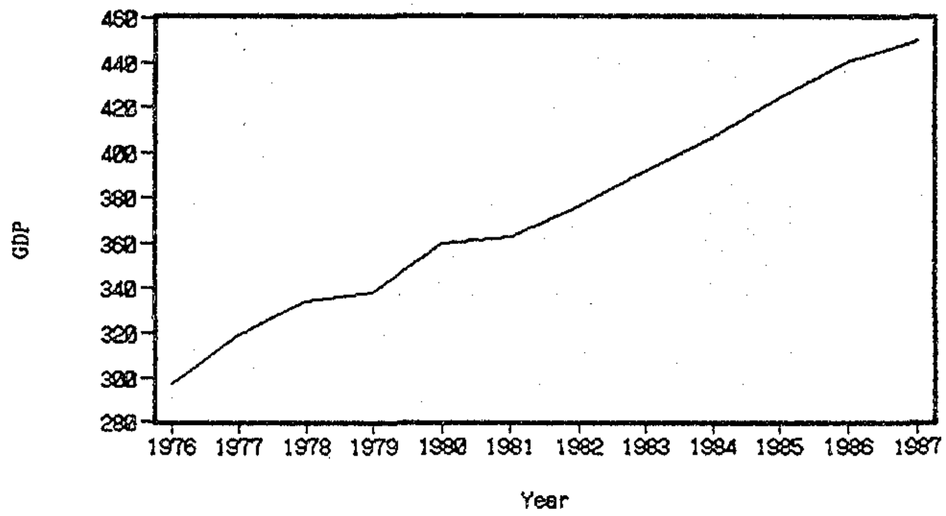


Fig. 1.2 Transition GDP

Table 1.5 GDP at constant(1984-85) Market prices

(Unit:Million Taka)

Year	1976-77	1977-78	1978-79	1979-80	1980-1981	1981-82	1982-83	1983-84	1984-85	1985-86	1986-87	1987-88
Agriculture	138,071	152,983	140.770	149.813	156,081	158.407	165.719	168,377	169.970	175.549	176.258	174,370
Mining	4	4	16	16	4	8	4	4	4	3	4	2
Industry	30.173	32,757	34,849	35.564	37,498	38.090	37,470	38.844	40.112	41.156	44.493	44,328
Construction	11,311	12,032	17,530	13.797	15.544	16.519	16.706	20.065	22.518	22,908	24.469	27.475
Power,Gas,Water & Sanitary	728	821	862	1.004	1,116	1,321	2.022	2.165	2,348	2.642	3.217	4.068
Toransport,Storage,Camunicat.	32,888	33.365	30,139	36.946	37.965	39.020	40.958	41.852	42,941	45.165	49.019	50.617
Trade Services	40.878	41,481	32,327	35.057	35.497	32,426	33.253	35.145	37.275	38,002	39.628	40.244
Housung Services	14.430	15.295	28.307	28.939	29.569	30.267	30,970	31.696	32.444	33.435	34.534	35.645
Public Administration,Defence	7.886	7,496	6.448	6.934	12.187	12,994	12,941	15.616	17.694	18.198	19.556	19,322
Banking & insurance	2.116	2,256	4.120	5.879	6.184	5.765	5.440	5.756	6.089	8.700	9.180	9.312
Professional & Misc. services	19,717	20.704	24,193	25.560	27.865	28.881	30.675	32.748	34.942	37.752	40.364	44.854
Total	297,504	319.115	333.562	337.908	359.710	362,617	376.166	392.268	407.137	424.300	440.624	450.237

Source:Statistical Yearbook

Table 1.6 Ratio of GRP by District

(Unit: %)

District	1980-81	1981-82	1982-83	1983-84	1984-85	1985-86	1987-88
Chittagong	9.35	9.29	9.51	9.86	9.34	9.47	10.27
Chittagong-Hill Tracts	2.66	2.62	2.99	3.32	3.19	2.65	3.19
Comilla	7.10	7.47	7.23	7.23	7.16	7.22	6.33
Noakhali	3.91	3.78	3.87	3.83	3.81	3.73	3.58
Sylhet	6.88	6.67	6.71	6.72	6.39	6.39	5.81
Dhaka	12.63	12.72	12.52	12.15	11.69	12.13	11.97
Faridpur	4.41	4.72	4.52	4.55	4.66	4.85	4.73
Jamalpur	2.45	2.33	2.50	2.45	2.57	2.47	2.87
Mymensingh	6.77	6.98	6.99	6.83	7.04	6.79	6.70
Tangail	2.56	2.70	2.85	2.81	2.61	2.72	2.71
Barisal	4.69	4.61	4.53	4.57	4.50	4.60	5.45
Jessore	3.96	4.17	4.01	3.96	4.16	4.23	4.44
Khulna	5.67	5.56	5.56	5.57	5.80	6.16	5.90
Kushtia	2.28	2.30	2.15	2.21	2.45	2.35	2.48
Patuakhali	1.95	2.06	2.00	2.10	2.05	2.05	2.50
Bogra	3.02	2.95	2.94	3.05	3.08	3.09	2.83
Dinajpur	3.87	3.54	3.56	3.48	3.62	3.45	4.23
Pabna	3.40	3.52	3.37	3.31	3.27	3.33	2.84
Rajshahi	5.31	5.33	5.14	5.22	5.19	5.33	4.79
Rangpur	7.10	6.70	7.06	6.81	7.40	6.96	6.37
Bangladesh	100.00	100.00	100.00	100.00	100.00	100.00	100.00

Source:Statistical Yearbook of Bangladesh

Table 1.7 GDP per Capita at (1984-85) constant prices

Year	GDP at constant Price (1984-85) (M.Tk)	Population (Thousand)	Per Capita GDP (Tk)
1976	297,504	80,815	3,681
1977	319,115	82,713	3,858
1978	333,562	84,655	3,940
1979	337,908	86,643	3,900
1980	359,710	88,677	4,056
1981	362,617	90,894	3,989
1982	376,166	93,199	4,036
1983	392,268	95,563	4,105
1984	407,137	97,986	4,155
1985	424,300	100,468	4,223
1986	440,624	102,860	4,284
1987	450,237	105,280	4,277

Sourc:Statistical Yearbook of Bangladesh

1.4.2 Agriculture, Industry and Foreign Trade

1) Agriculture

The ratio of the agricultural sector in the GDP was about 38.8 percent in 1987/88. However, the trend of the ratio is downward.

The area of the agricaltural sector with highest added value is crops, at about 74.9 percent, the second highest is livestock and the third-highest is fisheries.

The shares of added value of each item in the agricultural sector are shown in Table 1.8.

Table 1.8 Share of Value-added of Agricultural Sector

(Unit:Percent)

Year	Crops	Forestry	Livestock	Fishereis	Total
1976-77	74.85	3.94	8.37	12.84	100.00
1977-78	74.04	5.63	10.76	9.57	100.00
1978-79	75.76	5.20	11.50	7.54	100.00
1979-80	75.02	4.88	13.06	7.03	100.00
1980-81	76.76	5.37	11.43	6.44	100.00
1981-82	77.91	5.38	10.43	6.28	100.00
1982-83	76.89	6.26	10.87	5.98	100.00
1983-84	76.68	7.01	9.87	6.44	100.00
1984-85	74.37	5.74	12.85	7.04	100.00
1985-86	74.05	10.08	8.18	7.70	100.00
1986-87	75.07	9.35	7.38	8.20	100.00
1987-88	73.40	10.68	7.83	8.09	100.00

Source:Statistical Yearbook

2) Industry

The share of the industrial sector in GDP is about 8 percent or 9 percent. The growth rate of the industrial sector was about 3.3 percent per year between 1976/77 and 1987/88.

The major manufacturing industries in Bangladesh are food manufacturing, tobacco manufacturing, textiles, drugs & pharmaceuticals, chemicals and electrical machinery. These industries account for about 81 percent of the manufacturing sector's total gross added value.

The leading industrial products in Bangladesh are jute goods, of which Bangladesh is the world's largest exporter. However, jute goods have been facing increasing competition from synthetics and other substitutes on the world market.

3) Foreign Trade

The major export goods of Bangladesh are Jute, Jute products, Tea, Naphtha/Molasses, Bunker Oil, Shrimps, Garments and Sundries. The major imports are Foodgrains, Cement, Pols, Sugar, Salt, Oilseeds and Sundries.

Regarding Bangladesh's balance of foreign trade, the total export value is about 45 percent of the total import value in 1987. Thus, the balance of foreign trade is in the red. (Refer to Table 1.9)

Table 1.9 Balance of Trade of Bangladesh

(Unit:Crore taka)

Year	Export	Import	Balance
1980-81	1,148.4	3,728.8	-2,580.4
1981-82	1,238.7	3,872.9	-2,634.2
1982-83	1,801.6	4,526.5	-2,724.9
1983-84	2,013.6	5,087.4	-3,073.8
1984-85	2,622.5	6,826.3	-4,203.8
1985-86	2,739.6	6,292.9	-3,553.3
1986-87	3,368.2	6,849.6	-3,481.4
1987-88	4,116.1	9,158.8	-5,042.7

Note:1cror=10 million.
Source:Statistical yearbook of Bangladesh, 1989.

The total cargo throughput at Chittagong and Mongla Ports is tending upward. The total cargo throughput of these Port Authorities' facilities in 1988/89 has reached about 10,475 thousand tons and the growth rate of the total cargo throughput between 1982/83 and 1988/89 was about 7.7 percent per annum.

Sea-container transportation of Bangladesh's foreign trade is increasing rapidly. The total container cargo throughput at the facilities of Chittagong and Mongla Port Authorities has reached approximately 797 thousand tons. The growth rate of the total container cargo throughput at these ports between 1982/83 and 1988/89 was about 42.5 percent per annum.

The ratio of containerization to total containerizable cargo throughput at Chittagong and Mongla ports had increased from 9.51 percent in 1982/83 to 34.02 percent in 1987/88.

Fig.1.3, Table 1.10, and Fig 1.4 show the total cargo throughput, the total container cargo throughput and the ratio of containerization at both the Port Authorities' facilities from 1982/83 to 1987/88.

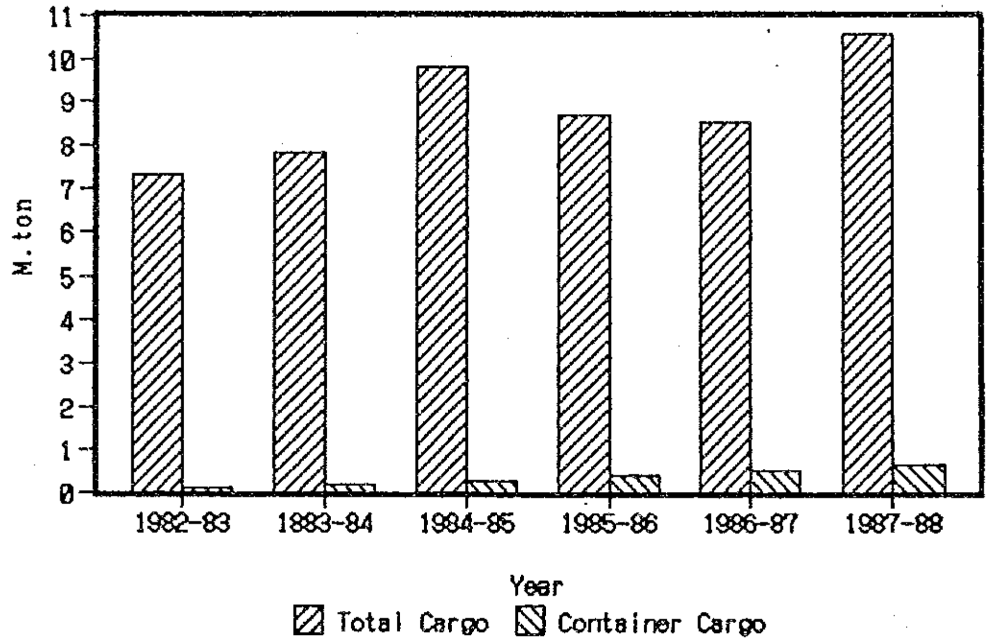


Fig. 1.3 Cargo Throughput at Chittagong and Mongla

Table 1.10 Cargo Throughput at Chittagong and Mongla Ports

Year	Total cargo (1000 tons)	Containerizable cargo (1000 tons)	Container cargo (1000 tons)	Containerization ration (%)
1982-83	7,319	1,314	125	9.51
1983-84	7,850	1,587	200	12.59
1984-85	9,821	1,661	285	17.14
1985-86	9,675	1,623	398	24.49
1986-87	8,528	1,956	537	27.46
1987-88	10,611	1,871	637	34.02

Source : Chittagong and Mongla Port Authorities

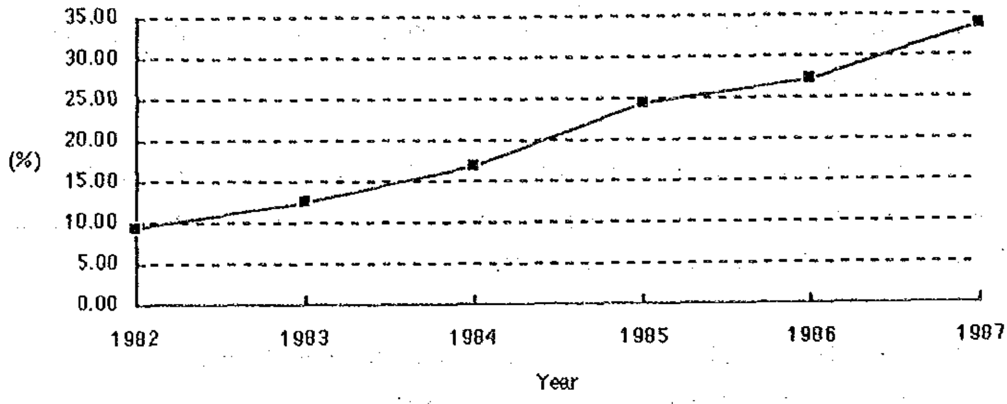


Fig. 1.4 Ratio of Containerization

1.5 Transport

Because Bangladesh's land is separated into many different parts by rivers meandering through the country's deltaic land and much of its industrial materials and consumer goods are imported, an efficient inland cargo transport system connected with the seaports, namely Chittagong and Mongla, is vital to the national economy. The two seaports and the river ports scattered through the country are connected by inland waterways, a great part of which are maintained by natural river flow. On the other hand, national highways connect principal cities such as Dhaka, Chittagong, Khulna and Rajshahi. Trucks must use ferries to cross large rivers such as the Jamuna. Aricha and Nagabari are important ferry ports connecting Dhaka and northwest part of the country. Railways also serve in inland transport, but are completely separated by the Jamuna, Padma and Lower Meghna rivers without any bridges for railways. Moreover, meter gauge is adopted in the east of the rivers and broad gauge is mainly adopted in the west part, resulting in there being quite different railway networks in one country. Double tracks are partly installed.

1.6 Development Plans in the Transport Sector

According to the Third Five-Year Plan (TFYP), the major targets of the plan in the transport sector were as follows:

- Construction of 1,288 km of paved roads, 15,244 meters of bridges including the Buriganga, Meghna and Gorai Bridges,
- Renewal of 925 km of railway tracks,
- Acquisition of 25 locomotives and 451 passenger carriages,
- Dredging of 23 million cubic meters of waterways,
- Development of container handling facilities at Chittagong and increasing loading/unloading capacity of the seaports by 6 lakh tons annually,
- Increase in shipping capacity by 2.86 lakh DWT,

- Development of major waterways by 161 km,

- Provision of launch landing stations in 150 places,

- Providing navigational aides to 483 km waterways.

Among the above targets, Buriganga Bridge has already been completed and Meghna bridge is now under construction and will be opened in the middle of 1990. As to the development of container handling facilities at Chittagong Port, a multi-purpose terminal with berths of 450 meters long, mainly for container handling, is under construction and is partly in operation.

Besides the above targets, the project of Jamuna Bridge is now being studied. The multi-purpose terminal project at Mongla Port has also begun, though only pile-driving has been finished.

Flood control projects are often conducted together with road construction projects since road banks can be used for flood protection. A flood control project at Dhaka City is now being studied in order to protect low-lying areas without protection such as riverbanks and roadbanks. Most of the western part of the city along the Buriganga River, except for Old Dhaka, is protected by banks which are recently constructed, though water gates and pumping facilities have not yet been installed. The banks can be used for road banks in the future. In Old Dhaka, a wall needs to be constructed to protect against floods because the area is built-up. The south part is protected by the Dhaka-Chittagong Road. The east part of the city from Demura to the upstream of the Sitalakha River is left low-lying, and so needs to be protected against flooding from the Sitalakha River. On the other hand, the areas south of the Dhaka-Chittagong Road are well protected, enclosed by the two roads running along downstream from Postogola Bridge and downstream from Kachpur Bridge, respectively, in addition to the Dhaka-Chittagong Road.

For the coming five years, from 1990 to 1995, the Fourth Five-Year Plan is now being worked out, though it has not yet formulated. The drafts of the transport sector are described in detail in Section 5.2.5.

Chapter 2 Natural Conditions

2.1 Meteorology

2.1.1 Climate

The climate of the Dhaka area is characterized by high temperature and high humidity, the climatic characteristies of the monsoon zones of Southeast Area. It is broadly divided into wet and dry seasons.

Generally, the wet seasons last from June to October, and the mean temperature is 29°C. The monthly average rainfall varies from 110 to 400mm, which is concentrated in the three-month period from June to August.

Located near the mouth of the Meghna River, which flows over 1,500Km and empties into the Bay of Bengal, the Dhaka area is inevitably stricken by floods is September when the wet season ends.

During the dry season, on the other hand, the weather is milder, with an average temperature of about 20°C, and the rainfall is less than 20mm during the November-February period.

