Chapter 4

Climate

The climate of Bangladesh is characterised by high temperatures, heavy rainfall, often excessive humidity and fairly marked seasonal variations. Though more than half this area is north of the Tropics, the effect of the Himalayan mountain chain is such as to make the climate tropical, more or less, throughout the year. The effect of the mountains to the north is obvious when one considers that the mean average temperature of Dhaka in January is 18.6°C, whereas that of Canton, on nearly the same latitude is 10°C. In fact, eastern Bangladesh and adjacent areas of Assam are the northern most part of the Wet Tropics. In recent years the weather pattern has been erratic, with a reduction of the cool, dry season. This could be a temporary phenomenon, or it may be the beginning of the long-term changes due to global warming caused by "Greenhouse" gases. The climate can be best understood by an analysis of its components.

TEMPERATURES

The maximum temperatures in the year are reached between the last week of March and the end of April. In this period, the mean maximum temperature ranges from 30.4°C in Cox's Bazar and Chittagong to 36°C in Rajshahi. From March to May, in the Northern Region and the Moribund Delta, a hot dry western wind, called Paschi (western), springs up nearly every day at about 10 a.m. and blows hard till about 5 p.m. The heat outside is then quite intolerable. Infrequent thunderstorms bring some relief. In the eastern part of the country, there are more frequent thunderstorms and the furnance-heat of the west is rare.

In June, there is a marked fall in the temperatures, because of the monsoon rains. Throughout the months with heavy rainfall (June to October), the mean maximum temperatures over most of Bangladesh are about 31°C and the mean minimum are 6 degrees less. Around Rajshahi the mean temperatures are two to three degrees higher. In October, there is a marked fall in temperatures. In Cox's Bazar, for example, the mean maximum goes down from 31°C at the beginning of the month to 30°C at

1. There are several rice crops, vide Chapter 10.
2. Often erroneously called 'tidal wave'.

Table 4.1

Mean Monthly Maximum and Minimum Temperatures

Recording Station — 1931 - 60 Average — (In Celsius)

	Jan.		Feb.		Mar.		Apr.		May.		Jun.	
	Max.	Min.	Max.	Min	Max.	Min.	Max.	Min.	Max.	Min.	Max.	Min.
1. Chittagong	25.9	13.8	27.5	15.8	30.4	20.2	32.0	23.5	32.1	24.9	31.1	25.2
2. Cox's Bazar	26.6	13.4	27.8	10.8	30.4	19.6	31.9	23.3	32.2	24.8	30.4	24.9
3. Rangamati	26.4	10.2	28.9	12.9	31.5	16.8	35.1	22.7	34.7	24.5	32.1	24.6
4. Maijdi Court	25.7	12.9	27.9	15.8	31.2	19.7	32.6	24.2	32.1	25.5	30.7	25.4
5. Comilla	26.4	12.1	28.3	14.7	32.6	19.7	33.6	23.2	32.8	24.7	31.3	25.4
6. Srimangal	25.8	8.6	27.9	11.3	32.1	16.6	33.5	21.6	32.2	23.2	31.8	24.4
7. Dhaka	25.5	11.7	28.0	13.4	32.5	18.8	35.1	23.4	33.7	25.4	31.7	25.9
8. Narayanganj	26.4	13.3	28.4	15.7	32.8	20.4	33.9	23.4	33.2	24.9	32.2	25.8
9. Mymensingh	25.3	11.5	27.6	13.7	32.1	18.1	33.9	21.9	32.4	23.4	31.3	24.9
10. Rangpur	24.4	11.1	27.0	12.8	31.2	16.3	34.8	21.8	33.6	23.6	31.9	24.6
11. Dinajpur	24.9	14.7	27.2	12.2	33.4	16.5	35.6	21.1	33.8	23.7	32.2	25.2
12. Faridpur	24.3	11.6	27.2	13.7	32.4	18.1	24.4	22.8	33.1	24.2	31.6	25.3
13. Jessore	25.5	10.3	28.4	13.1	33.5	18.4	35.9	23.1	35.0	24.8	32.9	25.6
14. Khulna	26.3	13.6	28.9	15.8	33.3	20.6	34.6	24.2	34.1	25.4	32.7	26.1
15. Barisal	25.9	13.6	28.3	16.3	32.5	21.6	33.9	24.3	33.4	25.7	31.9	26.0
16. Sylhet	25.1	12.8	26.8	13.9	30.6	17.4	32.8	21.8	31.1	22.4	30.8	24.6

1971 - 81 Average

	Jan.		Feb.		Mar.		Apr.		May.		Jun.	
	Max.	Min.	Max.	Min	Max.	Min.	Max.	Min.	Max.	Min.	Max.	Min.
1. Chittagong	26.4	13.3	28.7	14.9	32.1	18.8	32.4	22.3	33.1	23.1	23.1	23.4
2. Cox's Bazar	26.9	10.9	28.6	14.9	31.6	18.7	32.4	22.6	32.6	27.7	31.7	24.2
3. Rangamati	-	-	-	-	-	-	-	-	-	-	-	-
4. Maijdi Court	26.2	12.5	29.4	14.2	32.5	18.5	33.4	22.0	33.3	22.9	33.6	25.2
5. Comilla	26.1	10.7	29.5	14.8	33.6	17.9	33.8	22.2	33.6	23.2	32.2	23.8
6. Srimangal	-	-	-	-	-	-	-	-	-	-	-	-
7. Dhaka	25.8	11.0	29.7	13.4	34.1	17.9	35.4	21.9	33.7	22.9	32.6	24.5
8. Narayanganj	27.8	13.2	29.7	18.7	33.4	18.8	35.5	22.1	35.2	24.1	33.2	25.2
9. Mymensingh	26.3	9.9	30.0	11.1	34.7	14.2	35.3	20.9	33.8	20.6	34.3	23.3
10. Rangpur	28.2	9.3	29.8	10.7	33.9	13.8	36.7	15.8	36.3	16.6	35.1	18.7
11. Dinajpur	-	-	-	-	-	-	-	-	-	-	-	-
12. Faridpur	25.2	11.1	29.0	12.1	34.4	17.3	36.0	21.7	34.8	23.2	33.3	23.9
13. Jessore	26.6	10.0	29.9	11.7	34.7	17.0	37.7	22.4	36.3	23.5	34.7	24.6
14. Khulna	27.2	11.9	30.2	14.3	35.2	18.9	30.1	22.3	35.6	24.1	22.1	23.9
15. Barisal	26.3	10.9	29.4	12.3	33.6	17.3	34.6	22.1	29.9	23.3	33.4	24.3
16. Sylhet	25.5	11.3	28.3	12.8	31.8	16.8	32.1	20.2	32.1	17.3	31.6	23.6

Table 4.1 Contd.