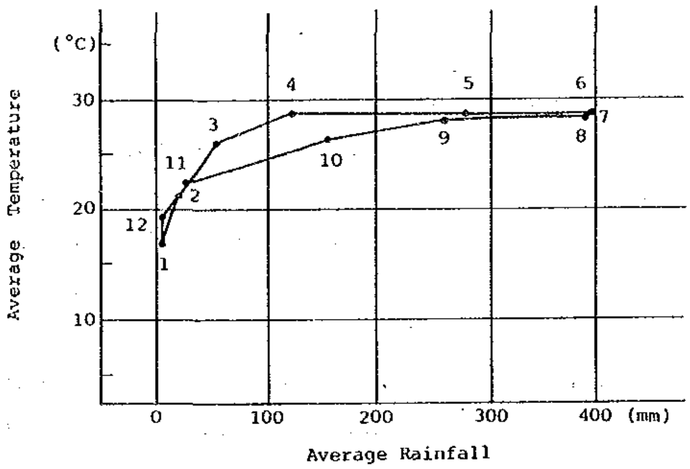


Fig. 2-1-1 Climo Graph

Table 2-1-1 Weather Conditions in the Dhaka Area

Manth	Jan	Feb	Mar	Apr	May	Jun	Jul	Aug	Spt	Oct	Nov	Dec	Total
Temperature °C													
High(Extreme)	14.2	36.6	40.6	42.3	40.6	38.4	35.2	35.3	35.3	38.8	33.3	31.2	-
Low (Extreme)	5.6	4.5	10.4	15.6	18.4	20.4	21.7	21.9	22.4	10.4	10.6	6.7	-
Ave.(Extreme)	16.8	21.5	26.1	28.7	28.9	28.7	28.7	28.7	28.7	27.4	23.6	19.8	-
Relative Humidity percent	70	66	63	71	79	86	87	86	86	81	75	74	-
Days of Rain per month	1	2	4	6	14	19	22	22	16	9	2	1	118
Average Rainfall millmeters	6.5	20.2	52.3		124.0	283.0	398.2	391.4	328.0	160.0	25.3	7.4	2,060.3
Wind Velocities KNOTS (1 KNOT= 1.852 km/hr	2	2	3	5	5	4	4	4	4	3	2	1	1

Source BMD(1983~1985)

2.1.2 Wind

(1) Frequency of occurrence of Wind Direction

Winds blowing over the Dhaka area at a velocity of over 1m/sec account for 46.2% of the frequencies of wind occurrence observed. Throughout the year winds from three directions between south and east prevail, with the southerlies representing 37.5%, south easterlies 22.4% and easterlies 10.1%.

Seasonwise, as Fig.2-1-2 shows, the south and southeast winds prevail during the wet season with a frequency of occurrence of 22.3% and 15.8%, respectively. In the dry season, winds occur with a 15.6% frequency, but the north-to-northwest winds are predomindant.

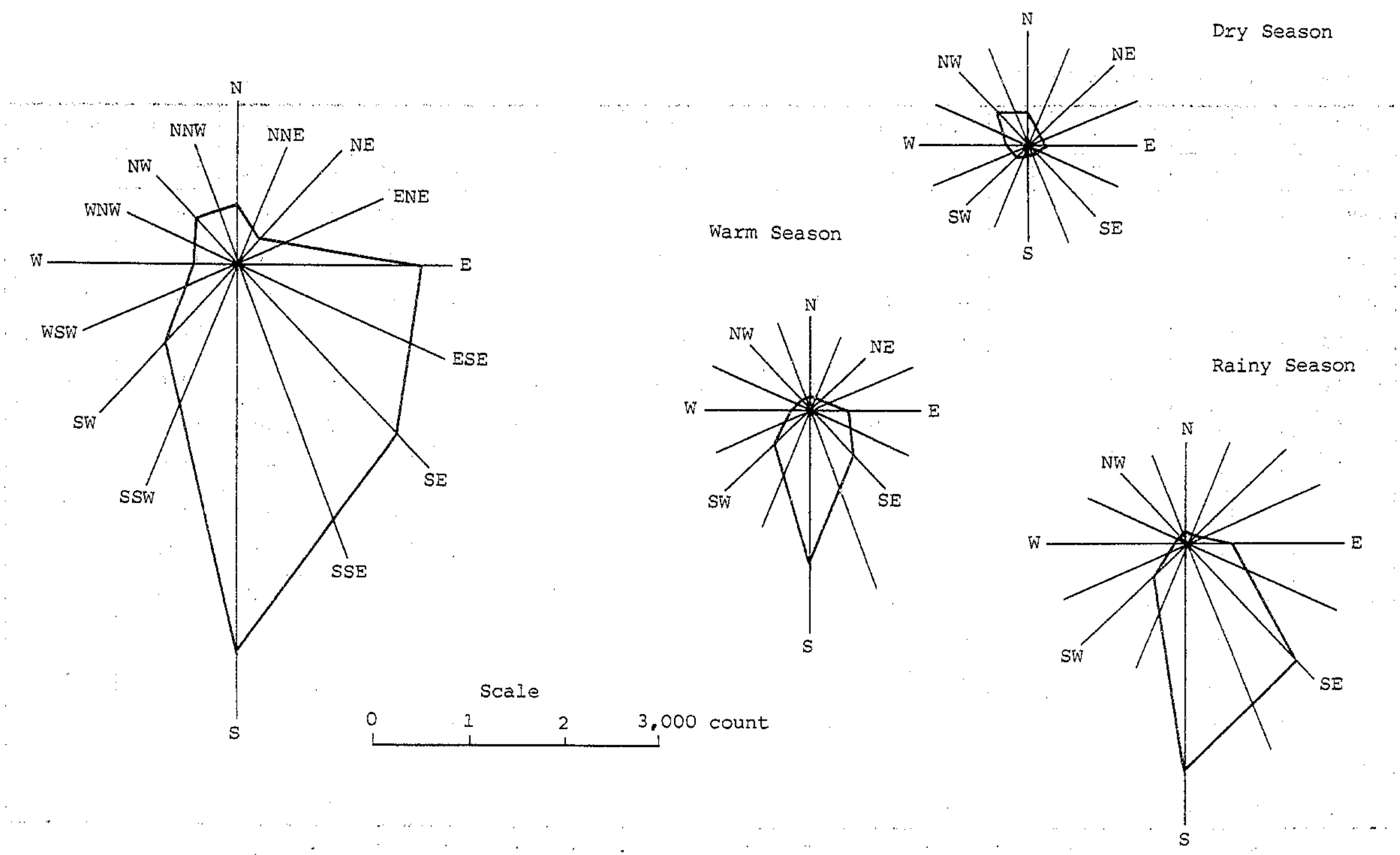


Fig. 2-1-2 Frequency of Occurrence of Wind Directions

Source : BMD

Table 2-1-2 Frequency of occurrence of Wind Direction in Dhaka Area

(1981-1988;8/counts/day)

		N	NNE	NE	ENE	E	ESE	SE	SSE	S	SSW	SW	WSW	W	WNW	NW	NNW	TOTAL
Dry Season	Nov	136	-	53	-	83	-	27	-	7	1	7	-	17	-	78	5	414
	Dec	90	1	37	1	37	9	10	-	11	-	20	1	56	-	76	3	43
	Jan	91	2	39	-	39	-	25	-	8	1	13	-	54	4	174	1	451
	Feb	77	1	27	-	33	-	17	-	39	2	36	-	87	-	161	1	481
	Total	394	4	156	1	192	0	79	0	65	4	76	1	214	4	489	10	1,689
Warm Season	Mar	26	1	42	1	75	-	92	3	362	3	231	1	106	-	76	-	1,019
	Apr	35	-	38	1	155	1	282	2	654	13	131	-	43	1	23	-	1,379
	May	24	1	31	2	197	-	258	2	559	1	90	-	37	-	12	4	1,218
	Total	85	2	111	4	427	1	632	7	1,575	17	452	1	186	1	111	4	3,616
Rainy Season	Jun	12	4	15	1	115	-	486	5	602	8	57	1	22	-	8	-	1,336
	Jul	-	2	1	-	58	-	321	6	895	9	112	-	5	-	4	-	1,413
	Aug	13	-	-	1	126	1	550	1	510	6	92	-	7	-	1	-	1,308
	Sept	23	2	14	-	98	1	268	2	350	3	166	1	10	-	9	4	951
	Oct	109	1	27	-	75	-	79	-	56	-	53	-	38	1	46	3	488
	Total	157	9	57	2	472	2	1,704	14	2,413	26	480	2	82	1	68	7	5,496
Grand Total		636	25	324	7	1,091	3	2,415	21	4,053	47	1,008	4	482	6	668	21	10,801

Source: Meteorological Department

(2) Frequency of Strong Winds

Generally, winds with a velocity of 10m/sec or over, which may affect port activities, are referred to as strong winds.

Wind observation records at the Dhaka weather station, where observations are made eight times a day, do not indicate strong winds with a velocity of 10m/sec or over. Table 2-1-3 presents data on somewhat strong winds corresponding to the velocity range from 5 to 9 m/sec on the wind scale. As the table shows, winds with velocities of 5 to 9m/sec occur 41.6 times a year on average and their frequency of occurrence accounts for 3.1% of all winds recorded of 1m/sec or more in velocity.

Table 2-1-3 Frequency of Occurrence of Winds with Velocities of 5 to 10m/sec

	Jun	Feb	Mar	Apr	May	Jun	Jul	Aug	Sep	Oct	Nov	Dec	Total
1981			3	12	5	7	7	10	1			1	46
1982			3	24	9	7	10	22	1				76
1983		1	16	11	6	6	5	5	4				54
1984				6	2	6	2	1					17
1985			3	2	3	1	2	6		7			24
1986			1	12		2	5		14		4		38
1987		1	7	12	4	2	1		2				29
1988				11	10	7	2	11		2	6		49
Total		2	33	90	39	38	34	55	22	9	10	1	333

Source: BMD

For the purpose of determining the impact of winds on ship navigation in the Bay of Bengal, the available wind data pertaining to the Chittagong area were examined to obtain information on the frequency of occurrence of strong winds sweeping over the bay.

Table 2.1.4 Presents data compiled on strong winds sweeping the sea area off Chittagong. In compiling this data, wind speeds of 10m/sec or over recorded in Chittagong's shore areas were assumed to be equal to wind speeds of 15m/sec or more at sea.

Table 2.1.5 gives the number of winds of 10m/sec of more in velocity blowing in the Chittagong area three consecutive times for a total of nine hours or over. As seen from the table, these strong winds occur with an average frequency of 17 days per year.

Table 2-1-4 Frequency of Occurrence of Strong Winds of 10m/sec in Chittagong Area

	Jun	Feb	Mar	Apr	May	Jun	Jul	Aug	Sep	Oct	Nov	Dec	Total
1984		1		21	37	53	25	32	4	6		2	181
1985		9	24	40	18	15	27	16	6	3			158
1986			3	41	3	23	15	3	5	2	4		99
1987			6	32	4	6	34	11	6				99
1988				7	29	14	11	10	1	7	4		85
Total		11	34	141	91	111	112	72	22	18	8	2	622

Table 2-1-5 Days per year when ships cannot be sailed in the Bay of Bengal

	Jun	Fev	Mar	Apr	May	Jun	Jul	Aug	Spt	Oct	Nov	Dec	Total
1984				4	2	10		6		1			23
1985		2	4	7	2	3	3	1		1			23
1986				7		4	1				1		13
1987			1	5		1	7	1					15
1988					5	1	2	2		1	1		12
Total		2	5	23	9	19	13	10		3	2		86

Source: BMD

(3) Frequency of Occurrence of Maximum to end Velocity

Table 2-1-6 presents the results of analysis of maximum wind velocities by month recorded by the Dhaka Weather Station at unspecified hours. The table does not include strong winds with a velocity of 10m/sec or more recorded during the eight-times-per day wind observations made at the weather station at fixed hours.

Generally, maximum winds are generated by cyclones. In the Dhaka area, a wind velocity of 48.8m/sec (95knots) was once recorded.

Table 2-1-6 Monthly Maximum Wind Speed (in knots) at Dhaka

Year	Mon	Jan	Feb	Mar	Apr	May	Jun	Jul	Aug	Sep	Oct	Nov	Dec	Ave
1953		9	14	24	53	60	35	11	19	25	15	13	9	23.9
54		9	13	20	18	60	16	17	14	15	24	5	7	18.1
55		10	12	78	71	60	15	16	13	40	16	10	7	29.0
56		12	9	60	52	25	26	35	16	22	12	9	9	23.9
57		27	14	14	35	43	30	16	14	12	14	7	9	19.6
58		10	40	16	30	71	35	18	20	18	12	7	9	24.4
59		9	16	35	22	87	18	22	15	12	19	7	9	22.6
60		10	16	26	60	40	18	25	18	16	28	9	7	22.8
61		7	13	39	52	60	35	18	16	16	14	10	10	24.1
62		14	17	48	52	43	19	19	14	35	9	10	13	24.4
63		12	17	25	45	40	36	21	20	22	–	–	–	–
64		9	45	50	43	65	70	19	19	25	25	13	9	32.7
65		9	9	39	31	79	25	19	19	13	9	40	13	25.4
66		9	9	14	28	30	30	13	10	10	30	5	5	16.0
67		9	9	35	15	50	36	13	13	13	9	9	5	18.0
68		9	9	52	52	65	30	35	13	13	13	5	5	27.6
69		17	9	30	17	9	13	9	13	17	13	5	5	13.1
70		15	28	60	65	40	20	28	18	24	90	40	10	36.5
71		14	13	–	–	50	25	25	20	13	20	20	–	–
72		12	22	35	60	45	29	42	26	20	18	15	10	27.8
73		9	60	20	60	40	13	10	9	9	9	13	25	21.4
74		6	5	35	55	31	9	10	14	19	5	5	5	16.6
75		14	27	25	50	44	35	9	9	5	5	–	–	–
76		17	5	35	48	17	42	13	19	19	15	5	5	20.3
77		20	30	35	50	52	37	13	20	13	5	5	9	24.1
78		9	43	40	55	45	10	12	13	19	13	9	9	23.1
79		5	9	25	65	40	25	19	25	9	13	13	5	21.1
80		5	45	52	74	95	38	38	15	9	15	5	5	33.0
81		15	13	19	19	19	20	13	13	13	9	9	44	17.2
82		10	9	13	19	19	13	18	19	9	9	5	9	12.7

Source: Bangladesh Meteorological Department

1 Knot = 1.852 Km/Hr

100 Knots = 51.4= m/sec.

2.1.3 Rainfall

(1) Rainfall

As shown in Table 2-1-1, the mean annual rainfall in the Dhaka area is 2,060mm. In the wet season an average of about 400mm of rainfall in recorded in the June-August period.

The amount of precipitation in 1988 that brought about the worst floods in recent years was 2,411mm, or 1.2 times the average precipitation in ordinary years.

Fig. 2-1-3, June shows 571mm of rainfall, or 1.4 times that in the corresponding month in ordinary years.

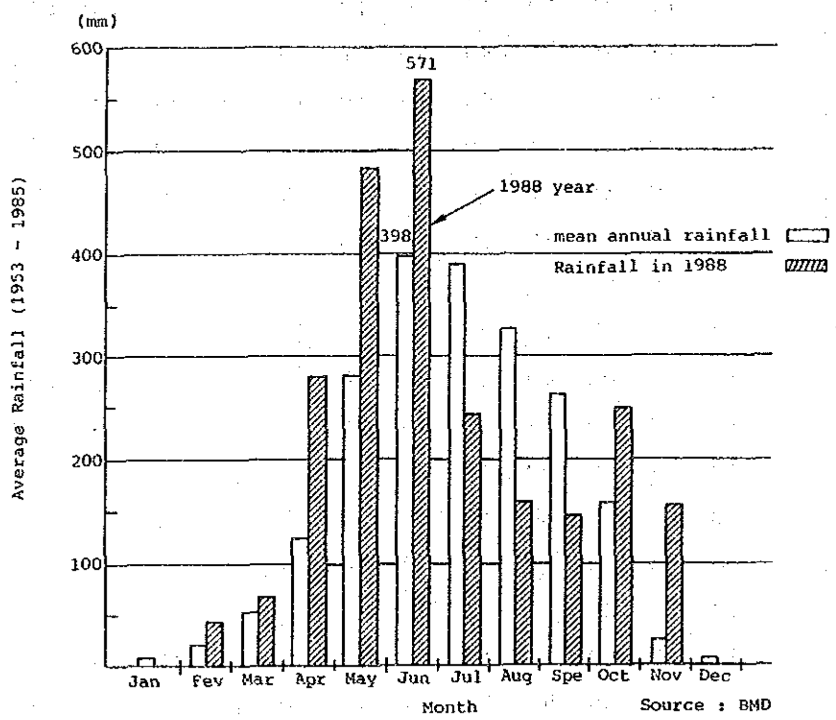


Fig. 2-1-3 Rainfall in Dhaka Area by Month

(2) Frequency of Rainfall

The results of analysis of the rainfall data covering 1988, which witnessed a larger amount of rainfall than any other recent years, are presented in Tables 2-1-7 and 2-1-8 and Fig. 2-1-4.

In Table 2-1-8, which gives the frequency of rainfall, it can be seen that there were 294 occasions on which there was 1mm or more of rainfall every three hours, accounting for nearly 10 % of the total number of observations.

The frequency of less than 10mm of rainfall accounts for 77.2% of the total frequency, followed by 10 to 29mm with 16.3%, 30 to 69mm with 5.8%, and 70mm or over with 0.7%.

In Table 2-1-7, in terms of days the the frequency of less than 10mm of rainfall is 68 days, or 53.5% of the annual total of raing days, followed by 10 to 29mm of rainfall for 34 days with 26.8%, 30 to 69mm with 15.7% and 70mm or more with 3.9%.

Table 2-1-7 Frequency of Rainfall and Maximum Monthly Rainfall Intensity in Dhaka Area

	Jan	Feb	Mar	Apr	May	Jun	Jul	Aug	Sept	Oct	Nov	Dec	Total
1 ～ 9		3	1	5	9	8	15	13	6	6	1	1	68
10 ～ 19			2	1	3	3	6	2	5	1	2		25
20 ～ 29				3	1	1	2	1	1				9
30 ～ 49		1	1			3	2	2	1	1			11
50 ～ 69					5	4							9
70 ～ 99					2								2
100～159				1							1	1	3
Total(Day)	-	4	4	10	20	20	25	18	13	9	4	1	128
Total(mm)	-	44	68	282	483	571	244	165	147	250	155	2	2,411
Max(mm/Day)	-	30	38	122	93	103	40	36	30	158	117	1	-

Source: BMD

Table 2-1-8 Rainy Days and Maximum Daily Rainfall in Dhaka

	Jan	Feb	Mar	Apr	May	Jun	Jul	Aug	Sept	Oct	Nov	Dec	Total
1 ～ 4		5	2	8	19	30	40	31	19	7	11	2	174
5 ～ 9		2		4	7	11	11	5	6	5	2		53
10 ～ 19		1	2	1	6	10	4	2	4	2	1		33
20 ～ 29				3	2	2	2	2	1	2	1		15
30 ～ 49			1		4	4				1			10
50 ～ 69				1	3	2				1			7
70 ～ 80				1								1	2
Total(A)	-	8	5	18	41	59	57	40	30	18	16	2	294
Total(B)*1	-	4	4	10	20	20	25	18	13	9	4	1	128
A/B	-	2.0	1.3	1.9	2.1	3.0	2.3	2.2	2.3	2.0	4.0	2.0	2.3
Max(mm/Day)	-	17	38	81	68	51	24	26	26	69	86	1	-

*1 To reffer Table 2-1-7. Source: BMD

(3) Intensity of Rainfall

Rainfall intensity in the Dhaka area was analyzed with respect to selected days with a daily amount of 20mm or more of rainfall. The analysis result is illustrated in Fig. 2-1-4.

In the figure, the number of days with less than 40 mm of rainfall is 29 days with the mean rainfall of 25 mm, followed by six days with 40 to 60 mm of rainfall and five days with over 60 mm rainfall.

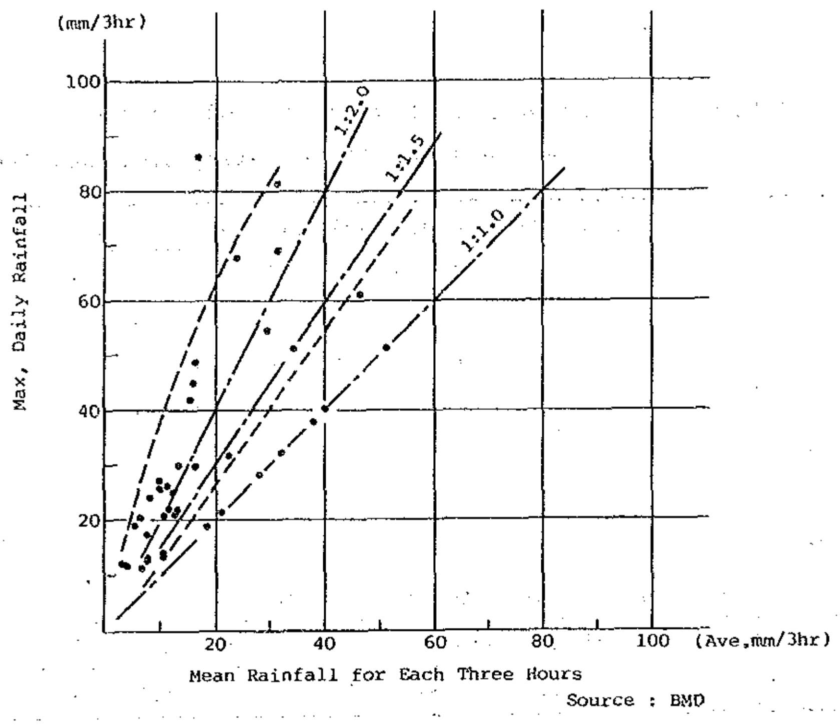


Fig. 2-1-4 Frequency of Maximum Daily Rainfall Intensity

2.2 Rivers

2.2.1 Speed of River Flow

(1) Flow Speed in Dhaka Port

In the absence of long-term flow observation records covering Dhaka Port, observation records pertaining to nearby Demra on the Lakya River were compiled to prepare Fig. 2-2-1. This figure illustrates a correlation between flow speeds and water levels at Demra during the flood periods in 1988 and 1989.

The river width at the proposed container terminal site in Dhaka Port is about 300m, a width substantially equal to that of Demra. The water level at the site does not fluctuate very widely, For these reasons, it may safely be assumed that the river flow speed at the project site during floods is substantially equal to that observed at Demra.

In Fig. 2-2-1, the river flow speed tends of decrease with lowering water level and the correlation between flow speeds but water levels is somewhat erratic. However, the flow speed in Dhaka Port in average floods is estimated to be 0.6 to 0.80m/sec with a maximum of about 1.20m.

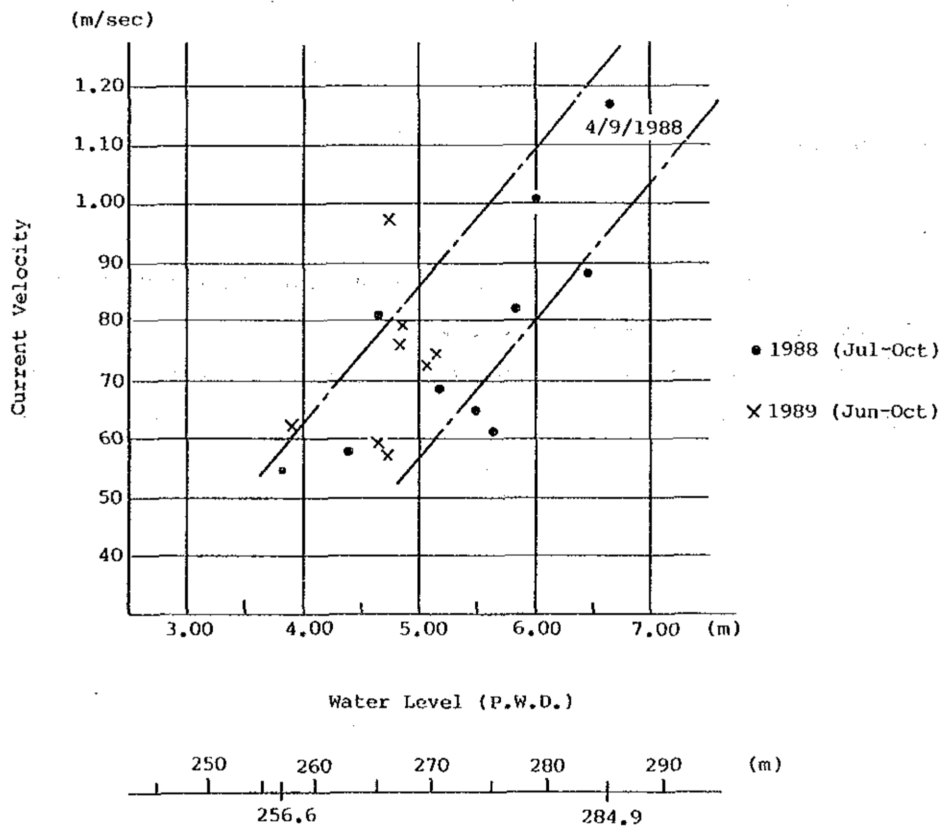
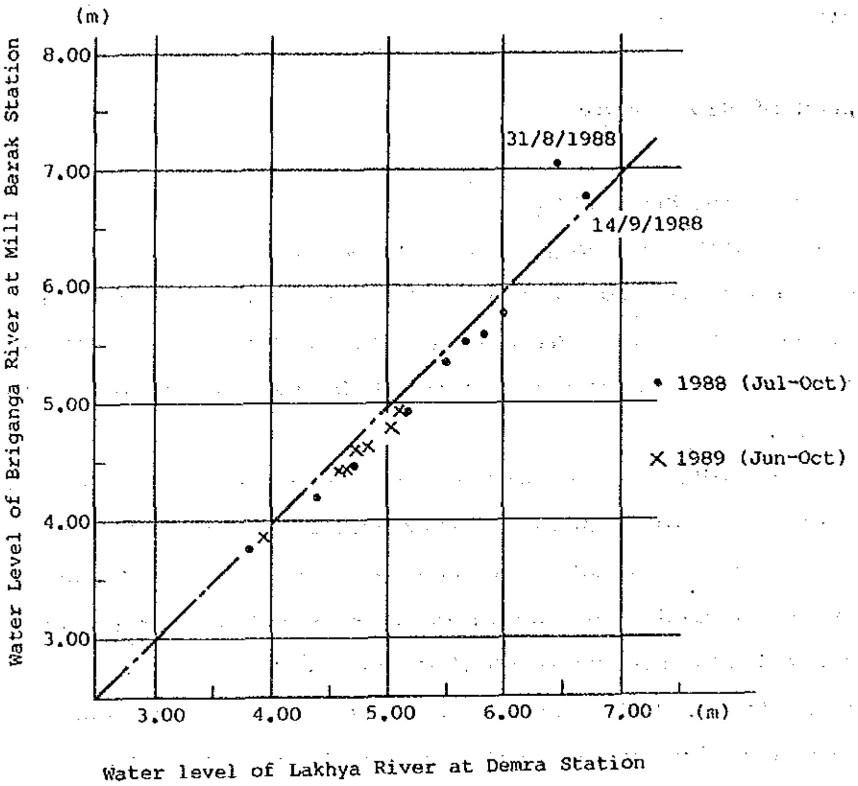


Fig. 2-2-1 Water Level and River Width during Flow Speed Observation at Demra



Source : BWDB

Fig. 2-2-2 Correlation between Water Levels at Demra on Lakya Rivers and at Mill Barak on Buriganga River

(2) Water Level in Dhaka Port

1) Datum Level

The datum level used for planning design and construction of river and port structures is based on P.W.D.

Fig. 2-2-3 gives the water levels in Dhaka Port which are the same as in Narayanganj Port.

H.H.W.L	+7.580 (4/9/1988)
M.H.W.S	+5.154
M.L	+2.968
M.L.W.S	+0.783
L.A.T	+0.656
C.D	+0.198
P.W.D	±0

Fig. 2-2-3 The Water Level in Dhaka Port
Source: Tide Table 1990, BWTA & BWDB

2) Fluctuations in Water Level

Fig. 2-2-4 shows the monthly mean water levels at the gauging station at Mill Barak in Dhaka Port during the 1977-1988 period. In this figure, the water level fluctuations vary appreciably from year to year and in particular, during the 1988 floods the fluctuations were noticeable. In that year the water level fluctuation reached peaks in June, July and September and the the differences from the mean water level were 0.80m in early June, 0.90m in Mid-July and 2.20m in early September. The differences in the water level are attributable to varying discharges of the river and tides generated in the innermost part of the Bay of Bengal. The differences tend to decrease in the wet season, when the discharge is large, and to increase in the dry season, when the discharge is smaller. The average difference is about 0.10m in the wet season and 0.60 to 0.70m in the dry season.

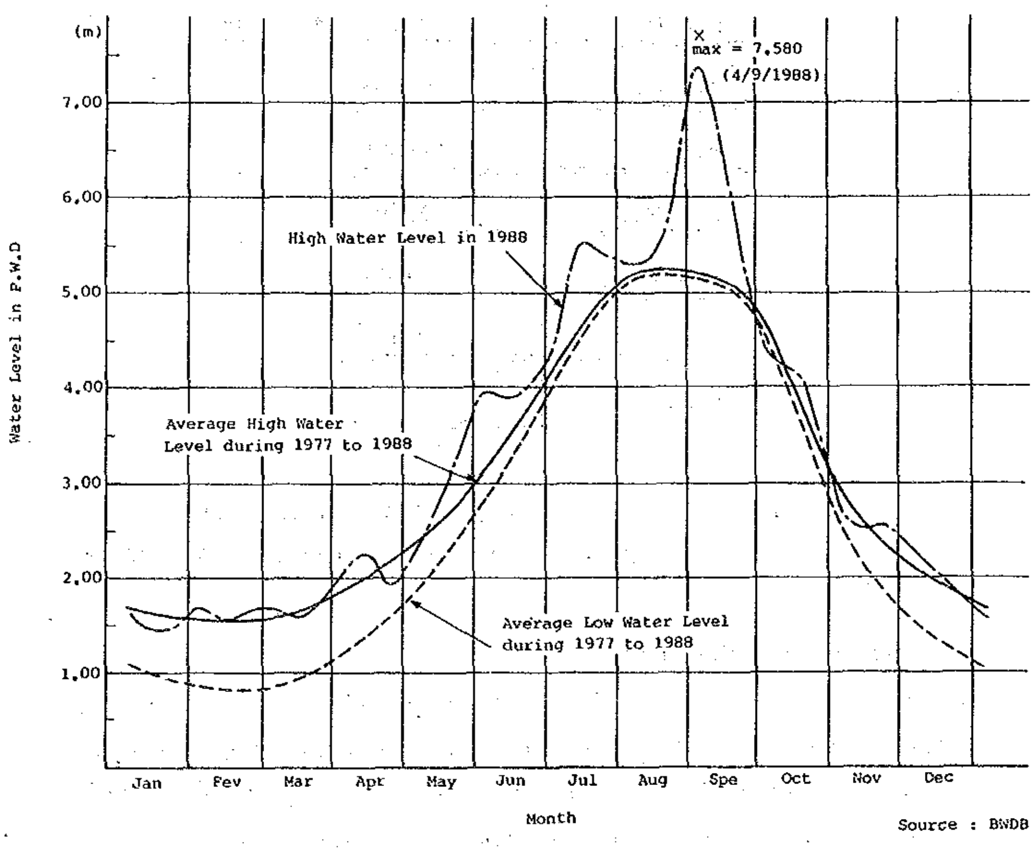


Fig. 2-2-4 Monthly Fluctuations in Water Level at Mill Barak on Buriganga River in Dhaka Port

2.2.2 Flooding

Available records of the number of days when there was flooding are rather scanty, although some records can be traced back to the year 1787. On the basis of extensive data collected for past flooding patterns and a model study, the B.W.D.B. has identified several factors causing floods in Bangladesh.

Bangladesh occupies a large part of the delta formed by the Ganges, Brahmaputra and Meghna rivers through which the rainfall and melted snow of the Himalayas drain into the Bay of Bengal.

The Buhriganga River is a tributary of the Jamuna River, which flows into the Bay of Bengal. The Brahmaputra River lies on the western border of the study area and drains waters from the Gazipur and Dhaka districts, which are among the areas of the country with the most intense rainfall. In the Study Area the river is tidal, with maximum variations at Narayanganj station of about 0.5m in the dry season.

Floods submerge large parts of the Study Area every year. Normally the inundation occurs between June and October. As shown in Figure 2-2-5, more than 50 percent of the Pangaon site is inundated for more than four and a half months (mid-June to November) in an average year.

The highest flood level in the last decade was recorded in 1988 when Dhaka city was inundated for a while. The road level at the Pagla site, which is approximating +7.0m.P.W.D., was under water for 13 days in August 1988 and the Pangaon site was submerged in nearly all of the Study Area at that time.

2.2.3 River cross section

Outline cross-sections of the Buriganga River are shown in Fig 2-2-6 where the water depth is indicated based on the average Lowest Low Water. The section in front of the BIWTA VIP Jetty in Dhaka Port is 300m wide and 6.7m deep in the center of the river.

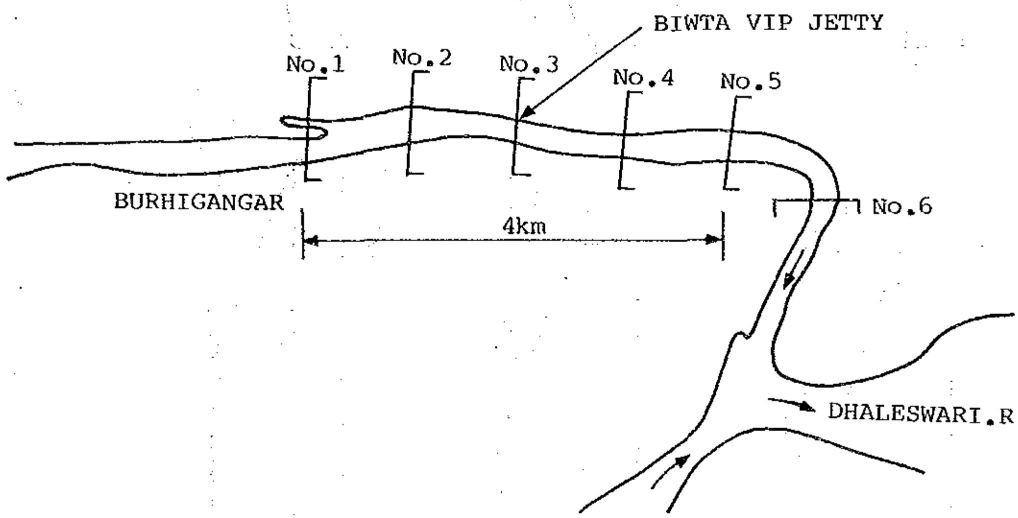


Fig. 2-2-5 Location of River Cross Sections

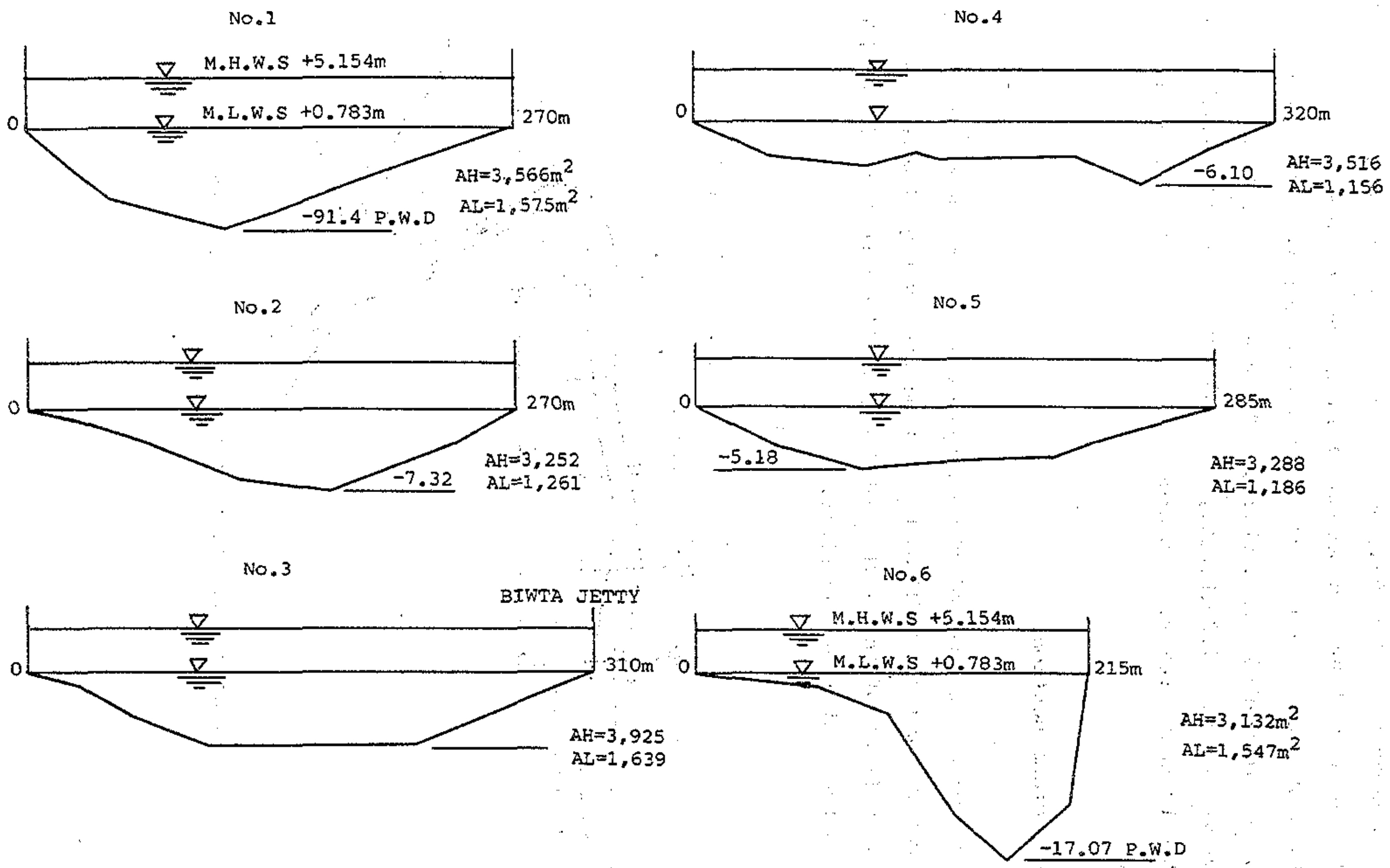


Fig. 2-2-6 River Cross Sections in Dhaka Port

2.3 Marine Conditions

2.3.1 Waves

(1) Coastal Waves

Waves reaching the sea areas of Chittagong located at latitudes 20°to 23°N. in the innermost part of the Bay of Bengal are generated by south to southwest winds sweeping over the bay.