Recording Station — 1931 - 60 Average — (In Celsius)

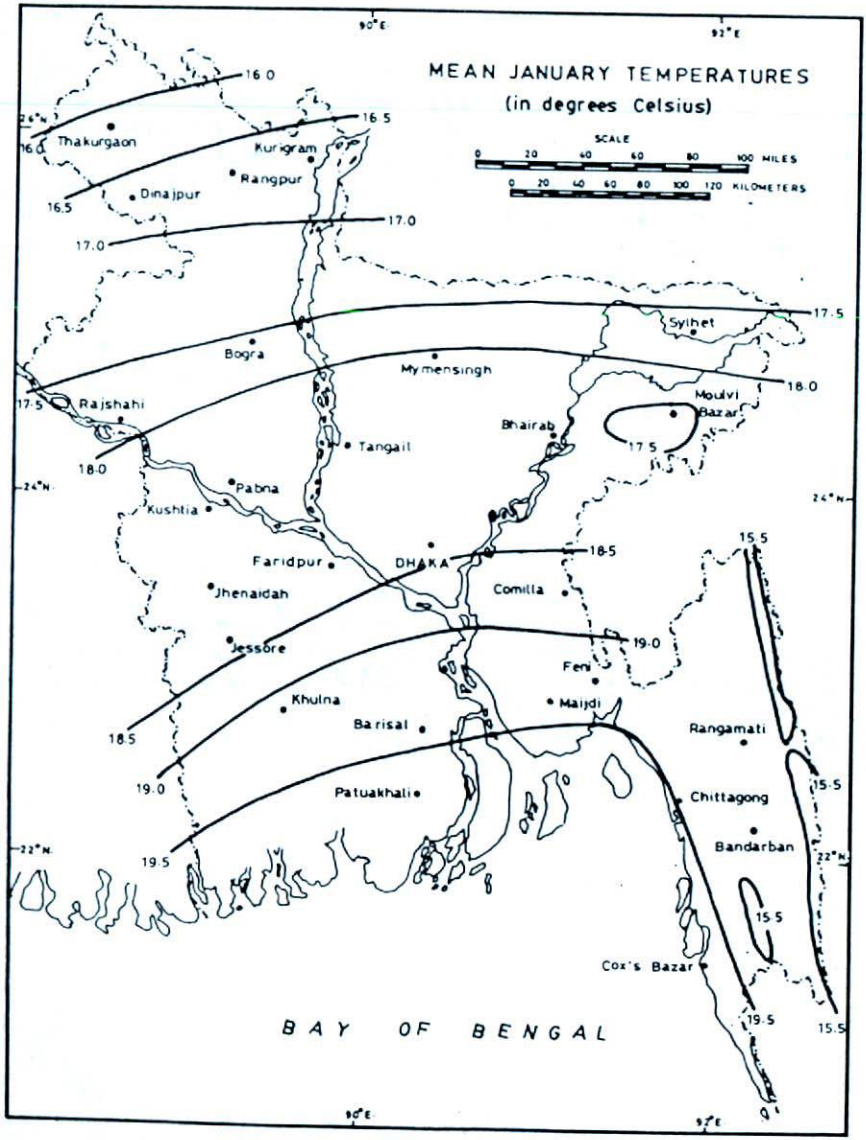
	July		Aug.		Sept.		Oct.		Nov.		Dec.	
	Max.	Min.	Max.	Min	Max.	Min.	Max.	Min.	Max.	Min.	Max.	Min.
1. Chittagong	30.5	24.8	30.2	24.8	30.9	25.0	30.8	23.7	29.2	18.8	26.3	15.4
2. Cox's Bazar	29.7	24.7	29.7	24.7	30.3	24.6	30.9	23.6	29.4	19.4	30.0	15.5
3. Rangamati	30.9	24.7	31.6	24.9	31.5	24.6	31.3	23.7	28.9	16.6	27.1	13.4
4. Maijdee Court	29.9	25.4	30.2	25.6	30.7	25.5	30.6	24.2	28.2	18.9	26.2	14.4
5. Comilla	30.9	25.3	31.1	25.3	31.6	24.2	31.2	23.7	29.2	18.3	26.8	13.8
6. Srimangal	32.1	24.9	31.8	24.8	32.0	24.4	31.1	21.7	28.9	15.4	26.4	10.4
7. Dhaka	30.7	26.0	31.1	26.2	31.2	30.8	30.9	23.7	28.7	17.6	26.3	12.7
8. Narayanganj	31.4	26.1	31.4	26.2	32.1	26.2	31.9	24.4	29.8	19.2	27.2	14.8
9. Mymensingh	31.3	25.7	31.4	25.6	31.6	25.4	30.8	23.4	28.8	18.1	26.5	13.5
10. Rangpur	31.8	26.1	31.7	26.3	31.7	25.7	30.8	22.7	28.6	16.5	25.5	13.1
11. Dinajpur	31.6	26.0	31.8	25.9	32.0	25.4	31.3	22.3	28.9	16.0	26.1	11.6
12. Faridpur	30.7	25.7	30.7	26.1	31.2	25.9	30.7	23.7	28.0	18.0	25.2	13.2
13. Jessore	31.4	25.6	31.6	25.7	32.1	25.3	31.6	22.9	29.1	16.4	26.5	11.3
14. Khulna	31.2	26.2	31.3	26.1	31.8	25.9	31.2	24.2	29.0	19.0	26.7	14.7
15. Barisal	30.6	25.8	30.8	25.8	31.4	25.9	31.2	24.3	28.9	19.3	26.4	14.8
16. Sylhet	31.2	25.3	31.6	25.3	30.8	24.6	30.2	22.4	28.7	17.1	26.4	14.1

1971 - 80 Average

	July		Aug.		Sept.		Oct.		Nov.		Dec.	
	Max.	Min.	Max.	Min	Max.	Min.	Max.	Min.	Max.	Min.	Max.	Min.
1. Chittagong	31.4	23.7	31.6	24.3	32.3	24.2	32.2	23.5	30.1	19.7	27.4	14.1
2. Cox's Bazar	29.9	24.5	30.7	23.9	30.2	24.3	31.6	23.4	30.2	20.1	27.6	14.8
3. Rangamati	-	-	-	-	-	-	-	-	-	-	-	-
4. Maijdee Court	30.6	24.8	-	23.4	31.9	25.3	31.1	23.5	30/3	17.8	28.9	12.9
5. Comilla	31.4	25.1	31.9	24.7	31.2	24.2	31.8	22.9	29.9	18.2	26.9	11.8
6. Srimangal	-	-	-	-	-	-	-	-	-	-	-	-
7. Dhaka	31.7	25.4	31.8	24.6	32.3	25.1	31.7	23.3	30.2	17.7	26.7	12.0
8. Narayanganj	31.7	25.4	31.8	25.7	32.8	26.1	33.2	24.6	31.5	19.9	29.4	14.5
9. Mymensingh	33.4	24.0	32.8	23.9	33.2	24.0	33.4	22.4	30.7	17.4	28.0	11.3
10. Rangpur	34.3	20.3	35.0	20.3	34.1	19.1	32.9	17.0	31.7	13.3	29.1	10.6
11. Dinajpur	-	-	-	-	-	-	-	-	-	-	-	-
12. Faridpur	32.1	24.1	33.1	24.4	32.7	24.6	31.7	23.3	29.7	18.8	26.4	15.1
13. Jessore	32.2	25.1	32.5	24.7	32.4	24.9	32.7	23.1	30.5	17.1	27.2	10.9
14. Khulna	32.8	25.1	32.0	24.6	33.2	25.2	33.1	23.6	31.1	19.7	27.2	13.5
15. Barisal	31.1	25.3	31.6	25.3	32.3	24.7	32.1	23.3	30.1	18.5	26.6	12.2
16. Sylhet	31.7	24.0	36.6	24.4	37.2	24.0	31.4	21.7	29.7	17.9	27.1	12.4

Source : Agricultural Yearbook of Bangladesh, 1982 ; Statistical Pocketbook of Bangladesh, 1980, B.B.S.

Map. 4.1


MEAN JANUARY TEMPERATURES
(in degrees Celsius)
SCALE
0 20 40 60 80 100 MILES
0 20 40 60 80 100 120 KILOMETERS
90°E
93°E
26°N
24°N
22°N
16.0
16.5
17.0
17.5
18.0
18.5
19.0
19.5
15.5
Thakurgaon
Kurigram
Rangpur
Dinajpur
Sylhet
Bogra
Mymensingh
Moulvi Bazar
Rajshahi
Bhairab
Tangail
Pabna
Kushtia
Faridpur
DHAKA
Jhenaidah
Comilla
Jessore
Feni
Khulna
Maijdi
Barisal
Rangamati
Patuakhali
Chittagong
Bandarban
Cox's Bazar
BAY OF BENGAL

the end: the mean minimum goes down from 24°C to 22°C. In the west there are even sharper falls. In Rajshahi, the mean maximum goes down from 32°C to 25°C and the minimum falls from 25°C to 20°C. These falls may not seem to be much but for those who are used to high temperatures even 20°C is cool : and most of the people are lightly clad.