Analysis of winds of 10m/sec or more in the Chittagong area indicated that nearly 75% of the winds were from south to southwest. These winds prevail for 13 days of the 3-year average with a frequency of occurrence (17 days).

Deep sea wave height is estimated at 2 to 2.5m judging from the fetch and distances to shores. Waves with a height of about 2m are estimated to reach the coast for 11 to 13 days on average between April and August.

(2) Waves during Cyclones

During the 1970-1988 period, high waves generated by cyclones were visually observed three times and the waves heights ranged from 1.5 to 4.4m. Of the cyclone-generated waves, those occurring in November 1988 were the highest.

In most cases, cyclones, generated in the vicinity of latitudes 10° or 15°N. or almost in the center of the Bay of Bengal, skirt round the west of the bay, pass through its innermost part and turn into depressions after coming into contact with land.

These cyclones sweep over the sea for three or four days, but those generated near latitude 10°in the mouth of the bay are often gigantic, with a longer duration.

Estimation of cyclone-generated waves can only be made after in-depth analysis of the wind characteristics of cyclones. However, the height of deep-sea waves generated by cyclones as they reach the innermost part of the Bay of Bengal is assumed to attain levels of 8 to 10m.

Table 2.3.1 Chronology of Major Cyclonic Storms and Surges in Bangladesh

Year	Month & Date	Wind Speed	Phenomenon wave	Affected Areas
1970	10/23			Khulna, Patuakhali Dhaka, Chittagong Meghna
1970	11/12-12	62m/s		
1971	5/7-8	22m/s		
1971	9/28-29	31m/s		
1971	11/5-6			
1973	1116-18			
1973	12/6-9			
1974	8/13-15	22m/s		Barisal
1974	11/24-28	45m/s		Cox's Bazar, Chittagong
1975	1/5	27m/s		Chittagong
1975	59-12	30m/s		Barisal, Cox's Bazar
1976	10/19-20			Chittagong, Noakhali, Patukhali, Barisal, Chittagong.
1978	9/30-10/3	21m/s		Khulna, Sundarbans
1983	10/15	55m/s		Coastal, Chittagong
1983	11/9	61m/s	1.5m	Chittagong, Cox's Bazar Coast
1986	5/24-25	69m/s	4.3m	Chittagong, Cox's Bazar, Noakhali
1986	11/9	31m/s		Chittagong, Patuakhali Borguna, Patharghata
1988	11/29	44m/s	4.4m	Khulna cast near river Raimangal

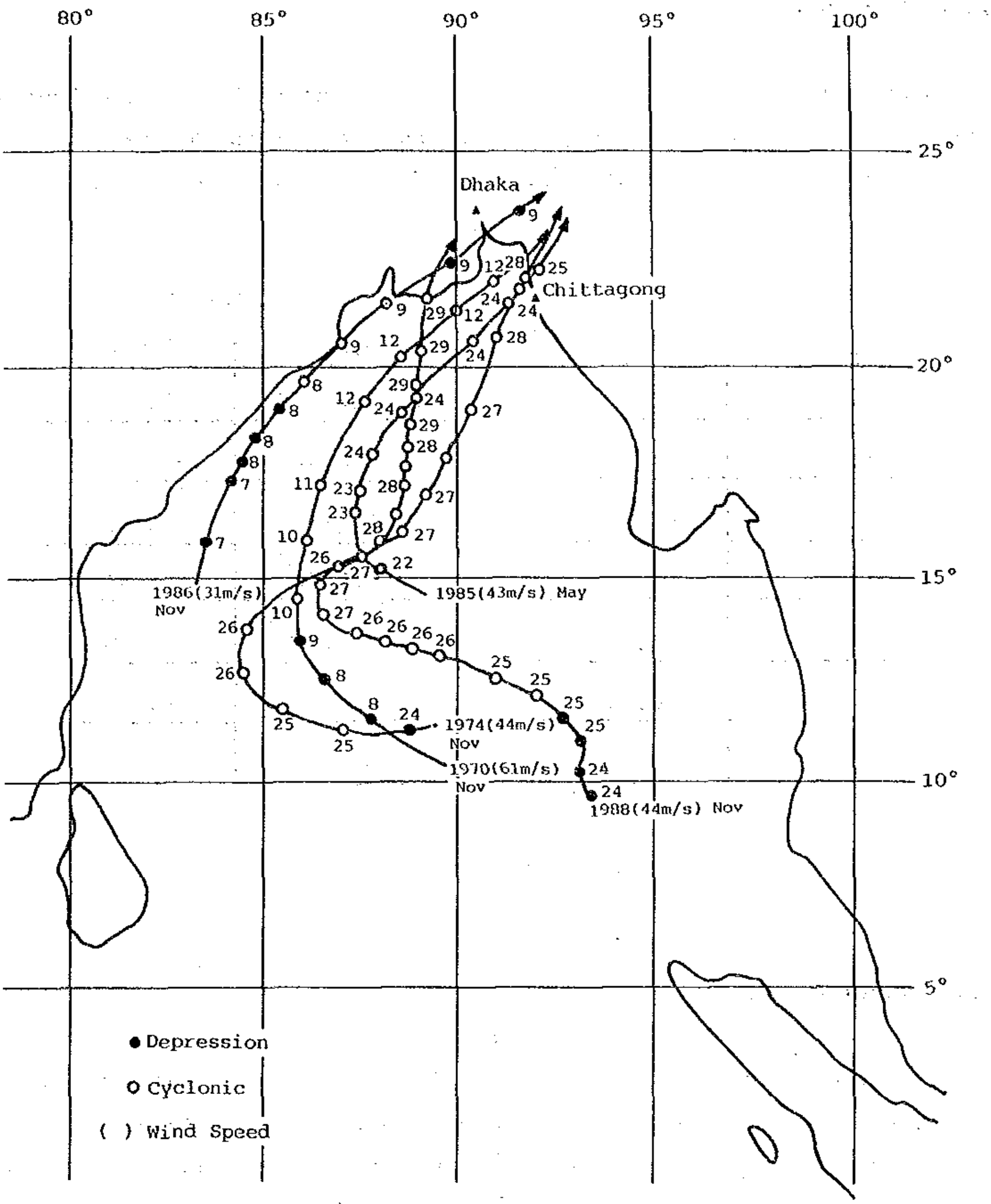


Fig. 2-3-1 The Routes of Cyclonic Storms

2.3.2 Tide Levels

Along the navigable waterway from Chittagong to Dhaka tide levels are observed at two tide stations, one at KHAL No.10 in Chittagong and the other at SANDWIP. The tide data from the two stations are presented in Fig. 2-3-2.

(KHAL No.10)

H.A.T	+5.772
M.H.W.S	+5.067
M.H.W.N	+4.097
M.L	+2.664
M.L.W.N	+1.231
M.L.W.S	+0.261
C.D	±0.000
L.A.T	-0.444

(SANDWIP)

H.A.T	+7.070
M.H.W.S	+6.248
M.H.W.N	+4.851
M.L	+3.243
M.L.W.N	+1.634
M.L.W.S	+0.238
C.D	±0.000
L.A.T	-0.583

Fig. 2-3-2 Tide Levels

2.3.3 Tidal Currents

The highest current velocity is observed between Sandwip and Hatia along the navigable waterway leading from Chittagong to Dhaka. Captains of ships navigating in this area have reported that current velocity as visually measured ranged from 2 to 4m/sec depending on the tidal range.

At a point described by latitude 22°15'N. and longitude 91°15'E off Chittagong, currents were moving northward at flood tide at a velocity of 5.5 knots two to three hours prior to the advent of H.W.L, while they were running southward at a velocity of 5.5 knots after H.W.L was reached.

2.4 Ground Conditions

2.4.1 Topography

The proposed sites are located in the south eastern part of Dhaka city, along the river Buriganga and the lower parts of the sites are subject to extensive flooding every rainy season. The flood waters remain for a minimum of two months to a maximum of five months.

The site is in a fairly large area of lowland containing small areas of higher ground. There are long and irregular depressions at places where good paddy is raised.

During the monsoon specially from July to September the lowlying areas form a vast swamp and houses seem to float in water. In winter and summer the flood water recedes almost completely from the fields and the swamps blossom into green dry pastures and crop lands.

2.4.2 Geology

The Geological formations of the sites are partly new alluvial formation and partly alluvial formation of moderate antiquity. The sites may be divided broadly into the western alluvium, the alluvial area of the east, and the new alluvium of the south.

(1) Field Investigations

Pangaon Site

Boring was performed at 12 sites in total, including 5 boring sites in the river bed. The average depth of the each boring was 30m. Standard Penetration Tests (SPT) were carried out at intervals of 1.5m, and sampling of undisturbed soil was made twice in per each borehole. The locations of the sites are shown in Fig. 2.4.1. Soil profiles are shown in Fig. 2-4-2.

Fig. 2-4-2 suggests that bearing layers for the foundations of the container terminal are situated at 20m to 30m in depth from ground surface or river bed. N-values obtained by SPT are in the range from 30 to 50. Bearing layers consist of brownish, dense and fine to medium sand. The layers from ground surface to 10m-25m in depth are composed of loose silty sand, soft clay, clayly silt etc. Their N-values are generally range from 1 to 10.

Consequently, the foundations of important and heavy structures in the container terminal should be designed with piled or well foundations.

The ground water level is almost the same as mean river water level. (refer to Fig. 2-4-2.

Pagla Site

Boring was performed at 8 sites in total, including 4 boring sites in the river course. The average depth of each borehole and intervals of the SPTs were similar to these at Pangaon site.

The locations of the boreholes are shown in Fig. 2-4-1. Soil profiles are shown in Fig. 2-4-3.

As seen in Fig. 2-4-3, bearing layers for the foundations of the container terminal are situated at about 22-25m in depth from the ground surface or riverbed, being brownish, dense and fine to medium sand. The layers from ground surface to 5-15m in depth are composed of loose silty sand, soft clay, clayed silt etc. Their N-values are generally in the range from 1 to 10.

The ground water level is almost the same as mean river water level (refer to Fig. 2-4-3)

(2) Laboratory Tests

Pangaon site

The natural moisture content is in the range of 21% to 78%. Specific gravity is in the range of 2.53 to 2.69. Gradation tests and Atterberg limits tests results show the sub-surface soil taken from the boreholes is classified into ML, MH, CL, CH, SM by the Unified Soil Classification System.

The unit weight of cohesive soil is in the range of 1.8 to 2.0g/cm3 except in some test specimens.

The shear strength of undisturbed soil is as follows.

- Cohesion (C) : 0.15 to 1.2 kgf/cm^2
- Angle of internal friction (Fai) : 4 to 20 degrees

The unconfined compressive strength (qu) was obtained by laboratory test. It is in the range of 0.4 to 3.2 kgf/cm^2. This value (qu) is theoretically equivalent to twice of the cohesion (C) for saturated soils.

(Pagla Site)

The natural moisture content is in the range of 20% to 150%. Specific gravity is in the range of 2.54 to 2.69. The subsurface soil is classified into ML, MH, CL, CH, SM, OH. The unit weight of cohesive soil is in the range of 1.75 to 2.0g/cm^3 except in some test specimens.

The shear strength of undisturbed soil is as follows.

- Cohesion (C) : 0.07 to 0.55kgf/cm^2
- Angle of internal friction (Fai) : 6 to 25 degrees

The unconfined compressive strength (qu) is in the range of 0.3 to 2.4 kgf/cm^2.

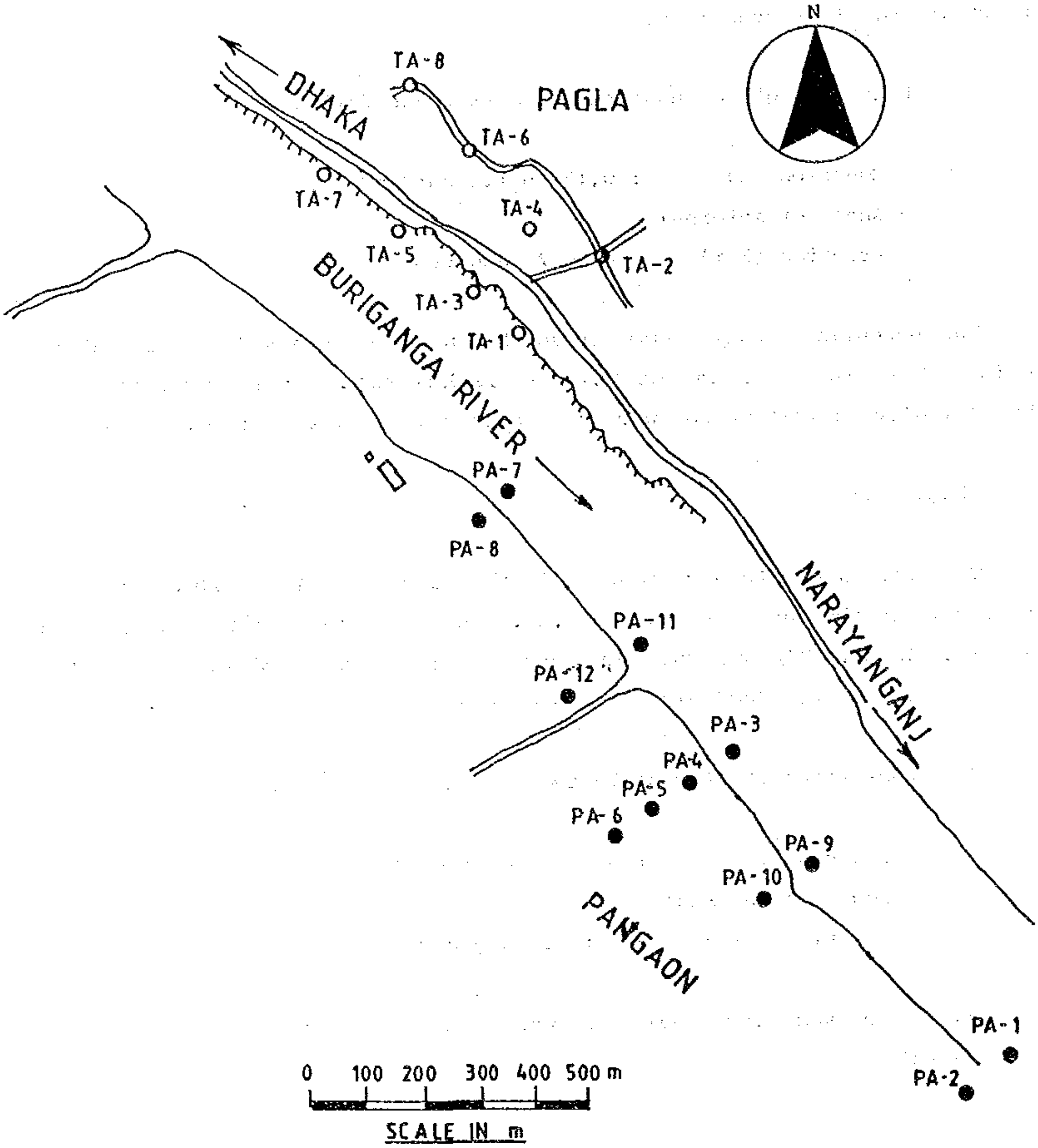


Fig. 2-4-1 Location Map of Boreholes

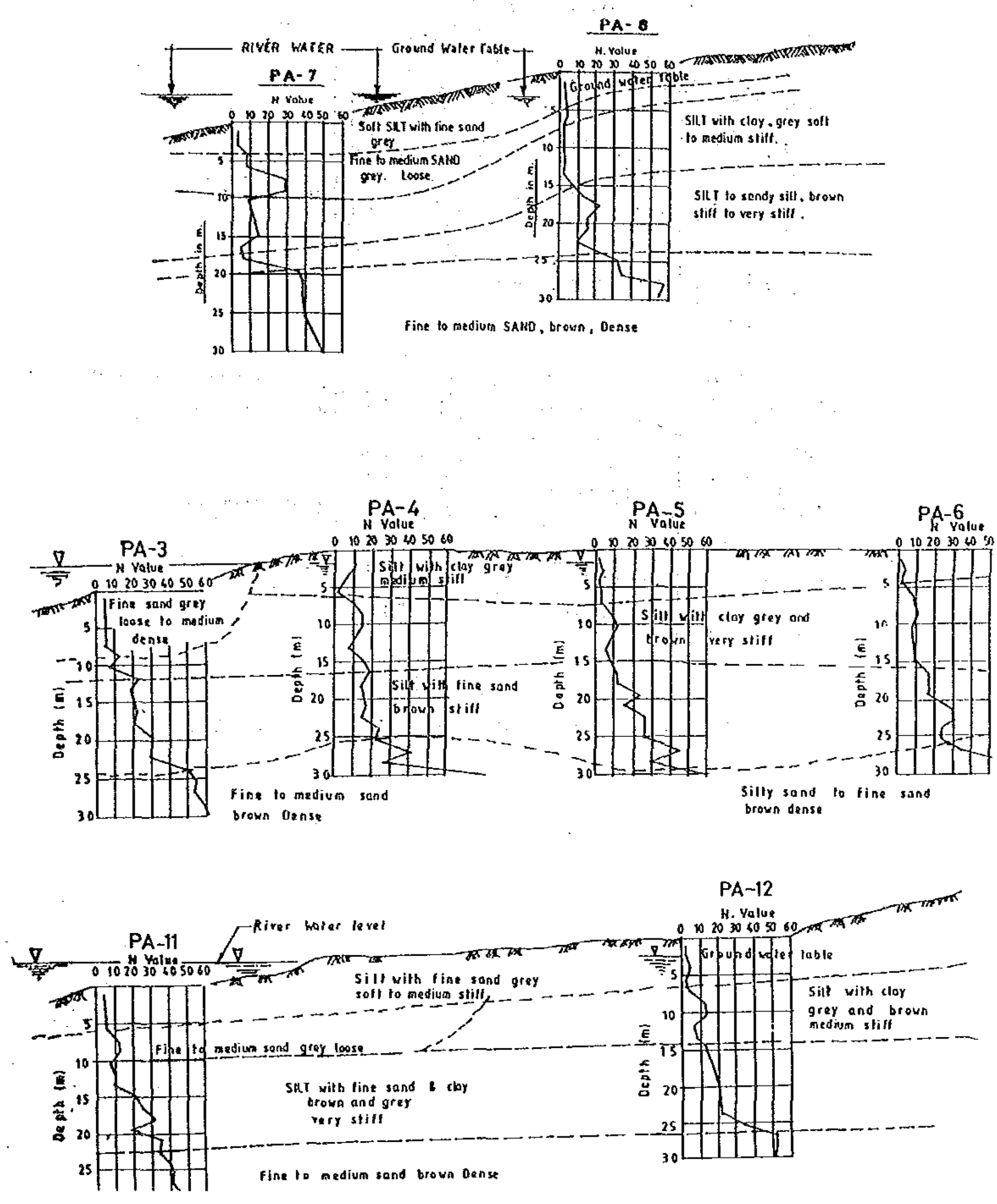


Fig. 2-4-2 (1) Geological Profile (Pangaon Site)