Throughout November and December the temperatures fall gradually. In the last week of December, the northern areas of the Northern Region record a minimum of 9°C and, in the Sylhet Hills, the mean minimum is 8°C. This, for a tropical country, is very cold. The south is milder, mainly because of the sea : Cox's Bazar has a mean minimum of 15.5°C in December. January is the coldest month and minimas of 2°C have been recorded in northern Dinajpur and southern Sylhet.

In February and March, the temperatures rise quite sharply. In Cox's Bazar, the mean maximum rises from 27°C at the end of January to 31°C in the first week of April. In the west the rise is steeper : at Rajshahi corresponding rise is from 25°C to 32°C. This rise is fastest from the first week of April when the mean maximum goes up 6°C in Rajshahi, 5°C in Dinajpur and 4°C in Jessore. In the east, the summers are milder and the rise in that period is 2°C in Noakhali, 1°C in Chittagong and very little in Cox's Bazar or Sylhet district.

The broad features of the temperature regime are that : (i) the highest temperatures are recorded in the months of March, April and May; (ii) there is a period of equable temperatures from July to September. June being a transitional period; (iii) then is a steady fall in maximum and minimum temperatures from October to the end of December; (iv) the coolest period is from the last week of December to the last week of January ; February is a transitional month, leading to the next three hot and dry months.

RAINFALL

There are three main sources of rainfall in Bangladesh : (i) the western depressions of winter, (ii) the early summer thunderstorms known as the Nor'westers (North-Westerlies), and (iii) the summer rains from the S.W. Trades known as the Monsoons.

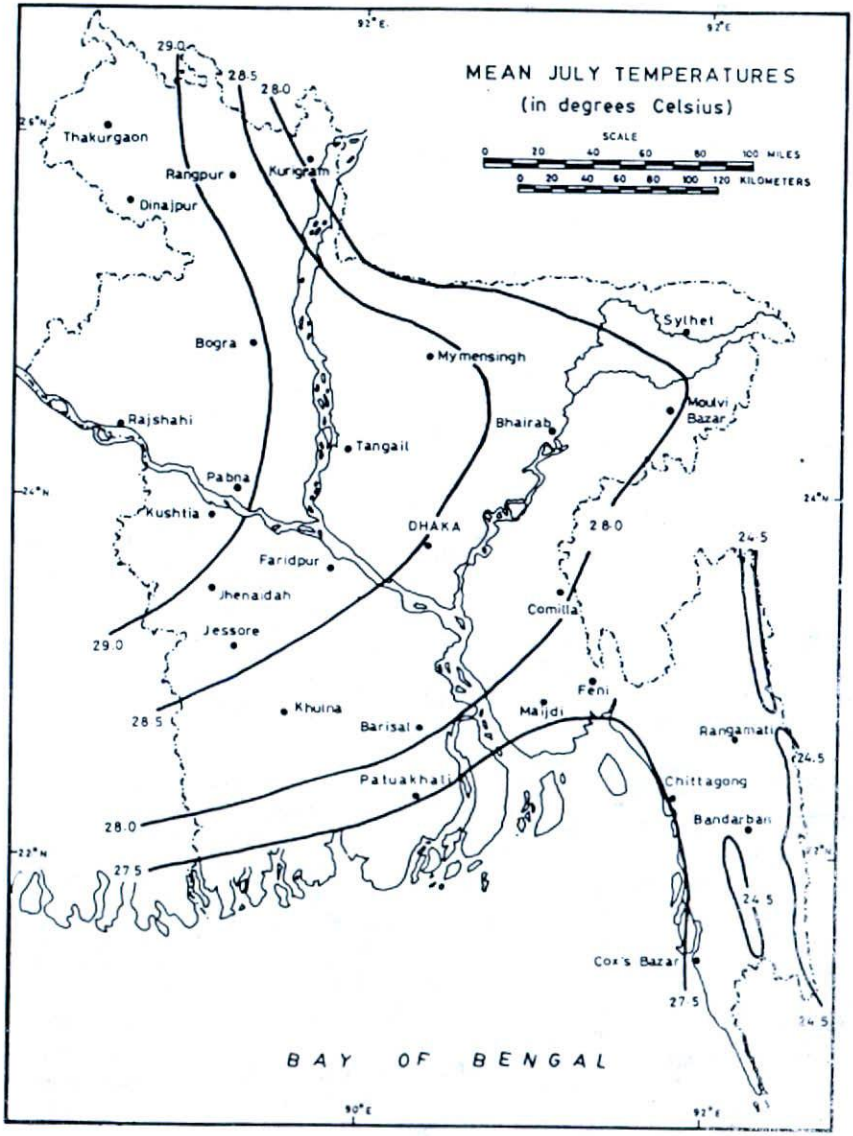
The westerly depressions (anticyclones) form in the region of the Elburz Mountains, or even further west, in the Mediterranean region. They generally intensify as they move eastwards and precipitate considerable amounts of snow on the western Himalayas. Continuing eastward they bring rain to the lower slopes of the eastern Himalayas, and as they are 'trapped' in

the area of the Assam Hills, to all parts of Bangladesh also. The main period of these rains is from 20th January to 25th February. In these 35 days, it rains from 1 cm. (Cox's Bazar) to 4 cm. (Srimangal) and more. There is a slight break, of about fifteen days, before the second rainy period begins on about the 10th of March. The Nor' westers are due to a variety of reasons, of which the main ones are the steady flow of cool dry air above 1800 metres altitude from the north-west (anti-trades), and a warm moist current below 1800 metres from the south, intense evapo-transpiration in the Bengal Basin and Assam, and katabatic winds from the surrounding mountains.

There are four main centres of origin of these thunderstorms ; the Chhota Nagpur Plateau (Type A), the slopes of the eastern sub-montane Himalayas (Type B), the western ranges of the Arakan Yomas (Type C) and the southern slopes of the Meghalaya Plateau (Type D). The type 'A' nor'westers have a tendency to move in a south-east to north-west direction. Type 'B' generally moves to the Meghna Delta from the north. Types 'C' and 'D' usually pass over the delta from the north-east. These mildly cyclonic storms are heralded by large thunderheads, and much thunder and lightning. They are usually of a short duration, but are intense, with windspeed upto 100 kmph., and heavy rainfall. These storms cause temperature drops of 9 to 11 degrees celsius and some times of as much as 17 degrees celsius. Hailstorms occur during this period and hail of upto 5 cm. in diameter are not uncommon, especially in Sylhet and Sunamganj districts. In 1967 unusually large hail, of over 7 cm. diameter, fell in Dhaka city. Great damage to the Boro rice crop can be caused by these storms. The main period of the Nor'westers lasts within the first week of May. The rainfall varies in this period from 8.8 cm. (Dinajpur) to 41.8cm. (Srimangal) and more (in north Sylhet). There are, however, showers due to local instability of air - masses throughout the month of May.

The main rainy period begins with the coming of the moisture-laden south-west-trades popularly known as the monsoons, which are drawn to the Indian Sub-Continent by the intense heat, and consequent low pressure over the Punjab and Upper Ganges valley, which gives rise to a "tropical cell" with convection currents of massive proportions. These winds blow across the north Indian Ocean and reach the Malabar coast of India two weeks before they come up the Bay of Bengal to Bangladesh. One arm of these vast trades moves up the Ganges valley, while another one brings copious rains to the west coasts of Burma and quickly moves north into Assam. It is the orogenic rains caused by the striking of this east-flowing air mass against the Arakan Yomas, Meghalaya Plateau and the Himalayas that forms the major part of the rainfall of Bangladesh. The trade winds, the rains they bring and also the period of the year which they effect, are called Monsoons, a word derived from the Arabic word for weather, *Mausim*.

Map. 4.2


MEAN JULY TEMPERATURES
(in degrees Celsius)
SCALE
0 20 40 60 80 100 MILES
0 20 40 60 80 100 120 KILOMETERS
92°E
92°E
26°N
24°N
22°N
90°E
92°E
29.0
28.5
28.0
27.5
24.5
Thakurgaon
Rangpur
Kurigram
Dinajpur
Bogra
Mymensingh
Sylhet
Moulvi Bazar
Rajshahi
Tangail
Bhairab
Pabna
Kushtia
DHAKA
Faridpur
Jhenaidah
Jessore
Comilla
Feni
Khulna
Barisal
Maijdi
Rangamati
Patuakhali
Chittagong
Bandarban
Cox's Bazar
BAY OF BENGAL

Over the past decade satellite imagery has shown that depressions originating in the Pacific Ocean cross over to the Bay of Bengal and are also a source of rain and storm.

The timing of the arrival of the monsoon rains is very important to the agriculture of the country. Heavy early monsoon rains can destroy the Aus rice crop. Heavy late rains are even worse, since they mean the ruin of the main crop (Aman) and also the very valuable jute crop. Since the monsoon current travels from the south and east to the north and west, the rains begin in places like Cox's Bazar and Noakhali on about the 20th of May, and spread to Kushtia and Rajshahi in about ten days. It must be understood that a definite break between the Nor'westers and the monsoons in unusual in Bangladesh. One merges into the other. Only in a few places (e.g., Khetlal) is there a definite dull, dry period before the sudden 'breaking' of the monsoon, as is so common in north India. The monsoons bring very heavy rainfall for five months, from the end of May to mid-October. The mean cloudiness then is from eight to nine-tenths. The total rainfall in these months varies from 122 cm. at Rajshahi, and 149 cm. at Narayanganj, to 338 cm. at Cox's Bazar and over 500 cm. in those parts of north Sylhet across the border from Cherapunji and Mawsyriem, two of the rainiest places in the world.

After the 14th of October, the monsoon rainfall peters out rapidly. In the western half of the country and in Central Bengal the rains are normally over between the 20th and 25th of October, whereas in the east and south-east they do not end till about the 10th of November. Very little rain falls from this time till the middle of January. Mean cloudiness is then only one to two-tenths. There is a slight difference in the period of maximum rainfall in different parts of Bangladesh. In most places, the maximum rainfall is recorded in June, though July and August record nearly as much. Dinajpur and the north-west of the North Bengal, Kushtia, Satkhira and Noakhali get their maximum rainfall in July. Many places, such as Comilla, Brahmanbaria, Bogra and Srimangal have a slight tendency to record "double-maxima" in July and in September.

The distribution of the average annual rainfall makes the isohyets swing round in a curve from the south towards the east and then towards the north-west (Map 4. 3). The average annual rainfall is 388 cm. at Cox's Bazar, but only 273 cm. at Chittagong, the isohyets having swung east towards the higher ranges of the Arakan Yomas. Most likely the high Basi Toung and Tyambang range east of Cox's Bazar gets 500 cm. or more of rainfall, as they lie athwat the monsoonal winds that blow across the Arakan coast. Nakhyongchhari gets 295 cm. and to the north-east at Lama Bazaar it is 300 cm. Both places are in the rain-shadow of the Muranja Range. Further north, Kaptai receives 282 cm. ; 257 cm. at Rangamati, 198 cm. Barkal

Table 4.2

Distribution of Monthly and Total Annual Rainfall (cm.)

(Mean Monthly and Annual Rainfall)

	Recording Station	Period	Jan.	Feb.	March	April	May	June	July	Aug.	Sept.	Oct.	Nov.	Dec.	Annual
1.	Bhola	1966-77	0.76	1.57	3.86	10.34	21.69	50.32	50.98	44.04	33.55	18.84	5.84	2.06	243.85
2.	Brahmanbaria	47-72	0.84	1.45	6.55	14.00	23.32	41.40	35.66	26.67	24.21	18.31	3.51	0.23	196.15
3.	Bogra	47-77	1.35	1.14	2,77	6.07	18.42	50.60	36.63	32.44	26.31	17.02	1.50	0.15	194.40
4.	Barisal	47-77	1.17	1.47	3.10	8.46	20.29	44.12	43.33	36.30	33.53	22.21	4.52	0.71	219.28
5.	Chandpur	64-77	0.28	0.56	6.35	9.09	17.42	34.87	35.56	28.93	21.74	13.51	2.21	0.30	170.82
6.	Cox's Bazar	47-77	0.81	1.22	2.39	9.04	29.06	83.34	110.08	75.36	39.19	30.33	5.89	0.89	387.60
7.	**Chittagong**	**47-77**	**0.66**	**1.47**	**5.26**	**11.91**	**24.23**	**58.88**	**75.87**	**54.74**	**27.94**	**5.97**	**6.05**	**0.99**	**273.97**
8.	Comilla	47-77	0.66	2.74	4.98	19.30	28.60	52.20	52.73	41.61	29.13	23.75	4.88	0.69	261.27
9.	**Dhaka**	**53-77**	**0.86**	**2.03**	**5.51**	**11.35**	**26.52**	**37.49**	**46.33**	**32.28**	**27.56**	**16.56**	**2.87**	**0.58**	**209.94**
10.	Dinajpur	47-73	1.14	0.53	2.41	5.44	15.93	35.86	40.23	31.65	26.14	10.74	0.79	-	170.86
11.	Faridpur	49-77	0.79	1.40	4.43	14.40	24.79	37.19	39.12	30.18	25.25	10.74	3.20	0.46	191.84
12.	Hatiya	65-77	0.41	1.45	8.05	15.65	26.16	58.67	80.31	63.12	47.96	17.98	4.34	2.69	326.79
13.	Ishurdi	62-77	1.98	1.40	2.79	9.12	17.32	37.47	35.15	30.45	22.99	22.35	1.63	0.94	183.59
14.	Jamalpur	62-76	0.74	1.30	4.67	10.24	21.23	45.29	45.54	42.82	28.27	14.81	1.07	-	215.98
15.	Jesssore	47-77	0.91	1.37	3.30	7.77	14.73	29.41	32.59	28.85	22.58	27.83	2.54	0.61	162.49
16.	**Khulna**	**47-78**	**0.81**	**1.88**	**3.58**	**9.32**	**18.42**	**34.98**	**39.34**	**28.58**	**27.97**	**16.13**	**2.49**	**0.15**	**183.65**
17.	Kaptai	63-77	0.53	1.37	3.56	12.85	25.32	63.86	74.07	42.47	33.05	16.05	7.04	1.65	281.82
18.	Lalmonirhat	62-77	0.76	0.38	3.43	7.34	32.84	38.51	61.11	33.91	26.39	9.42	1.40	-	215.49
19.	Mymensingh	47-77	0.97	1.60	4.29	11.13	25.27	47.29	41.28	36.78	6.25	19.23	1.80	0.20	196.09
20.	Maijdee Court	47-77	1.01	2.54	4.62	11.18	28.24	62.10	73.55	63.20	41.99	26.31	3.81	0.66	319.21
21.	Narayanganj	47-77	0.89	1.85	5.64	17.45	23.65	38.00	37.64	32.89	24.61	16.13	2.79	0.64	202.18
22.	Pabna	47-69	1.35	1.47	3.23	5.97	15.75	29.67	25.45	28.60	23.67	18.49	1.47	0.18	155.30
23.	**Rajshahi**	**47-77**	**1.47**	**0.99**	**2.51**	**3.68**	**11.66**	**26.21**	**36.78**	**25.81**	**21.23**	**11.61**	**1.42**	**0.13**	**143.50**
24.	Rangpur	47-78	1.27	1.01	2.90	8.05	26.59	52.02	43.89	31.88	27.89	16.00	0.94	0.05	212.49
25.	Rangamati	59-77	0.56	1.78	3.28	10.57	21.18	62.46	64.24	54.10	25.65	18.85	3.56	1.19	267.42
26.	Sandwip	66-77	0.53	1.57	4.75	19.58	27.84	75.29	96.70	76.50	43.94	25.45	12.42	1.19	385.76
27.	Sylhet	57-77	1.50	4.11	9.86	33.69	53.85	100.20	77.93	64.95	45.77	23.72	2.77	0.66	417.71
28.	Srimangal	47-77	1.32	3.02	8.38	25.02	38.36	54.97	40.82	31.70	25.76	18.62	4.52	0.69	253.45
29.	Sirajganj	47-76	1.40	1.98	3.43	9.04	22.83	32.21	37.39	32.72	24.68	15.29	2.59	0.15	183.71
30.	Satkhira	47-78	1.30	2.62	3.63	7.37	15.09	30.58	37.01	30.48	30.18	14.81	2.72	0.74	176.53