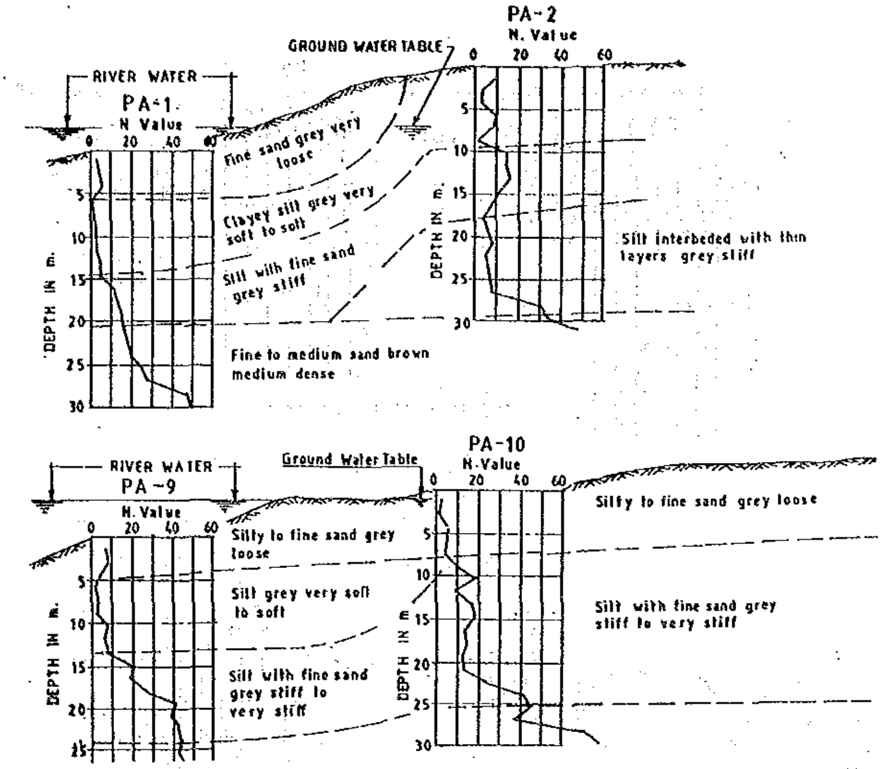


Fig. 2-4-2 (2) Geological Profile (Pangaon Site)

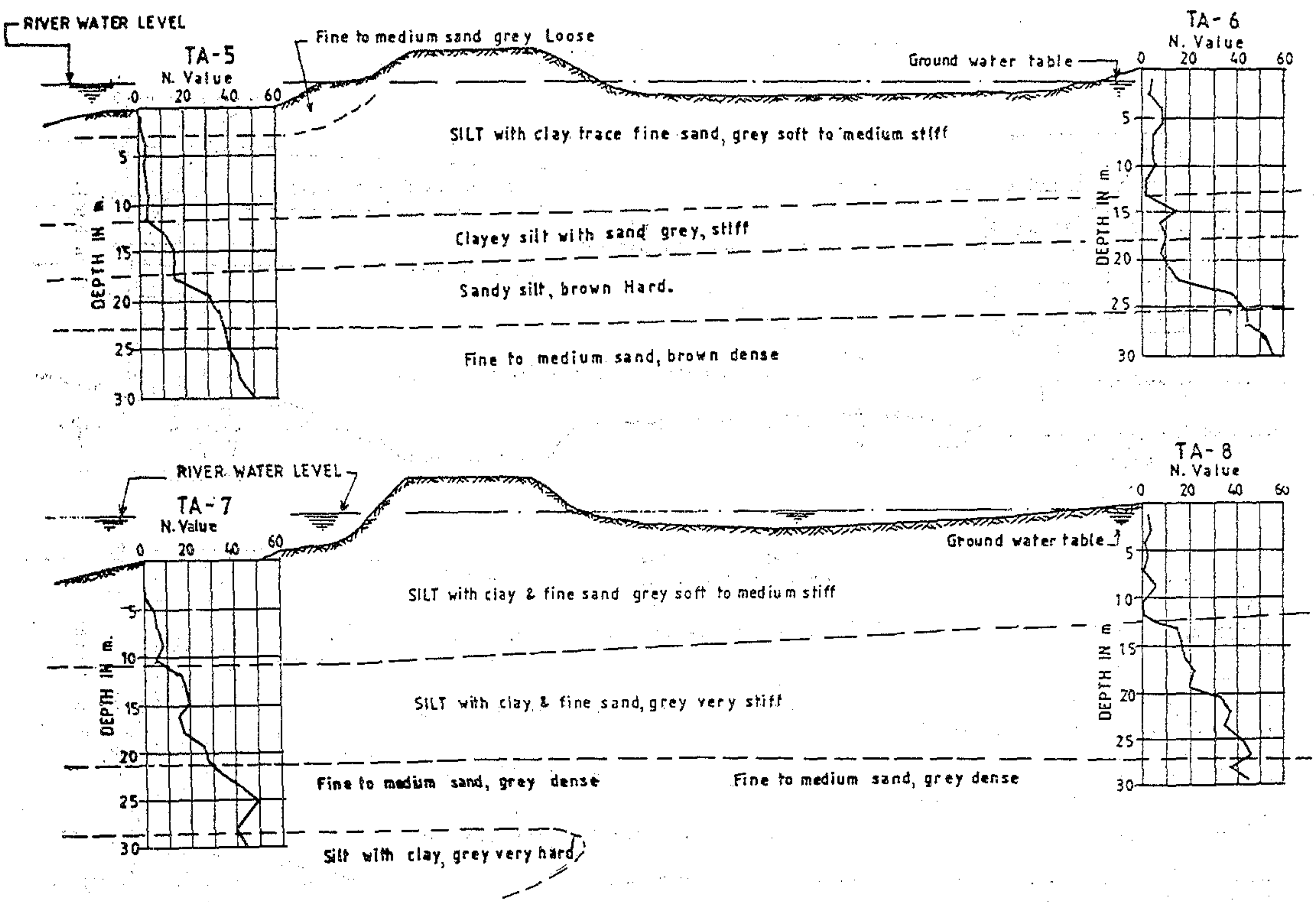


Fig. 2-4-3 (1) Geological Profile (Pagla Site)

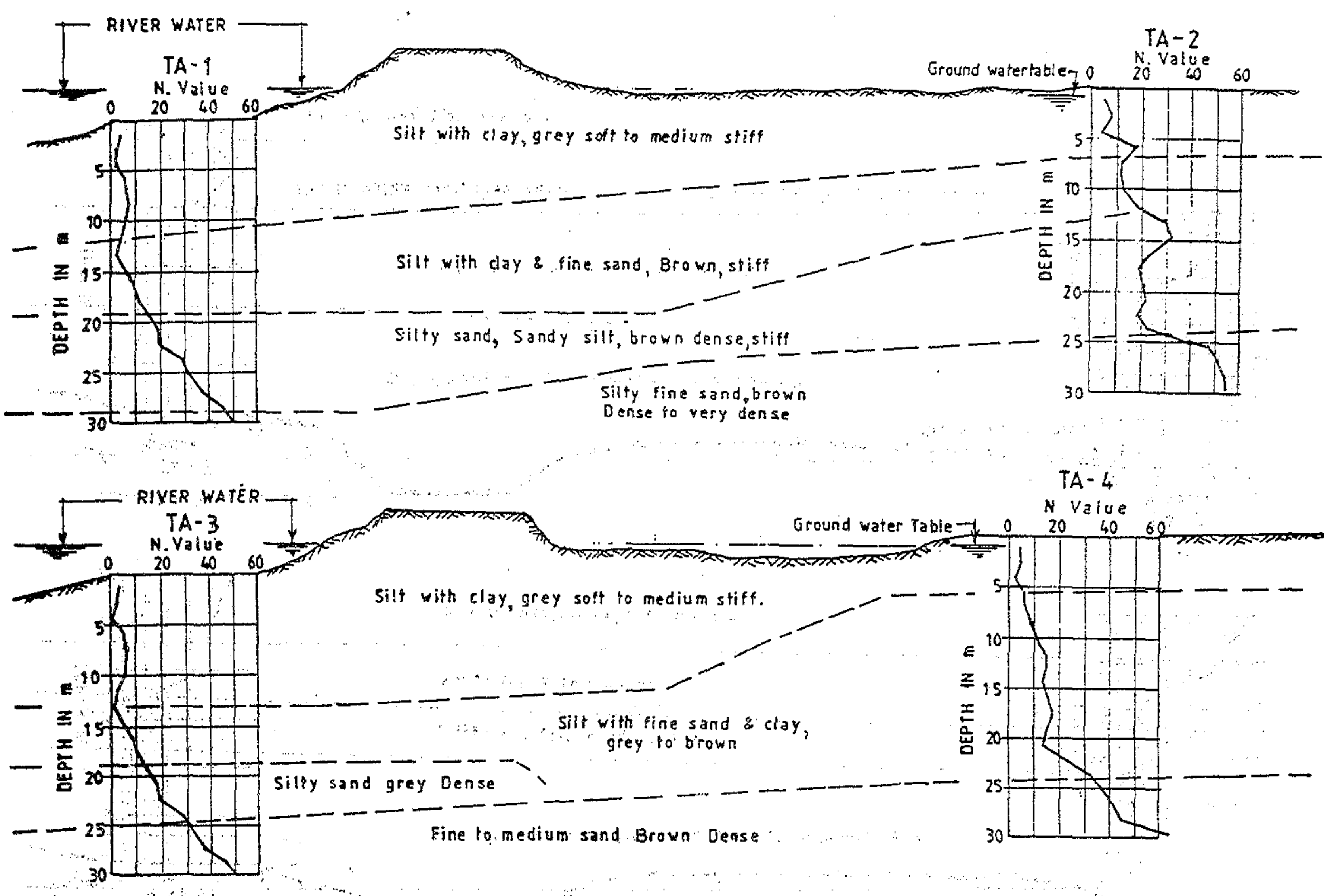


Fig. 2-4-3 (2) Geological Profile (Pagla Site)

CHAPTER 3 PRESENT CONTAINER CARGO FLOW

3.1 Cargo Throughput at Chittagong and Mongla Ports

According to the data of The Chittagong Port Authority (CPA), the cargo throughput at Chittagong port, excluding the quays of private companies, reached about 7,747 thousand tons in 1987/1988.

For exports of Chittagong port, the total cargo throughput and the container cargo throughput were about 638 thousand tons and 185 thousand tons, respectively.

For imports, the total cargo throughput and the container cargo throughput were about 7,109 thousand tons and 364 thousand tons, respectively, in 1987/1988.

The growth rates of the total cargo and the container cargo at Chittagong port between 1979/80 and 1987/88 were about 2.8 percent and about 48 percent per annum, respectively.

Tables 3.1, 3.2, Fig. 3.1 and 3.2 show the cargo throughput at Chittagong port by export and import by commodity from 1979 to 1987.

Table 3.3 and Fig. 3.3 show the cargo throughput at Chittagong port from 1979 to 1987.

Table 3.1 Exports Handled at Chittagong Port

(Unit:M.tons)

Commodity	1979-80	1980-81	1982-83	1883-84	1984-85	1985-86	1986-87	1987-88
Jute	16,870	13,038	18,361	11,910	5,932	7.099	3,596	81
Jute Products	153,809	170,001	193,819	180,520	143.532	129,804	114,236	120.851
Tea	30,415	36,236	31.588	31,135	25,161	24.594	13.246	23.025
Hide & Skin	9,367	13,819	8.720	2.229	2.814	2.172	1.504	6.536
Bone & Bone Meal	2,287	2,688	2,033	2.253	2.726	2.907	2,526	1,387
Paper	4,008	201						1
Oile Cake	2.032	3,251	4.349	1.739	141	208		
Fish Dry & Frozen	4.831	5,109	65	1.136	740	36	72	11.517
Cottn Waste	1,517	379	712	512	596	284		
Timber	834	1.601	546	655	169	293	70	
Bran(Wheat/Rice)	10,596	12.359	18.293	32.656	24.359	1.047		
Chillies	2	0			21			
Rayon	718	380	93	117				
Sundrise	22,838	21,295	57,077	59,965	96.676	128.164	194,577	166,435
Naphtha/Moasses/Banker/etc.	68.978	251,134	109.124	59.724	18.000	33,436	69.000	117.804
Fertilizer	0	7,442						171,347
Shrims	0	0	9,120	7.329	8,904	7,886	4,982	1.083
Frog legs	0	0	453	601	174	94	15	
Tobacco			52	576	23	9	11	
Germns								18.581
Total	329.102	538.933	454.405	393.057	329.968	338.033	403.835	638.648

Table 3.2 Imports Handled at Chittagong Port

(Unit:M.tons)

Commodity	1979-80	1980-81	1981-82	1982-83	1883-84	1984-85	1985-86	1986-87	1987-88
Foodgrain	2,044,146	1,020,710	998,438	1,254,318	1,572,306	2,060.331	793,705	1,340.119	2,272.995
Sugar	65.228	25,778	43,090	5,077	555	350,881	116,458	177.386	140.743
Salt			83,055	280.280	520.292	129.519	288,220	109,764	144.286
Oil in Drums	71,306	100,768	65,756	180,508	48,936	69.511	100,282	188.056	81.861
Oil Seed	22,106	14,946	17,373	15,424	33,776	28,165			132.821
Cement	311,499	247,365	330,698	550,664	614.132	735,028	597,068	626,387	578,565
Fertilizer	439,074	239,750	309,033	208,069	232,099	430.340	489,539	51,377	105.706
Cotton	46,786	54,393	45.017	36.329	64,149	36,460	36.193	33.711	28,188
Cotton Piece Goods	7,098	17,439	20.103	16,088	10,902	17,310	9,247		2.371
Iron & Steel	117,904	57,766	24.596	59,164	119,407	220.699	227.264	224,823	55,461
C.I.Steel	23,445	41,528	33,384	5,490	13,952	2,524	7,005	5,686	
Chemical	53,810	109,480	63,108	17,884	4,613	3,493	2,347	276	428
Iron Materials	46.365	114,761	62.628	4,383	1,443			14,342	96.530
Cement Clinker	248,668	184,842	218,088	149,848	168,667	91,675	131,275	162,649	167,929
Timber					4,447	13,220			
Paper	2,292	1,734	1,093		259	3,574	1,077		
Pig Iron	86,655	121,307	81,304	10.477	48,437	115,753	33,404		9,850
Sundries	463,850	604,896	796,095	540,584	797,927	913,684	1,040,722	1,215,512	1,189,880
Coal	126,960	183,201	196,938	93,374	32,768	1,020	30,342	88,551	48,019
Pols(in Bulk)	1,727,621	1,795,272	1,757,680	1.535.176	1,392,000	1.605.000	1.910,000	1.597.199	2.053.096
Total	5,904,813	4.935.936	5,147.477	4.963.137	5,681.067	6,828.187	5,814.148	5,835.838	7.108.729