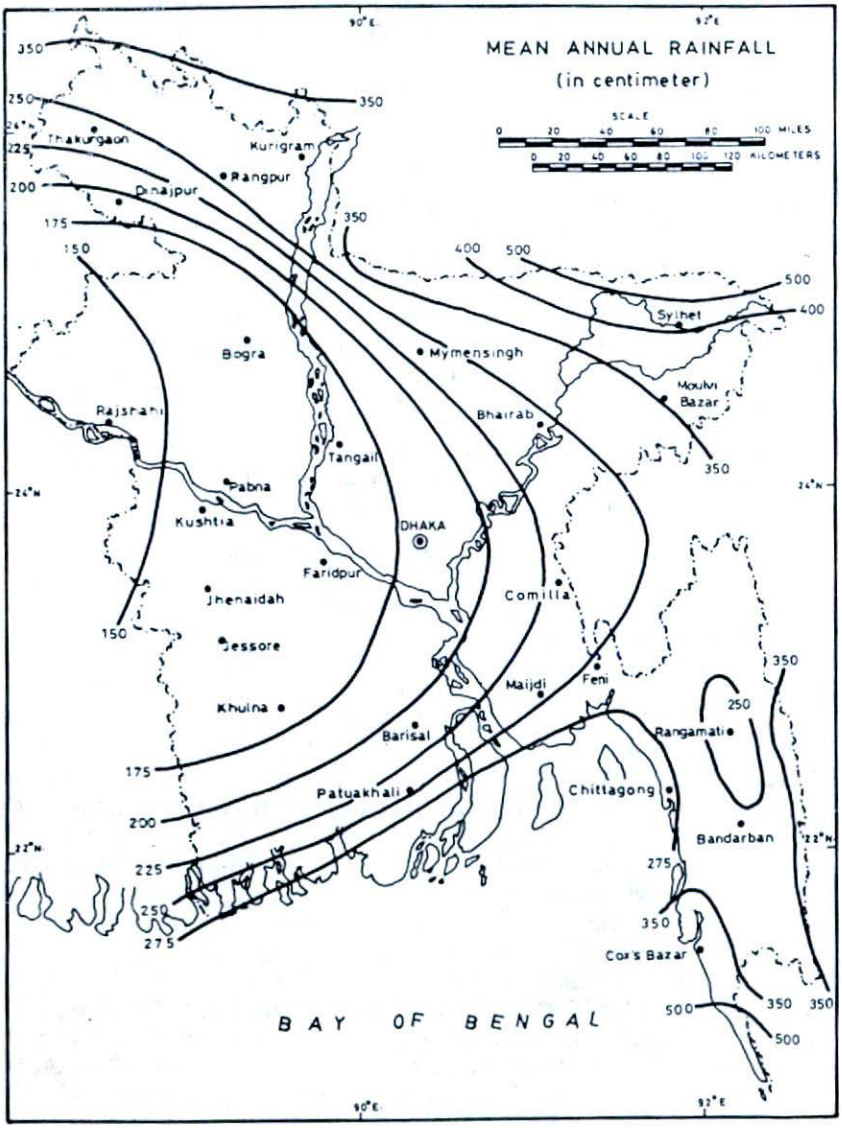
Source : Climate Data of Bangladesh : Monthly and Annual Rainfall Records.
Supplementary Issue No. 1, June, 1980, Bangladesh Meteorological Department, Dhaka.

and 259 cm. at Manimukh. There is a sudden increase in rainfall as one goes inland from Chittagong, but a definite fall in the lee of the Phoromain Range. The rainfall increases northwards, even though the hills are lower, because of the proximity of the Meghalaya Plateau and the Naga Hills. Along the coast the rainfall increases rapidly north of Chittagong (it is 307 cm. at Noakhali), but decreases after the southern most spurs of the Tippera Hills are passed. There is a broad band between the 200 and 250 cm. isohyets in Barisal, west-Noakhali and most of Comilla (Comilla town gets 259 cm). The 200 cm. isohyet swings through Dhaka towards Rangpur: Brahmanbaria is in a 'dry' projection into this wet area, its rainfall averaging 196 cm. In the Surma valley and neighbouring hills, the rainfall is very high. In the foothills of south-Sylhet, Rashidpur gets 249 cm., Srimangal 253 cm., Patrakhola 216 cm., Kurmah 262 cm., Shamshernagar 269 cm., and Hingajia 292 cm. At Sylhet the rainfall average is 418 cm. and near the foot of the abrupt Meghalaya Plateau, at Sunamganj it is 533 cm. and at Lalakhal it is 650 cm. the highest of any station in Bangladesh. (Cherapunji, barely 16 kilometres across the border, in a straight line, to the north of Chhatak, records an astonishing average of 1082 cm. annually).

In the rest of Bangladesh (with the exception of the northern parts of the Northern Region) the isohyets swing in an arc from the south-west to the north-east and then to the north-west (Map 4, 3).

The 200 cm. isohyet passes south of Khulna town, just east of Faridpur town and almost over the town of Bogra. Thus Faridpur records 197 cm., Narayanganj 202 cm., Bogra 194 cm. and Dinajpur 148 cm. The 150 cm. isohyet passeds north of Jessore and Pabna towns, and east of Naogaon town. Satkhira receives 177 cm. The whole of Rajshahi and Kushtia is an area with less than 150 cm., Meherpur gets 137 cm., Chuadanga 150 cm., Rajshahi town 144 cm., and Mahadebpur 137 cm. In the north-west of Rājshahi district, Nithpur (Porsha) records and 145 cm. The West Barind, and probably the East Barind too can have very variable rainfall in certain years. In 1873, the West Barind recorded a mere 69 cm., probably the lowest ever recorded anywhere in Bangladesh. In contrast to these areas of low rainfall, in the southern part of the Northern Region those in the north get nearly twice as much. The rainfall increases northwards from 183 cm. at Nawabganj to 190 cm. at Parbatipur, 213 cm. at Rangpur, 216 cm. at Thakurgaon, 231 cm. at Kurigram, 257 cm. at Atwari and 282 cm. at Debiganj. Still further north, at Banglabandha, the rainfall is most likely around 305 cm., since Jalpaiguri (in India), only a few kilometers away, averages 310 cm. Bhurungamari, to the north-east of Rangpur, probably records as much, since Cooch Bihar, just across the border in India, has averaged 373 cm. An interesting phenomenon which has not yet been scientifically studied is the correlation between phases of

Map 4.3


MEAN ANNUAL RAINFALL
(in centimeter)
SCALE
0 20 40 60 80 100 MILES
0 20 40 60 80 100 120 KILOMETERS
90°E
92°E
24°N
22°N
350
250
225
200
175
150
400
500
Thakurgaon
Kurigram
Rangpur
Dinajpur
Bogra
Mymensingh
Sylhet
Moulvi Bazar
Rajshahi
Bhairab
Tangail
Pabna
Kushtia
DHAKA
Faridpur
Comilla
Jhenaidah
Jessore
Khulna
Maijdi
Feni
Barisal
Rangamati
Patuakhali
Chittagong
Bandarban
Cox's Bazar
BAY OF BENGAL

the moon and rainy spells. It is believed that new and full moon periods, known, respectively, as *Amabashya* and *Purnima*, are definitely rainier than the periods in-between.

FOG, MIST, DEW & HOAR-FROST

Fog and mist are a common feature of the weather from November to March. At the beginning and end of this period, mist, but not fog, usually develops as the sun sets and remains till sunrise. In December and January, there is fog on many nights, and may persist even upto noon. Heavy long-lasting fogs usually form in these two months, over the Brahmaputra-Jamuna river, in Sylhet district and the Hill Tracts. Dew-fall is also very heavy in these two months. In the damper places such heavy dew forms that in the mornings, when it drops off the leaves of the trees, it could be mistaken for a light shower. Dew possible accounts for two centimetres or more of precipitation in the wetter areas. In North and Central Bengal, cold air masses from the upper Ganges valley sometimes flow in and lower the night temperatures sufficiently for hoar-frost to form. Frost may also form in winters on the highest ranges of the Hill Tracts district.

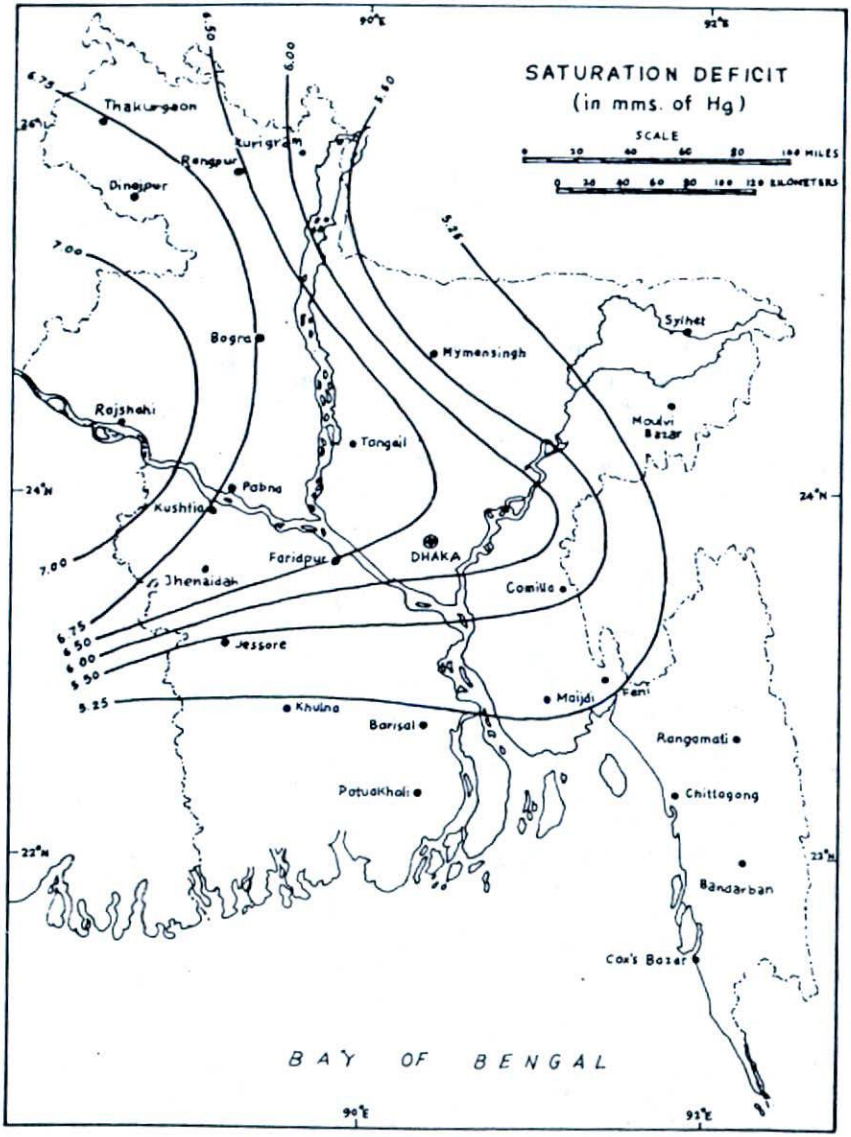
HUMIDITY

The humidity is high throughout the year. Only on certain days when the hot Paschi blows strongly, does the relative humidity drop quite low. March and April are the least humid months over most of the western part of Bangladesh. The lowest average relative humidity figure, of 57.00, is recorded in Dinajpur in March. The least humid months in the eastern areas are January, February and March. Here the lowest monthly average of 58.50 is recorded at Brahmanbaria in March. The relative humidity is everywhere over 80 during June, July, August and September. The saturation deficit is lowest in July or August, (Map. 4.4), but the most trying month is September, when the humidity is high and the rainy days are not many. The average relative humidity for the whole year ranges from 78.10 at Cox's Bazar to 70.50 at Pabna.

WINDS

From November to February, the general directions of the winds are north-easterly in the Northern Region, north-westerly over the rest of western Bangladesh, and northerly in the eastern part. From March

Map 4.4


SATURATION DEFICIT
(in mms. of Hg)
SCALE
0 30 60 90 120 MILES
0 30 60 90 120 150 KILOMETERS
90°E
92°E
24°N
22°N
Thakurgaon
Rangpur
Kurigram
Dinajpur
Bogra
Rajshahi
Pabna
Kushtia
Jhenaidah
Jessore
Khulna
Barisal
Patuakhali
Faridpur
Tangail
Mymensingh
DHAKA
Comilla
Maijdi
Feni
Sylhet
Moulvi Bazar
Rangamati
Chittagong
Bandarban
Cox's Bazar
6.75
6.50
6.00
5.50
5.25
7.00
5.75
5.25
BAY OF BENGAL

to May, the winds are westerly or south-westerly in the western half but south-south-easterly in the eastern half. Occasional Nor'westers, of course, change the wind direction and bring relief from the dull heat. From June to September, the winds are not all southerly, much of it being south-easterly, and even easterly. In October, the winds are very variable, but there is a definite strengthening of the northerly winds at the expense of the south-easterlies. The Inter-Tropical Convergence Zone is in the north of Bangladesh during the four monsoon months and thus it is a pronounced field of air-mass convergence.