Source:Chittagong Port Authority

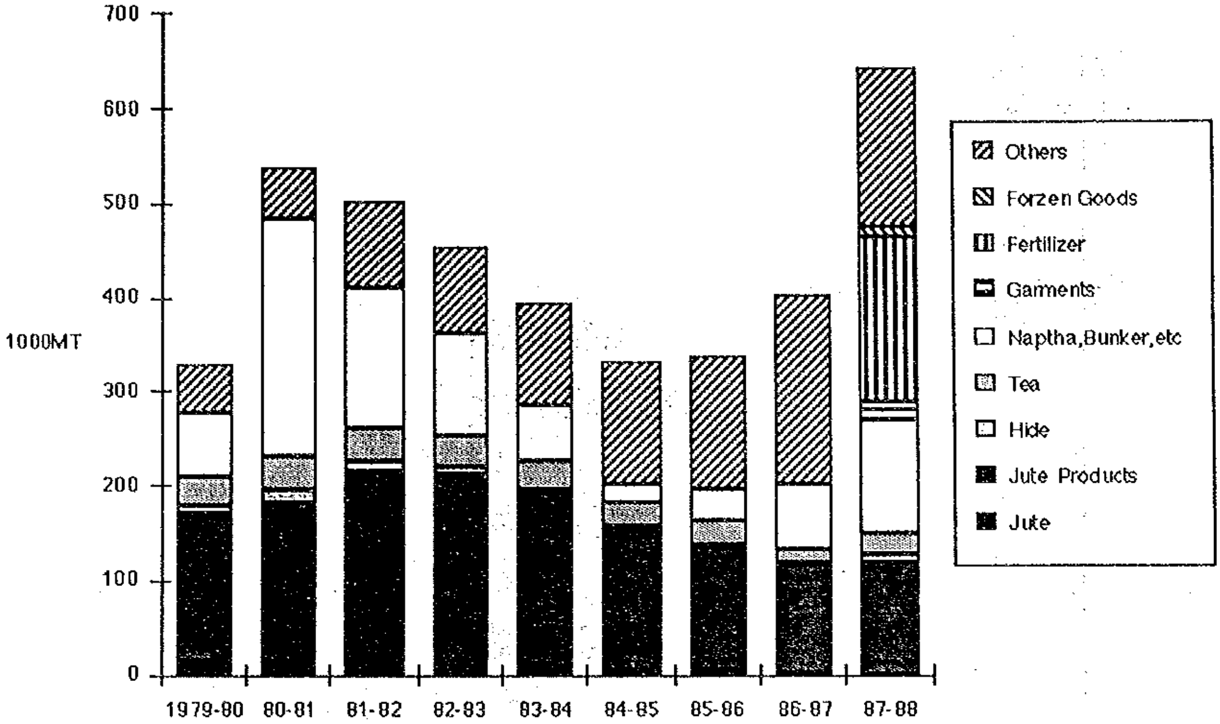


Fig. 3.1 Export Cargo Volume at Chittagong Port

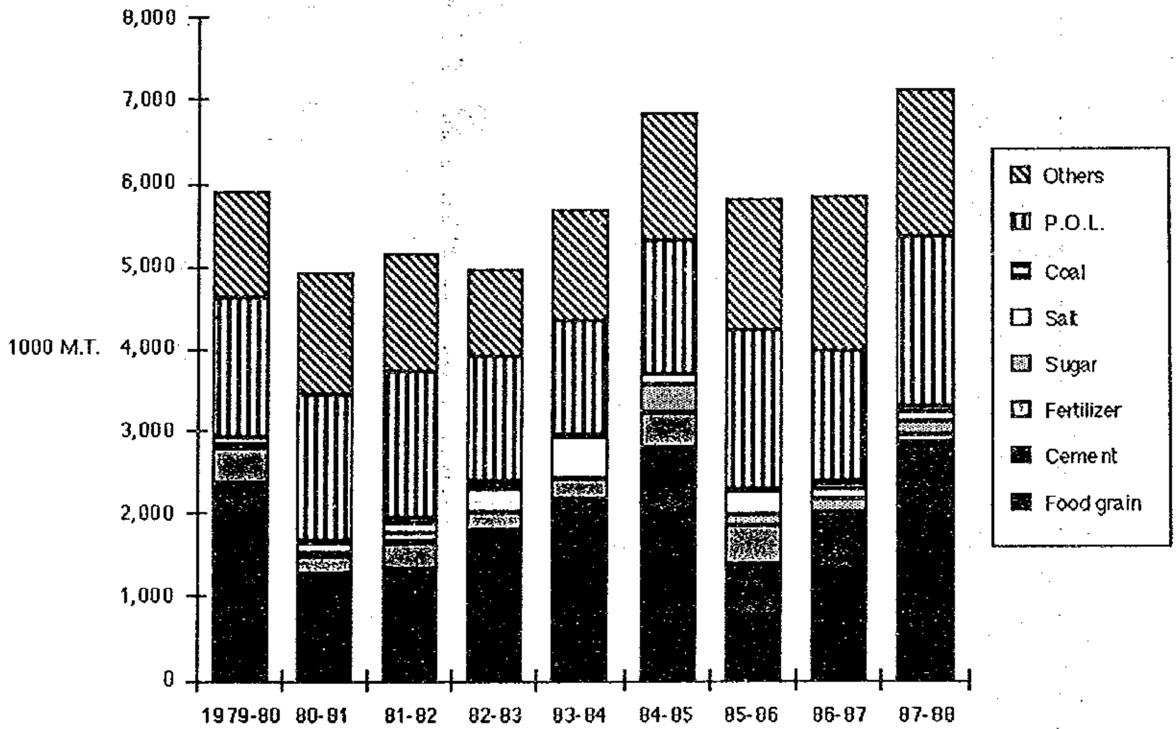


Fig. 3.2 Import Cargo Volume at Chittagong Port

Table 3.3 Container Cargo Through-put at Chittagong Port

(Unit:Thousand tons)

Year	1979-80	1980-81	1981-82	1982-83	1883-84	1984-85	1985-86	1986-87	1987-88
Export	13,194	8,968	18,614	58,296	87,233	90,906	112,509	150,217	184,636
Import	10.542	14.116	24,536	49,877	81,428	165,968	227.411	305,243	364.043
Total	23,736	23,084	43,150	108,173	168,661	256,874	339,920	455,460	548,679

Source:Chittagong Port Authority

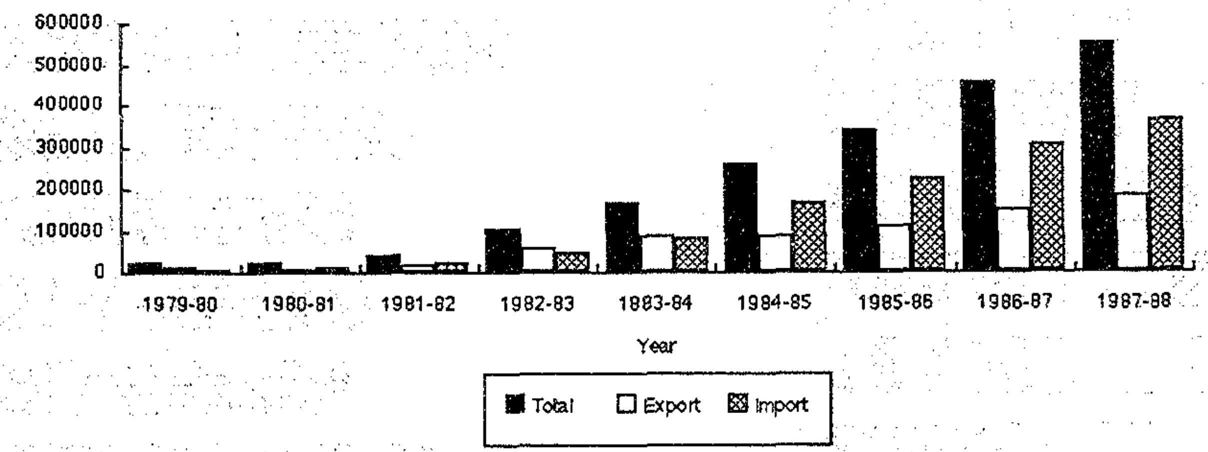


Fig. 3.3 Container Cargo Throughput at Chittagong Port

In general, commodities of containerizable cargo are mainly decided by the size, the weight, the packing style, etc., of the cargo. In Bangladesh, containerizable cargoes are as follows;

Exports : Fish and Crustaceans meat, Bran, Tea, Other foods (including chills, frog legs, tobacco, grain products, etc..), jute products, textiles, (including cotton waste, garments rayon, etc..), bone and bone meal and others (including hide and skin, paper, etc..).

Imports : Vegetables, fruit and nuts, milk and cream, other foods, textiles (including cotton and cotton goods, nylon yarn, etc..), rubber, paper, chemical, machinery and others.

At present, bagged packing-style of grain, sugar and salt are containerized. But, in future, the volume of these cargo will increase. Therefore, these cargo will change their packing style from bag to bulk. Viz., there bagged cargoes will not be containerizable in future.

The ratio of containerization to containerizable cargo is increasing rapidly, reaching about 32 percent at Chittagong port in 1987/1988.

The number of containers throughput at Chittagong port favorably increased from 1,364 TEU in 1979-80 to 77,522 TEU in 1988-89.

The ratio of the number of empty containers to the amount of containers at Chittagong port in 1987-88 was about 23 percent.

Table 3.4 and Fig. 3.4 show the amount of container throughput and the ratio of empty containers at Chittagong port.

Table 3.4 Ratio of Empty Container at Chittagong Port

Year	Import			Export			Total		
	Loaded TEU	Empty TEU	Ratio of empty container	Loaded TEU	Empty TEU	Ratio of empty container	Loaded TEU	Empty TEU	Ratio of empty container
1984-85	11,411	2,152	0.16	6,943	4,530	0.39	18,354	6.682	0.27
1985-86	17,943	2,944	0.14	10,337	7,832	0.43	28,280	10.776	0.28
1986-87	24,990	3,327	0.12	14,922	6,782	0.31	39,912	10,109	0.20
1987-88	28,800	3,733	0.11	18,467	4,374	0.19	47,267	8,107	0.15
1988-89	35,119	4,444	0.11	20,756	17,203	0.45	55.875	21,647	0.28
Average	23,653	3,320	0.13	14,285	8.144	0.36	37,938	11,464	0.23

Source:Chittagong Port Authority

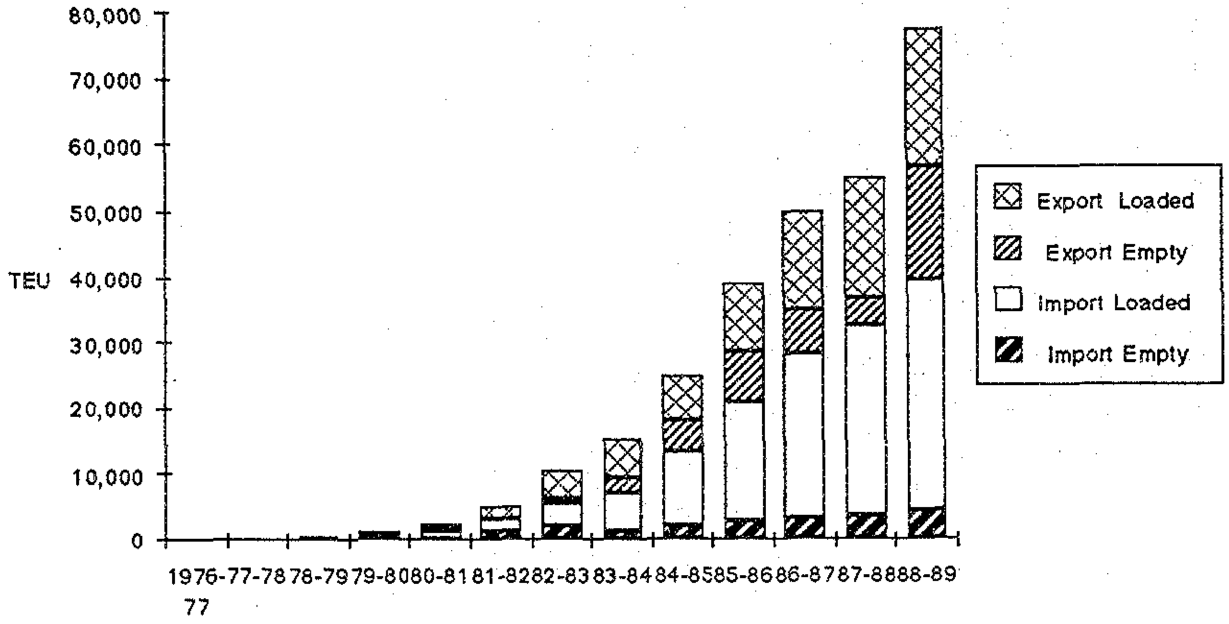


Fig. 3.4 Container Throughput at Chittagong Port

According to information from the Chittagong Port Authority, the average dwelling days of import cargo of FCL and LCL at the container yard of the CPA are about 28 days and 8 days, respectively. The average, dwelling days of empty container boxes is about 30 days.

According to the data of The Mongla Port Authority (MPA), the total cargo and the container cargo throughput at the facilities of MPA reached about 2,863 thousand tons and about 88 thousand tons, respectively, in 1987-88.

The average growth rates of the total cargo and container cargo throughput at Mongla port between 1983-84 and 1987-88 were about 12.7 percent per annum and about 44.2 percent per annum, respectively.

Tables 3.5, 3.6, Fig 3.5 and 3.6 show the cargo throughput at Mongla port by export and import by commodity.

The volume of container cargo at Mongla port is shown in Table 3.7 and Fig 3.7.

Table 3.5 Exports Handled at Mongla Port

(Unit:M.tons)

Commodity	1979-80	1980-81	1981-82	1982-83	1883-84	1984-85	1985-86	1986-87	1987-88
Jute	344,720	338,569	323,338	389,340	318,364	249,926	409,387	379,520	246,844
Jutegoods	300,192	349,608	369,907	345,215	336,015	314,179	340,502	340,078	353,022
Fertilizer		35,497		50,697	21,622				17,421
Newsprint	13,009	7,765	2,899	3,982	80			1,000	
Shrimp	1,576	2,121	2,659	3,951	4,065	4,969	8,718	8,344	8,037
Frog leg	119	219	357	322	494	340	526	269	649
Bamboo	3,987	5,743	5,642	5,704	6,136	3,680	2,005	586	115
C/Bone	118		575	303	103	197	259	265	238
Tobacoo						867	102	288	309
Human hair	18	35	182	27	35	61		27	
Fish		115	21		51	17	41	46	76
General cargo	11,927	1,768	2,413	2,986	2,451	2,851	463	370	980
Total	675,666	741,440	707,993	802,527	689,416	577,087	762,003	730,793	627,691

Source:Mongla Port Authority

Table 3.6 Imports Handled at Mongla Port

(Unit:M.tons)

Commodity	1979-80	1980-81	1981-82	1982-83	1883-84	1984-85	1985-86	1986-87	1987-88
Foodgrain	847,822	404,468	409,190	693,419	605,568	907,818	448,427	445,275	1,064,191
Cement	299,719	264,228	262,104	226,341	276,537	588,607	641,581	797,224	797,910
Fertilizer	237,116	164,362	157,353	120,735	131,700	429,047	485,154	96,618	199,895
Coal	18,479		24,126	20,178			4,710	80,362	49,146
Wood pulp	3,477	4,104	1,048	1,567	9,190	9,935	7,785	11,354	1,783
Machinery	3,185	2,489	1,433	3,141	1,217	2,911	9,280	6,144	2,079
Salt			15,842		10,011	70,420	85,774	24,270	62,889
Cotton					905	867	1,889	519	565
Steel pipe		970	970						
S.oil	3,874	1,067				3,682	1,529	3,077	8,625
C.I.Sheet	4,409	3,821	8,947		4,972		2,146		2,627
Pig iron	710				1,100	150			
Bitumen	22,371	12,666							
Milk powder	265	451					122		
Palm oil			4,739				717		
Sugar						11,042			
General cargo	28,553	26,970	34,326	33,154	45,571	61,572	72,055	92,300	46,058
total	1,469,980	885,596	920,078	1,098,535	1,086,771	2,086,051	1,761,169	1,557,143	2,235,768

Source:Mongla Port Authority

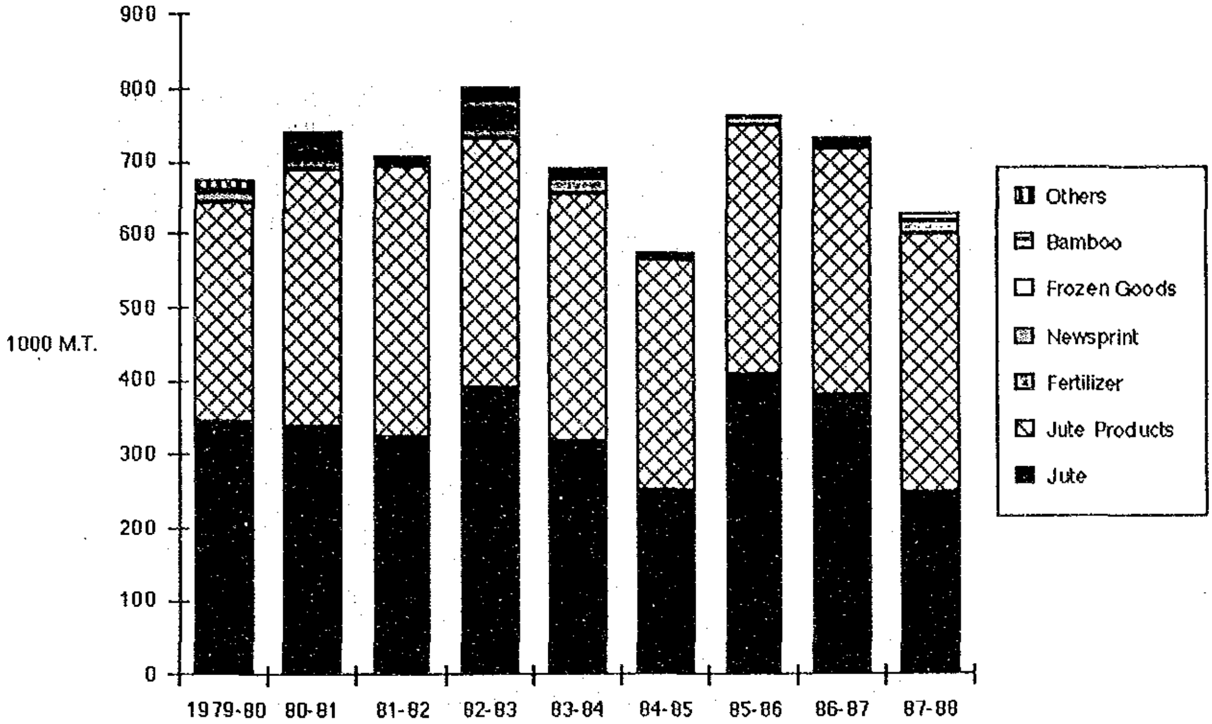


Fig. 3.5 Export Cargo Volume at Mongla Port

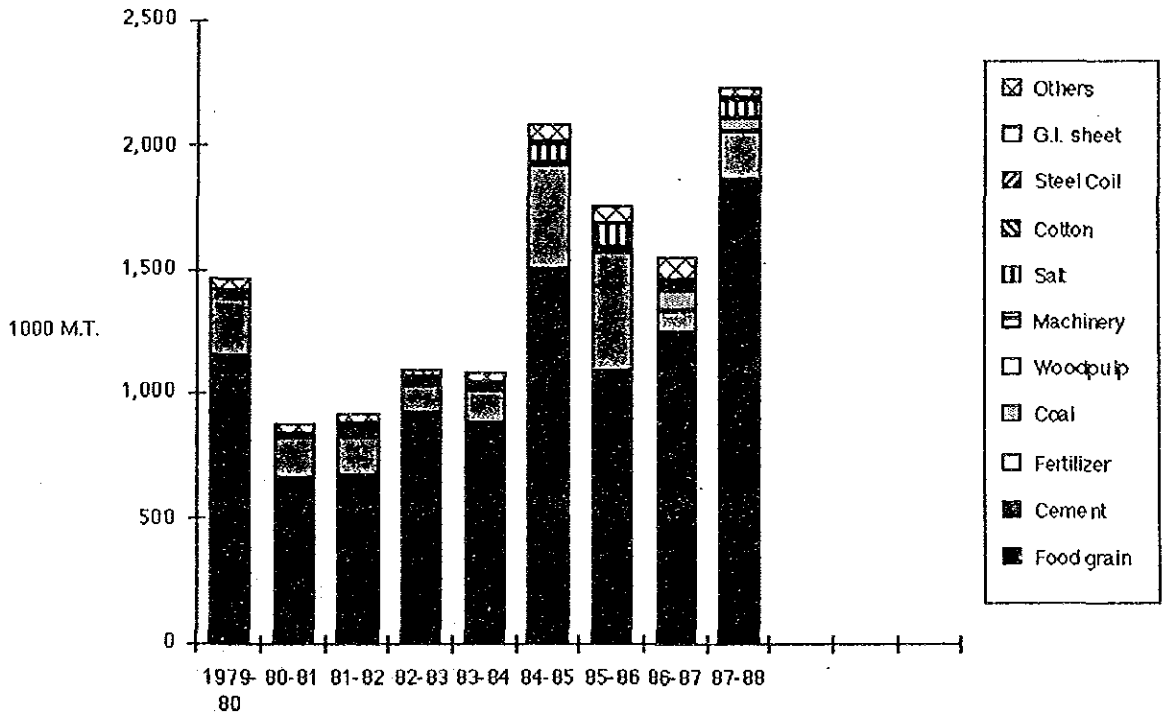


Fig. 3.6 Import Cargo Volume at Mongla Port

Table 3.7 Container Cargo Throughput at Mongla Port

(Unit:Thousand tons)

Year	1983-84	1984-85	1985-86	1986-87	1987-88
Export	31,109	27,482	50,540	73,575	81,049
Import	0	274	7,062	8,216	6,818
Total	31,109	27,756	57,602	81,791	87,867

Source:Mongla Port Authrity

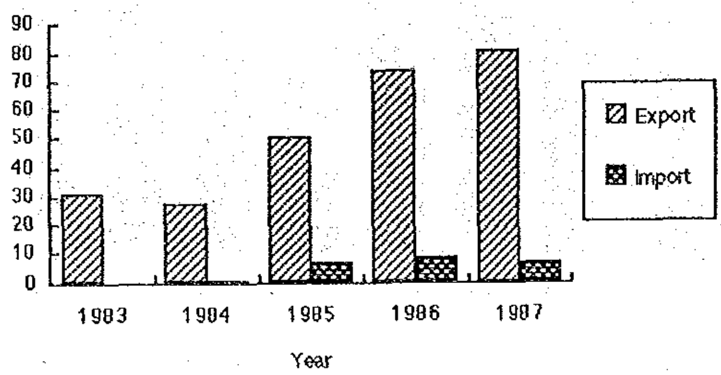


Fig. 3.7 Container Cargo Handled at Mongla Port

The ratio of containerization to the containerizable cargo at Mongla port in 1987/88 was about 21 percent. The average growth rate of the ratio of the containerization between 1983-84 and 1987-88 at Mongla port was about 20 percent.