CYCLONES (TYPHOONS)

Typhoons are Tropical Revolving Storms, not uncommon within the Inter-Tropical Belt. Typhoons are called 'Cyclones' in English, when they occur in the Indian Ocean area. They are called *Tufan'* in Bengali, from the Chinese *'Tai-fun'*. Cyclonic storms are of many types but typhoons are distinctive. The latter name has, therefore, been used here. They are probably the most intense storms affecting the surface of the earth. In the typical typhoon, there is an intense cyclonic circulation with winds attaining 110 to 160 kmph. or more. Near the center of the storm is an area of comparative calm, the so-called 'eye of the storm' . Within the area of violent circulation, there is dense nimbo-stratus and alto-stratus cloud, extending to above 6000 metres. Heavy and often continuous rain falls near the eye, and there are showers out to the limit of the cyclonic circulation. The air-mass converges rapidly to the centre in the lower part of the storm, with violent uplift near the eye in the lower part, and uplift all over in the higher reaches. It is quite usual for the typhoons in the Bay of Bengal to move north westerly till they are in 20.N latitude, then to suddenly turn to the north-east. Near the eye of the typhoon, there is a heavy swell known as the storm wave or storm surge. Soon after crossing the coast, the storm begins to fill up. There are, on the average, six typhoons in the Bay of Bengal every year. They generally come in early summer (April, May) or late rainy season (September, October, November). The forces that are responsible for the origin of these storms are still not well known. They may be, in this region, mainly due to the Coriolis force acting on the Trade Winds when the Inter-Tropical Convergence Zone is displaced.

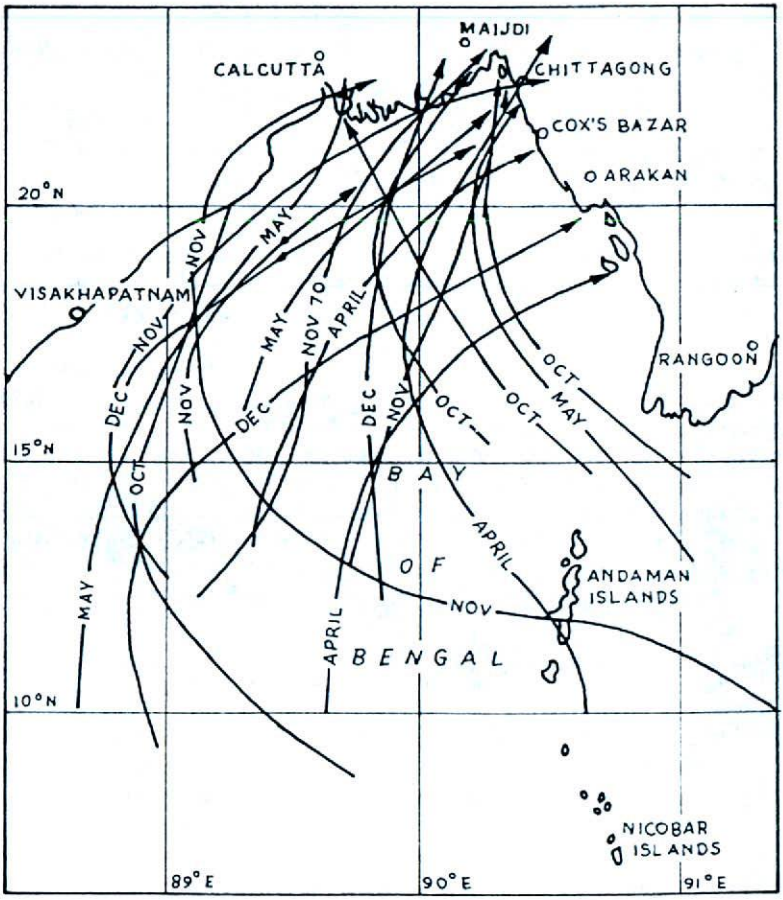
In the past three decades six violent cyclones (typhoons) affected Bangladesh severely (Map 4.5). The first one struck the Meghna estuary on October 9th,1960. The second came on 30th-31st October and struck the Chittagong coast and the Meghna estuary. The loss of human life in these two storms was estimated at over 14,000. The third

violent one struck the Meghna estuary and the Barisal coast on 28th of May, 1961. The loss of human life was probably over 4,000. Again in May 28th-29th, 1963 the fourth typhoon blew up along the coast of Chittagong and went inland just south of the Boro Feni estuary . The eye of the storm crossed inland north of Sitakunda and the storm wave caused very severe damage to Sitakunda and Mirsarai Upazilas. Further south, the destruction due to the storm wave was severe from Cox's Bazar to the Matamori delta. Wind speed of over 185 km.p.h. was recorded at Cox's Bazar and about 240 km.p.h. at Chittagong. More than 4,000 persons died due to the storm wave. A severe typhoon struck on 11th of May, 1965, crossed the coast of south Barisal and caused heavy damage upto a 160 km. inland. More than 20,000 persons died. Most of these casualties were due to the three-to-six metre high storm-wave.

The Meghna estuary has always been like a funnel 'drawing in' typhoons. The very low islands (most of which have not fully formed and are often no more then a meter above mean sea level but are occupied for habitation) and mainland coast are always very severely affected by the storm-wave which may be upto eight metres in height. Very strong winds accompanying the typhoons have blown off tin roofs as far inland as Netrokona. Embankments along the coast have been recently built to prevent the ingress of saline water and also to afford a measure of shelter against the storm-wave. However, when high tide and the storm-wave coincide practically nothing can prevent enormous damage. On November 12th - 13th, 1970, just such a coincidence during a severe typhoon devastated the coastal areas of Noakhali, Patuakhali and Bhola island. Conservative estimates of human deaths from that storm vary from 70,000 to 200,000. The cyclone of May 24th - 25th, 1985, brought in a storm surge of four metres height and devastated the coastal areas of Noakhali and Sandwip island. More recently, on the full moon night of April 29th, 1991 a very severe cyclonic storm (typhoon) with wind speed of over 245 kmph struck the northern Chittagong coast on a pattern very similar to the May 1963 cyclone. The path of the eye, close to the shore, raised a storm surge of unusual height - reportedly more than nine meters above mean sea level - which devasted the Naaf valley, the islands from Sonadia to Sandwip and the mainland coast from Cox's Bazar to Lakshmipur. The entire coastal embankment (between three to five meters high) from Patenga, at the mouth of the Karnafuli river, northward for 10 km. or more has been completely washed away. The damage to the physical infrasturcture of the port of Chittagong and adjoining industrial area has been colossal and recovery will take years. Death toll from the cyclone, storm surge and its aftermath will exceed 200,000 making it, along with the cyclone of November 1970, one of the world's major natural disasters of this century. (See Map 20.2)

Map 4.5

CYCLONIC STORM TRACTS IN THE BAY OF BENGAL 1960 – 1990



TORNADOES

Tornadoes are not infrequent between March and May when at least one strikes some part of the country every fortnight. They result from very intense cyclonic storms at a front between moist tropical and dry continental air-masses when wind speeds of over 140 kmph can devastate the narrow corridor over which it passes. They are more common in the central part of Bangladesh than in the other areas. Most of the severe tornadoes are recorded in the greater districts of Faridpur, Pabna and Dhaka areas.

ATMOSPHERIC PRESSURE

During the cooler months (mid-November to mid-February), Bangladesh is at the edge of the vast high pressure area of Central Asia. The mean pressure is 1,020 millibars in January. This definitely makes it an area of high pressure, but there are even higher pressures to the north-east, in China and Siberia. As a result there is a flow of air down the Brahmaputra and the Ganges valleys towards the delta. Considerable changes take place in the next few months. From March to September it is an area of low pressure, the average being 1,005 millibars. In fact the Inter-Tropical Zone of Convergence moves north till it is over northern Bangladesh. The reversal of winds and consequently in pressure changes in May-June and October-November often causes violent storms.