The number of containers throughput at Mongla port in 1988-89 was about 14 thousand TEUs.

The grow rate of the number of TEUs throughput at Mongla port from 1983 to 1987 was about 33 percent per annum.

The ratio of the number of empty containers to the amount of containers at Mongla pot in 1987-88 was about 52 percent.

Table 3.8 and Fig 3.8 show the amount of container throughput and the ratio of empty containers at Mongla port.

Tables 3.9 and 3.10, which were made by the port statistics of CPA and MPA, show the volume of containerizable cargo form 1979 to 1987 by commodity.

Table 3.8 Ratio of Empty Container at Mongla Port

Year	Import			Export			Total		
	Loaded TEU	Empty TEU	Ratio of empty container	Loaded TEU	Empty TEU	Ratio of empty container	Loaded TEU	Empty TEU	Ratio of empty container
1984-85	37	2,331	0.98	1,784	265	0.13	1,821	2,596	0.59
1985-86	789	4,573	0.85	4,915	660	0.12	5,704	5,233	0.48
1986-87	839	6,493	0.89	6,065	885	0.13	6,904	7,378	0.52
1987-88	704	6,494	0.90	6,398	619	0.09	7,102	7,113	0.50
1988-89	426	6,627	0.94	6.449	454	0.07	6.875	7,081	0.51
Average	559	5,304	0.91	5,122	577	0.11	5,681	5,880	0.52

Source:Mongla Port Authority

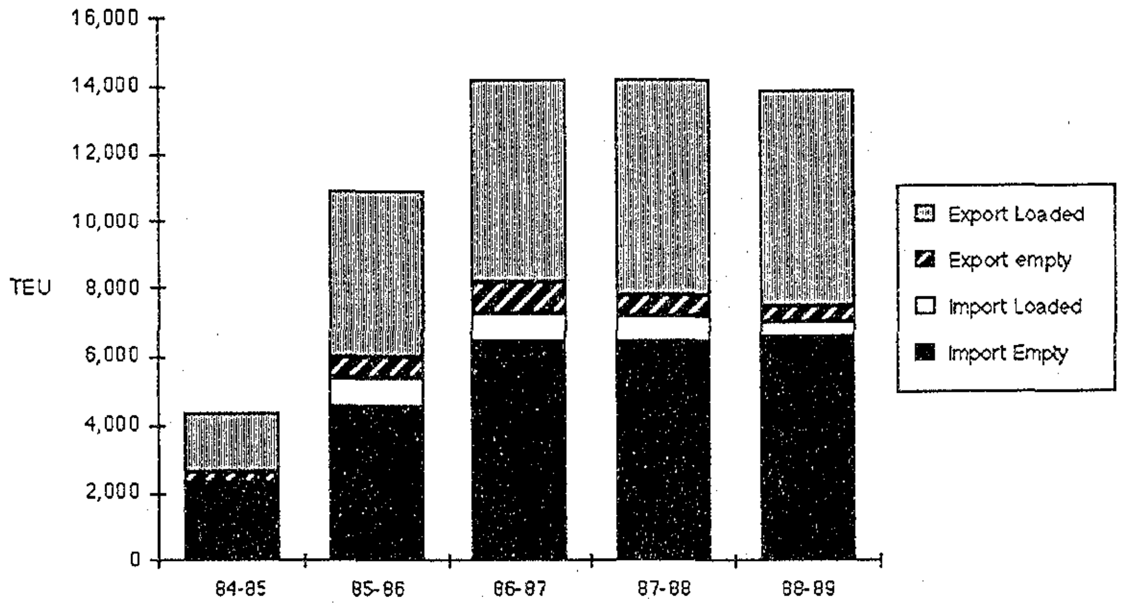


Fig. 3.8 Container Throughput at Mongla Port

Table 3.9 Export Containerizable Cargo in Bangladesh

(Unit: M.tons)

Commodity	1979-80	1980-81	1982-83	1883-84	1984-85	1985-86	1986-87	1987-88
Jute Products	454,001	519,609	539,034	516,535	457,711	470,306	454,314	473,873
Tea	30,415	36,236	31,588	31,135	25,161	24,594	13,246	23,025
Hide & Skin	9,367	13,819	8,720	2,229	2,814	2,127	1,504	6,536
Bone & Bone Meal	2,405	2,688	2,336	2,356	2,923	3,166	2,791	1,625
Paper	4,008	201	0	0	0	0	0	0
Fish Dry & Frozen	4,831	5,224	65	1,187	757	77	118	11,593
Cottn Waste	1,517	379	712	512	596	284		
Bran(Wheat/Rice)	10,596	12,359	18,293	32,656	24,359	1,047		
Chillies	2	0			21			
Rayon	718	380	93	117				
Sundrise	36,766	28,741	65,794	68,587	103,268	130,632	195,560	167,531
Shrims	1,576	2,121	13,071	11,394	13,873	16,604	13,326	9,120
Frog legs	119	219	775	1,095	514	620	284	649
Tobacco	0	0	52	576	890	111	299	309
Garments								18,581
Total	556,321	621,976	680,533	668,379	632,887	649,568	681,442	712,842

Table 3.10 Import Containerizable Cargo in Bangladesh

(Unit: M.tons)

Commodity	1979-80	1980-81	1981-82	1982-83	1883-84	1984-85	1985-86	1986-87	1987-88
Cotton	46,786	54,393	45,017	36,329	65,054	37,327	38,082	34,230	28,753
Cotton picés	7,098	17,439	20,103	16,088	10,902	17,310	9,247	0	2,371
Chemical	53,810	109,480	63,108	17,884	4,613	3,493	2,347	276	428
Paper	2,292	1,734	1,093	0	259	3,574	1,077	0	0
Sundries	461,341	579,199	424,549	562,744	837,723	966,195	922,579	1,240,247	1,126,583
Total	571,327	762,245	553,870	633,045	918,551	1,027,899	973,332	1,274,753	1,158,135

Source:Chittagong Port Authority and Mongla Port Authority

According to tables 3.9 and 3.10, the share of sundries is about 80 percent or more containerizable cargo for imports of Bangladesh. So, making a cargo forecast for the future is very difficult. For exports, the detailed data by commodity needed for the cargo forecast of the port study is lacking in Bangladesh.

Therefore, in this study, the volume of containerizable cargo by commodity from 1979 to 1987 is estimated for commodities included in the volume of port statistics using the data from the Statistical Yearbook of Bangladesh and data of CPA and MPA.

The results of the estimate are shown in Tables 3.11 and 3.12.

The ratios of containerization for exports and imports are shown in Table 3.13.

Table 3.14 shows the number of handling containers at seaports in Bangladesh by size.

Table 3.15 shows the cargo volume per TEU and the ratio of empty containers in Bangladesh.

Table 3.11 Estimated Containerizable Cargo by Commodity for Export from 1979 to 1987

(Unit:'000 tons)

Year	1979-80	1980-81	1982-83	1983-84	1984-85	1985-86	1986-87	1987-88
Fish and Crustaceans	6.407	7.345	13.136	12.581	14.631	16.681	13.444	20.713
Meat	0	0	0	2.518	1.557	2.929	2.319	4.461
Bran	10.596	12.359	13.293	32.656	24.359	1.047	0	0
Tea	30.415	36.236	31.588	31.135	25.161	24.594	13.246	23.025
Other foods	0.121	0.219	0.827	55.7	27.429	1.667	0.794	0.709
Jute products	454.001	519.609	539.034	516.535	457.711	470.306	454.314	473.873
Textile	0.718	0.38	0.093	0.117	0	0	0	18.581
Bone & bone meal	2.405	2.688	2.336	2.356	2.923	3.166	2.791	1.625
Others	51.658	43.14	80.246	14.781	79.116	129.178	194.534	169.855
Total	556.321	621.976	680.553	668.379	632.887	649.568	681.442	712.842

Note:this table was estimated using the statistical yearbook of Bangladesh and the yearbooks of CPA and MPA.

Table 3.12 Estimated Containerizable Cargo by Commodity for Import from 1979 to 1987

(Unit:'1000 tons)

Year	1979-80	1980-81	1981-82	1982-83	1983-84	1984-85	1985-86	1986-87	1987-88
Vegetable	1.2	0.0	0.0	1.1	1.4	2.6	3.7	3.4	19.9
Frute & nuts	0.0	0.0	0.0	0.0	0.0	26.5	27.1	23.1	24.4
Milk & Cream	0.0	0.0	0.0	0.0	36.5	66.5	60.2	72.2	60.2
Other foods	30.2	0.0	0.0	2.0	2.7	4.9	189.3	65.5	58.8
Textile	58.4	77.4	68.3	57.1	79.8	63.9	53.2	39.6	31.0
Rubber	1.0	0.0	0.0	0.3	1.2	2.9	2.6	3.3	4.4
Paper	2.3	1.7	1.1	0.0	0.3	3.6	1.1	0.0	0.0
Chemical	53.8	109.5	63.1	17.9	37.5	59.9	92.2	75.5	90.8
Machinery	97.7	130.3	94.7	108.3	157.1	175.8	166.4	218.0	198.0
Others	326.7	443.3	326.6	446.5	602.1	621.5	377.6	774.2	670.6
Total	571.3	762.2	553.9	633.0	918.6	1.027.9	973.3	1.274.8	1.158.1

Note:this table was estimated using the statistical yearbook of Bangladesh and the yearbooks of CPA and MPA.

Table 3.13 Ratio of Containerization in Bangladesh

Year		1976-77	1977-78	1978-79	1979-80	1980-81	1981-82	1982-83	1983-84	1984-85	1985-86	1986-87	1987-88
Import	Containerizable Cargo (M.Ton)	97.887	482,034	586,764	571,327	762,245	553,870	633,045	913,551	1,027,899	973,332	1,274,753	1,152,135
	Container Cargo (M.Ton)	195	1,821	4,805	10,542	14,116	24,536	49,877	81,428	166,242	234,473	313,459	378,861
	Ratio of Containerization (%)	0.201	0.379	0.819	1.845	1.852	4.430	7.879	8.865	16.173	24.090	24.590	32.822
Export	Containerizable Cargo (M.Ton)	38,731	335,254	326,217	556,321	621,976	-	680,533	668,379	632,887	649,568	681,442	712,842
	Container Cargo (M.Ton)	0	398	2,414	13,194	12,287	24,168	75,060	118,342	118,388	163,049	223,792	265,685
	Ratio of Containerization (%)	0.000	0.119	0.740	2.372	1.975	-	11.030	17.706	18.706	25.101	32.841	37.271
Total	Containerizable Cargo (M.Ton)	135,318	817,288	912,981	1,127,648	1,384,221	-	1,313,578	1,586,930	1,660,786	1,622,900	1,956,195	1,878,977
	Container Cargo (M.Ton)	195	2,219	7,219	23,736	26,403	-	124,937	199,770	284,630	397,522	537,251	636,546
	Ratio of Containerization (%)	0.144	0.272	0.791	2.105	1.907	-	9.511	12.588	17.138	24.495	27.464	34.022

Source:Chittagong and Mongla Port Authorities.

Table 3.14 Number of Handling Containers at Sea Ports in Bangladesh by Size

Year	Loaded			Empty			Total TEU
	20'	40'	TEU	20'	40'	TEU	
1984-85	16,411	1,882	20,175	7.472	903	9,278	29.453
1985-86	19,362	7,311	33,984	8,719	3,645	16,009	49,993
1986-87	26,604	10,106	46.816	8,969	4,259	17.487	64,303
1987-88	31,081	11.644	54,369	8,540	3,340	15.220	69,589
1988-89	35.722	13.514	62.750	15.428	6.650	28.728	91.478
Ave.	25,836	8.891	43.619	9.826	3.759	17.344	60.963

Source:Chittagong and Mongla Port Authorities.

Table 3.15 Cargo Volume per TEU and Ratio at Empty Container in Bangladesh

Year	Import					Export					Total				
	Loaded	Empty	Cargo Volume	Ton/TEU for loaded	Ratio of empty container	Loaded	Empty	Cargo Volume	Ton/TEU for loaded	Ratio of empty container	Loaded	Empty	Cargo Volume	Ton/TEU for loaded	Ratio of empty container
	TEU	TEU	ton			TEU	TEU	ton			TEU	TEU	ton		
1984-85	11,449	4,483	166,242	14.52	0.28	8.727	4.795	112,244	12.86	0.35	20.175	9,278	278,486	13.80	0.32
1985-86	18,722	7,517	234,473	12.52	0.29	15.252	8,492	160,503	10.52	0.36	33,984	16,009	394,976	11.62	0.32
1986-87	25,829	9,820	313,459	12.14	0.28	20,987	7,667	219.511	10.46	0.27	46,816	17,487	532,970	11.38	0.27
1987-88	29,504	10,227	370,861	12.57	0.26	24,865	4,993	265,495	10.68	0.17	54,369	15.220	636,356	11.70	0.22
1988-89	35,545	11,071	477,355	13.43	0.24	27,205	17,657	319,323	11.74	0.39	62,750	28,728	796,678	12.70	0.31
Average	24,212	8,624	312,473	13.03	0.27	19,407	8,721	215,415	11.25	0.31	43,619	17,344	527,893	12.24	0.29

Source:Chittagong and Mongla Port Authorities.

3.2 Kamalapur Inland Container Depot (KICD)

The Kamalapur Inland Container Depot has been set up at Dhaka railway station in order to transport containers between Dhaka and Chittagong by railway.

The container throughput at KICD from January 1989 to October 1989 was 2,265 boxes, including empty containers.

The ratio of empty containers to total container throughput at ICD in the period mentioned above was about 40 percent.

The ratio of the export cargo volume of L.C.L. to the total export cargo volume is very low, 2.5 percent.

Almost all the containers handled at KICD are loaded/discharged at the container yard of KICD.

Table 3.16 shows the number of container boxes handled from january 1989 to October 1989:

Table 3.16 Container throughput at Kamalapur ICD from January to October in 1989

(Unit:TEU)

	Loaded	Empty	Total
Receiving	503	583	1,086
Despatching	857	322	1,179
Total	1,360	905	2,265

Source: from Chittagong Port Authority

3.3 Container Cargo Movement in Bangladesh

The study team investigated the origin-destination (O/D) of break bulk cargo in order to gain an understanding of containerizable cargo movements in Bangladesh.

The O/D survey was carried out using the questionnaires (Refer to Appendix 3.1 and 3.2, which were answered by using the manifests and subsequent interviews with related enterprises.

The outline of the results of the O/D survey is shown in Table 3.17.

According to the result of the O/D survey Table 3.17, about 93 and 65 percent of the container cargo for import and export routed coming to/from Dhaka are handled Chittagong and Mongla ports.

The hinterland of Mongla Port is mainly the western region of Bangladesh. In Bangladesh, most of the container cargoes are either stuffed into or stripped from the container boxes at the container yard of the port authorities.

The customs clearance of most of the container cargoes is carried out at the container yard of the port authorities.

The transportation modes between Dhaka and Chittagong are road, railway and inland waterway. The most common transportation mode for break bulk cargo between Dhaka and Chittagong is road, which accounts for about 94 percent of the total volume of the transportation between the two ports. The next most-important mode of transportation is the railway, and the least used is the inland waterway, where the percentage is about 2.7 percent. as no facility has yet been provided in made of transport.

Table 3.17 Result of The O/D Survey

(Percent)

Item		Import	Export
Type of container	Dry	95	81
	Refer	0	19
	Others	5	0
Size of container	20 feet	64	66
	40 feet	33	34
	Others	3	0
FCL or LCL	FCL	70	90
	LCL	30	10
Vanning/Devanning Facilities	Private Facilities	0	100
	Facilities of P.A.	100	0
	Others	0	0
Customs Clearance Area	Private Facilities	0	100
	Facilities of P.A.	100	0
	Others	0	0
Ratio of through Dhaka	Through Dhaka	93	65
	Not through Dhaka	7	35
Transportation Mode	Road	80	62
	Railway	14	9
	Inland Waterway	6	29

CHAPTER 4 THE TREND OF OCEAN CONTAINER TRANSPORTATION

4.1 The Development of Container Transportation

4.1.1 Brief History of Containerization

Ocean transportation of cargo with the use of containers began in the early 20th century.

In 1916, a New York-based transport and storage company, Bowling Green Storage & Van Co. operated a container service for trans-Atlantic trade using 8 ft. wide, 8 ft. high and 18 ft. long steel containers.

However, other details concerning this container service was unknown.

Container transportation was olso pioneered by the New York Central Railway Co., which developed the world's first container service with the characteristics of interchangeability and adaptability to all kind of transportation modes.

In 1921, the company made containers 6 ft. wide x 7.5 ft. high x9 ft. long and began consolidation service for small lots of cargo in containers between Cleveland and Chicago. The container, on a chassis, was loaded onto railway flat cars. This system was called the "piggy-back" system and developed into door- to- door delivery service.

This container transportation system was adopted by railway companies in Europe within a few years. During World Wars I & II, several types of containers were used for transportation of military goods from the U.S. to Europe by ship. After World War II, suffering from increased shipbuilding, ship's crew and cargo handling costs, shipping companies in the U.S. sought improvement of cargo transportation methods for the purpose of saving on the above costs. They then introduced the container transportation system for ocean trade cargo in order to solve the problem.

Later on, the efficiency of this mode was studied on a commercial basis. International foreign trade by marine containers started in the latter half of the 1950s.

It should be pointed out that the pioneers of ocean transportation using container vessels which appeared as carrier of innovation of modern transportation were Sea-Land Service, Inc. and the Matson Navigation Co., both of the U.S.

In April 1966, Sea-Land introduced container service for trans-Atlantic trade, using four C-2 type vessels reconstructed for container carriers. The first vessel was the "FAIRLAND" with a loading capacity of 226 35-foot containers. In October 1966, Sea-Land started container transport of military goods to U.S. troops bases in the Pacific Ocean, using three reconstructed T-3 type container vessels.

Matson, which had operated a domestic container service between Oakland and Hawaii since August 1958, started a trans-Pacific container service using 24 foot containers in 1967.

Since then, almost all shipping companies in the world have hastened to deploy container vessel service on thier main liner service routes.

The containerization of liner service to/from Japan and Far East countries was started as follows:

August	1968:	California
October	1969:	East Australia
May	1970:	Seattle, Vancouver
December	1971:	Europe
August	1972:	New York, Atlantic
October	1972:	Mediterranean
October	1976:	New Zealand
February	1978:	West Australia
November	1979:	Persian Gulf

4.1.2 Merits of Containerization

The essential characteristics of containerization can be summarized as follows:

Shape of boxes(with walls),
Standardization of box size, and
Handling as unit loads.

These facters make it possible to adopt a module system of handling equipment, to effectively use ship holds and container yards, to use container boxes as exchangeable packages, to place them close together in clear order by stacking and to reduce the risk of damage and theft of cargo by reducing cargo handling and through the protection of the box's walls.

Containers also permit handling and transportation in all weather, leading to improvement in transportation schedules. .

Simplification of preparing and exchanging documents is also considered to be an important effect of containerization. Reefer containers are another factor allowing low-cost food transportation in small lots, etc.

Confirmation of cargo flow is easier by using container numbers, and shipping companies can offer such information to consignees and shippers.

For shipping companies, containerization contributes to savings and rationalization of cargo handling charges in ports and easier land transport. By shortening discharging/loading hours in ports, port dwelling time is reduced, allowing an increased number of voyages per year. In order to increase container handling efficiency, container terminals with gantry cranes have been developed by governments, port authorities and private companies.

Land transporters such as railways and trucking companies also benefit from the speedier loading and unloading of containers to and from rail flatcars and truck trailers, as compared with the slower handling methods required when dealing with break-bulk cargo.

For customers, the following merits can be listed:

1) to save packing costs
2) to lower FOB prices by simple packing of goods
3) to shorten the transit time of goods
4) to reduce marine cargo insurance fees
5) to lessen cargo damage during transportation
6) to prevent cargo contamination
7) to decrease cargo claims such as shortages and pilferage
8) to reduce the inventory cost of goods
9) to save working capital
10) to ease and simplify customs clearance
11) to save the volume of documentation and cargo marking fees
12) to expedite consolidation of LCL cargoes

Considering the essential requirements of the customs office, it is quite natural that conventional cargo is first brought into sheds inside a port fence by the port management body and inspected by the customs. For container cargo, container boxes can be handled as units of cargo and regarded as a kind of movable shed from the viewpoint of customs security. This concept is widely accepted throughout the world and regarded as one of the major factors to promote international trade, because it is unquestionably convenient for shippers and consignees. If this concept fails to gain acceptance within a country, most of the advantages of containerization are lost. It is necessary to move packed containers whenever possible, and for this purpose all measures should be pursued including changes of customs policy, and improvement of inefficient terminal operations and inland transportation systems.

4.1.3 Regulation of Containers

(1) Definition of Container

Generally speaking, the word "container" means receptacle.

The term "container" was prescribed by the "CUSTOMS CONVENTION ON CONTAINERS, 1972" as follows:

The term "container" shall mean an article of transport equipment (lift-van, movable tank or other similar structure):

i) fully or partially enclosed to constitute a compartment intended for containing goods;

ii) of a permanent character and accordingly strong enough to be suitable for repeated use;

iii) specially designed to facilitate the carriage of goods, by one or more modes of transport, without intermediate reloading;

iv) designed for ready handling, particularly when being transferred from one mode of transport to another;

v) designed to be easy to fill and to empty; and

vi) having an internal volume of one cubic meter or more;

The term "container" shall include the accessories and equipment of the container appropriate for the type concerned, provided that such accessories and equipment are carried with the container.

The term "container" shall not include vehicles, accessories or spare parts of vehicles or packing.

(2) Size and Type of Container

The standardization of container sizes is necessary in order to promote international containerization. Because of the limitations of railway flatcars, the dimensions of 8 feet in width and 8 feet in height are common for all types of containers. However, as for the length of containers, there are several. In 1963, in order to promote the interchangeability of containers, the International Organization for Standardization (ISO) set a standard container size. The width was 8 feet, 10 feet, 6 2/3 feet and 5 feet. However, Sea-Land started using 35-foot-long containers and Matson containers 24 feet in length because of the maximum length permitted in the eastern and western regions of the U.S.A. Other shipping lines mainly used 20 foot and 40 foot long containers by the early 1980s. In recent years, larger containers, 9.5 foot in height and 45 foot in length, have began to be used in order to pursue economies of scale.

The undermentioned two types of containers are most widely used in the world.

(ISO Standard)

ISO Code	Overall External Dimensions												Gross Weight (R) (Kg)
	Height				Width				Length				
	mm	Tol.	ft in	Tol.	mm	Tol.	ft in	Tol.	mm	Tol.	ft in	Tol.	
IAA	2591	0 -5	8 6	0 -3/16	2438	0 -5	8 0	0 -3/16	12192	0 -10	40 0	0 -3/8	30480
ICC	2591	0 -5	8 6	0 -3/16	2438	0 -5	8 0	0 -3/16	6058	0 -10	19 10 1/2	0 -1/4	20320

Tol: Tolerance (mm or inch)

Depending on the materials of the main structures such as side walls, roof sheets and end walls, the containers are divided into the following three groups.

i) Steel Containers

A great part of the structure is made of steel plate and steel material.

The cost of construction is lower than the other tow types of containers.

This type of container is stronger than aluminium containers and resists damage such as breakage, etc., but has defects such as its heavy weight and lack of resistance to corrosion.

ii) Aluminium Containers

Most of this type of container's external plates and rails are made of aluminium alloy. Light tare weight is its greatest advantage. As the container has high resistance to corrosion, it has a longer lifetime than steel containers. However, the cost of construction is high and the container easily sustains damage caused by rough handling due to its weak sectional strength.

This type of container is used for reefer container.

iii) Fiberglass Reinforced Plastic (FRP) Container

This type of container's external plates are made of plywood, the surface of which is coated with plastic rein-forced with fiberglass.

Such containers are constructed without internal reinforcement members such as side post, front post and roof bow because the fiberglass reinforced plastic panel itself acts as a strengthening factor of the container.

The container has a high resistance to shocks, heat intercept and corrosion in comparison with the above-mentioned steel and aluminium containers.

(3) Types of Containers by cargo

There are many types and kinds of containers used to transport various kinds of cargoes.

A suitable type and kind of container should be used to ensrue safe transportation.

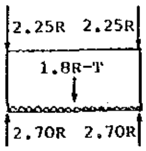
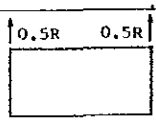
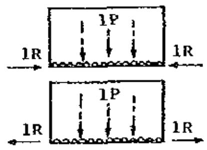
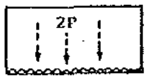
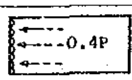
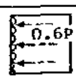
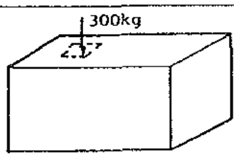
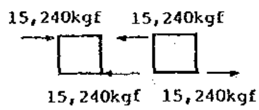
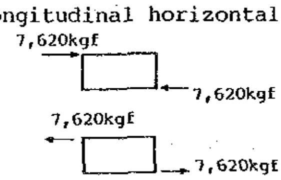
The following container types are summarized by type of cargo:

	Cargo Nature	Type of Container
.General Cargo	.Clean cargo .Dirty cargo .Delicate cargo	.Dry container .Ventilated container .Insulated container .Open-top container .Side-open container .Hide Container
.Special Cargo	.Perishable cargo .Refrigerated cargo	.Reefer container .Insulated container .Ventilated container
	.Livestock and plants	.Animal container .Ventilated container .Pen container
	.Heavy Cargo	.Open top container .Flat rack container .Platform container
	.Valuable cargo	.Dry container
	.Dangerous cargo	.Dry container, Others
	.Bulky cargo	.Tank container .Bulk container .Hopper container
	.Awkward cargo	.Flat rack container .Flatbed container
	.Unpacked cargo	.Others

(4) Strength of Containers

In order to carry cargoes safely, the strength of a container is an important factor.

The ISO and the JIS regulate the strength of container as follows:

Kind of Load	Place of Load	Direction of Load	Designed Load
Stacking Load	Upper corner fitting Distoration longitudinal 38mm transverse 25.4mm		9R 9/4 R per each upper corner fitting
Lifting Load	Upper corner fitting		2R 2/4R per each upper corner fitting
Restraint Load	Lower Corner fitting		2R 2/2R per each lower corner fitting
Floor Load	Whole floor		2P
End Load	Whole end wall		0.4P
Side Load	Whole side sheet		0.6P
Roof Load	Roof sheet		300kg per every 300 X 600 mm in area picked out at random.
Transverse Racking Load	Upper Corner fitting	Transuerse Horizontal 	15,240kgf(150KN) per each upper corner fitting
Longitudinal Racking Load	Upper Corner fitting	Longitudinal horizontal 	7,620Kgf(75KN) per each upper coner fitting

R : Max gross weight or Rating

T : Tare weight

P : Net weight or Payload

↓ : Concentrated load

⇣ : Equally distributed load

4.1.4 Container Vessels

In the 1960s, roll-on roll-off (RO-RO) type container vessels were mainly used for container transportation in short-distance trade in order to promote door to door service. Also, part-container vessels were used by modifying conventional vessels.

In the 1980s, major shipping lines deployed lift-on lift-off (LO-LO)-type full container vessels with cell guides so that they can maximize the use of hold space. Furthermore, mass transportation has been encouraged. In 1988, two major shipping companies started to deploy post-Panamax (more than 32.2 m in width) size vessels as fourth-generation vessels.

Generation	Length	Carrying Capacity
.First (1960 -)	140 - 200 m	200 - 1,000 TEU
.Second (1970 -)	210 - 250 m	1,500 - 2,500 TEU
.Third (1980 -)	230 - 270 m	2,500 - 3,500 TEU
.Fourth (1988 -)	280 - 300 m	4,000 - 5,000 TEU

4.1.5 Current Situation

As of the end of 1987, more than 800 full container vessels with a total capacity of 1,600 thousand TEU were in service throughout the world.

Major shipping lines are mainly using third-generation vessels on trunk routes. However, some of them intend to replace their fleets using fourth-generation vessels so that they can pursue economies of scale merit.

4.2. Present Situation of shipping

4.2.1 Shipping Service Network

Liner services on major trading routes is rapidly being containerized, using larger vessels. Although the smallest container vessel as of 1987 was 736 TEU, and the largest 3,147 TEU, currently the average size of container vessels serving the Far East/North America and Far East/Europe routes is 2,500 TEU to 3,000 TEU.

However, still-larger container vessels will probably serve these routes in the future. The number of calling ports will decrease while other ports will be served by feeder vessels.

Therefore, competition among container ports will become stronger and only those ports that can provide well-equipped facilities at low cost and quick dispatch through effective operations as well as providing a sufficient volume of cargo will be able to survive as the main ports of call.

To cope with larger container vessels, larger facilities are being constructed in the neighboring countries of Bangladesh as well as in Europe and North America.

However, in Bangladesh, shallow channels and insufficient cargo volume obstruct large size container vessels from calling at the ports of Bangladesh. Therefore, Bangladesh's container shipping service is limited to feeder services by small container vessels and by part-container vessels from Singapore or Colombo.

Bangladesh is less favored in this respect considering the long deviation from main trade routes needed to arrive at the country, at least while the cargo volume is insufficient. On the other hand, there is a good possibility for direct calls by container vessels on relatively short distance routes such as between Bangladesh/Japan, Korea, Taiwan and Hong Kong route.

Bangladesh has two foreign trade ports, Chittagong and Mongla, which are under the control of the Ministry of Shipping.

All the country's foreign trade passes through the two ports, except some cargo carried from India by inland water transportation.

Table 4.2.1 shows the number of vessels that called at both the seaports in the last 10 years. The number of container vessels (a) increased remarkably in the 1980s.

The containers originating in Europe and the U.S. East Coast were relayed from mother vessels to feeder vessels at Colombo. Containers originating from East Asia, Australia and the West Coast of North America were relayed at Singapore.

Table 4.2.1

F'cial Year	Chittagong		Mongla		Total	
	(a)	(b)	(a)	(b)	(a)	(b)
1979-80	38	942		536	38	1478
1980-81	63	886		430	63	1316
1981-82	130	1001		470	130	1471
1982-83	168	906		453	168	1359
1983-84	254	858	37	427	291	1285
1984-85	354	1086	69	540	423	1626
1985-86	425	1045	142	545	567	1590
1986-87	449	1009	169	517	618	1526
1987-88	360	1039	157	490	517	1529
1988-89	403		148	484	551	

(a) : Number of vessels which carried containers to/from Bangladesh.

(b) : Grand total of Number of vessels which called at the port (including (a))

(source : Chittagong Port Authority & Mongla Port Authority)

4.3 Trend of International Container Transport to the Bay of Bengal

4.3.1 Circumstances

Despite their positive activities on world-wide container routes, many container operators in the world have very limited performance in the Bay of Bengal route, including Bangladesh, due to the small volume of container traffic between their countries and the ports of the Bay of Bengal. Therefore, the terminal trade between the countries and this area has been covered by conventional chartered vessels with small container loading capacities or by feeder vessels from Singapore or Colombo.

The amount of containers handled at the ports in the Bay of Bengal in the last 5 years was as follows:

(unit : TEU)

Name of port	1983	1984	1985	1986	1987
Penang	86,614	98,280	104,116	112,333	125,430
Calcutta	32,642	38,897	53,827	70,159	92,752
Madras	28,127	45,155	83,862	100,700	86,228
Chittagong	15,475	25,036	39,056	50,019	55,392
Mongla	3,531	4,417	10,937	14,282	14,215
Tuticorin	1,072	1,233	3,186	7,192	8,038
Visakhapatnam	-	-	520	1,831	1,219

(source: Containerization International Year Book)

Most of these containers were relayed from mother vessels to feeder vessels at Singapore or Colombo, and delivered to their final destination. The amount of the containers to/from the ports in the Bay of Bengal has gradually increased from year to year, and this trend will continue in the future.

The vast area in the Indian Ocean between Singapore and the Suez Canal is now being seriously considered by many reputable international container operators.

4.3.2 Container Operators to Bangladesh

As mentioned above, international container operators are carrying out container service to Bangladesh by feeder vessel from Singapore or Colombo.

Some shipping companies operate their own conventional vessel and/or chartered vessel to carry containers to/from Bangladesh.

The main container operators to Bangladesh are as follows:

(1) Direct service with their own vessels

i) Bangladesh Shipping Company

It is the country's national line, operating part-container services on the following routes:

Bangladesh--UK/North Europe (monthly), 5 vessels

Bangladesh--Gulf of Mexico (monthly), 3 vessels

Bangladesh--Far East/Japan (monthly), 3 vessels

Bangladesh--Australia (monthly) via transshipment over Singapore and connecting carrier agreement with A.P.L.

Bangladesh--Singapore (fortnightly), 1 vessel comprising a commercial feeder operation.

Totaling 1,602 TEU (8 owned & 1,594 leased) are operated.

ii) Atlas Shipping Lines Ltd., (Bangladesh)

It operates one/two sailings per month between Bangladesh and Japan/Korea, using 4 multi-purpose vessels loading a limited number of containers.

iii) Ceylon Shipping Corp. (Sri Lanka)

It is the national flag carrier of Sri Lanka, operating container services on the following routes.

UK/North Europe--India/Pakistan/Sri Lanka (every 12 days)

Sri Lanka -- Far East (Bangladesh)/Japan (every 16 days)

Sri Lanka -- U.S./Canada (weekly)

Sri Lanka -- Australia (weekly)

Sri Lanka -- Red Sea (every 10 days)

Sri Lanka -- Mid. East (every 10 days)

Sri Lanka -- Singapore shuttle service (weekly transshipment to/from Australia)

Sri Lanka -- Upper Bay of Bengal (every 10 days, operated by the wholly owned subsidiary Ceylon Lines a and through an integrated sailing agreement with Cobra)

Sri Lanka -- West India (weekly feeder service)

Sri Lanka -- India/Pakistan (shuttle service by a conventional type operation)

Totaling 17,914 TEU (3,270 owned & 14,644 leased) are operated.

iv) Eastern Container Lines (Bangladesh)

It operates fixed day or weekly services between Bangladesh and Singapore, using one vessel in a joint service with

Regional Container Lines Pte., Ltd., Singapore.

(2) Feeder service from Singapore or Colombo

Mistui O.S.K. Lines, Ltd.
Nippon Yusen Kaisha
Kawasaki Kisen Kaisha Ltd.
Evergreen Ltd.
American President Lines, Ltd.
Sea-Land Service, INC.
Everett Orient Line

The above-mentioned shipping companies have a strong interest in providing container service to Bangladesh on condition that the volume of containerized cargo to and from Bangladesh increases in the future.

Many of the shipping agencies and forwarding companies have expressed the hope that a feeder service by inland water transportation to the Dhaka area will develop and stated that they would invest in the vessels required.