SEASONS AND CLIMATIC SUB-ZONES

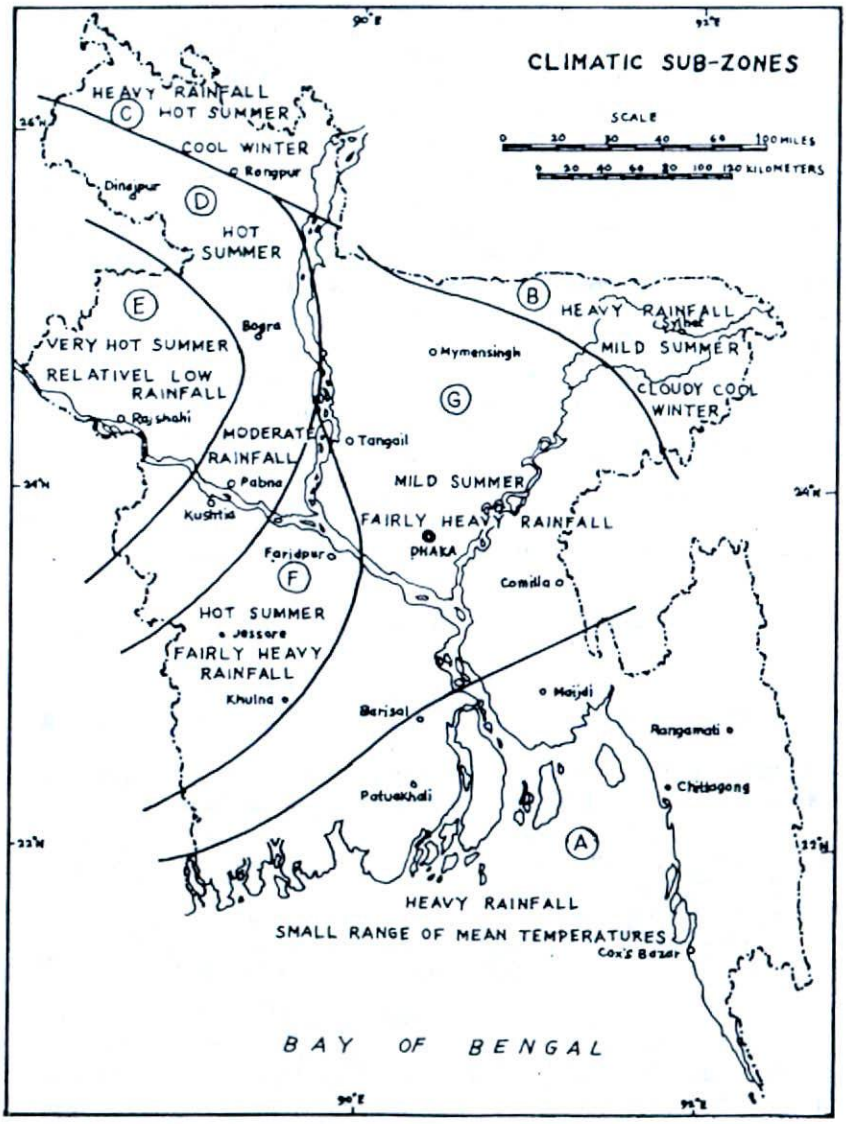
There are, traditionally, six seasons in the Bengali year : *Grissho* (Summer), *Borsha* (Rain), *Sarat* (Autumn), *Hemonto* (Late Autumn), *Sheet* (Winter) and *Bashonto* (Spring). This traditional division is quite reasonable, though there is no spring or autumn in the sense that it is understood in higher latitudes. Gardens have more flowers in winter than in any other season. The flowering trees bloom in succession from February to June. Over most of the Northern Region, winter generally lasts from November till the end of February, whereas in the south-eastern coastal areas, it is gone by the middle of that month. The summer (hot weather with mean maximas of 29°C and over), generally begins in the first week of March, and more or less coincides

with the beginning of the period of Nor'wester rains (the second half of February can, therefore, be considered as Spring or Bashonto). Though the high temperatures (maximas over 26°C and minimas over 21°C) continue unabated till October, there is a definite break in the weather when the monsoon rains start in earnest. The last week of May can be taken as the end of the summer, with its very hot rainless spells and sudden thunderstorms. From then on it rains almost every alternate day till the end of October. Except in the east and south-east, there is very little rain from the last week of October, but the temperatures are high. There is a brief return to summer (autumn) conditions for about a fortnight but the rapidly falling minimas compensate for the high maximas, and wintry conditions are preceptible from the very first week of November. Winter, which means maximas generally below 26°C and a mean of 21°C or less, begins in the first week of November and ends in the Chittagong Sub-Region by the middle of February ; in the delta, Comilla and Dhaka districts and the southern part of Northern Region by the last week of February ; and in Sylhet and northern part of Northern Region by the first week of March. The year can thus be divided into three well-marked periods. The cool season or winter (November to middle of February), summer (beginning of March to end of May), and the rainy season (end of May or beginning of June, stretching through October, according to locality). Spring (mid-February to March), and autumn (October to beginning of November) are transitional periods.

There are sufficient differences in the intensity of these seasons at different places for the division of Bangladesh into a few "climatic zones". The division may be made after Koeppen (1931), in which case, the whole country is a region of Megatherms, with half of it with Caw climate, most of the rest with Aw climate and the greater part of the south-east with AM climate. Following Thornthwaite (Kendrew 1961) four divisions based on precipitation and thermal efficiency can be defined-AwA, AwB, BwA and BwB. The homogenous nature of the large Bengal Basin, the effect of the long mountain chain all the way from the north-west to the south-east, and the moderating effect, not only of the sea, but of the abundant rivers, lakes, swamps and ponds, all modify to some extent purely theoretical divisions, which are in any case based on insufficient data.

Certain single-value climatic indices can be used in defining the climatic zones. Meyer's Quotient, which is normal precipitation to absolute saturation deficit of air (Meyer 1926), when worked out for the major stations shows that the range is from 200 to 700. The familiar pattern of north-west to south-east isopleths is revealed.

Map. 4.6


CLIMATIC SUB-ZONES
SCALE
0 20 30 40 60 100 MILES
0 30 40 60 80 100 120 KILOMETERS
90°E
92°E
26°N
24°N
22°N
HEAVY RAINFALL
C
HOT SUMMER
COOL WINTER
Rangpur
Dinajpur
D
HOT SUMMER
E
VERY HOT SUMMER
RELATIVEL LOW RAINFALL
Bogra
Rajshahi
MODERATE RAINFALL
Pabna
Kushtia
Tangail
B
HEAVY RAINFALL
Sylhet
MILD SUMMER
CLOUDY COOL WINTER
Mymensingh
G
MILD SUMMER
FAIRLY HEAVY RAINFALL
DHAKA
Faridpur
F
HOT SUMMER
Jessore
FAIRLY HEAVY RAINFALL
Khulna
Barisal
Comilla
Maijdi
Rangamati
Chittagong
Patuakhali
A
HEAVY RAINFALL
SMALL RANGE OF MEAN TEMPERATURES
Cox's Bazar
BAY OF BENGAL

Seven climatic sub-zones can be distinguished (Map 4.6) which are as follows:

(A) ***South - Eastern :*** This comprises the Chittagong Sub-Region and a strip of land extending from south-west Sundarban to the south of Comilla. The hills over 300 metres in height have zone B climate. The rest of the area has a small range of remperature, rarely going over a mean of 32°C and below a mean of 13°C. Rainfall in heavy, usually over 254 cm. In winter dewfall is heavy. If the Koeppen system is used this area would be classed as AM.

(B) ***North - Eastern :*** This includes most of east and south Sylhet and a wedgeshaped strip south of the Meghalaya Plateau. Here too, mean maximum temperature is rarely above 32°C but mean minimum is 10°C and below. Average humidity is even more than in zone A. In this sub-zone winter rain is appreciable. Fog is very common in winter. This is the cloudiest part of Bangladesh. The higher hills and mountains of the Chittagong Sub-Region can also be classified in this sub-zone.

(C) ***Northern part of the Northern Region :*** This is an area of extremes. In summer the mean maximum temperature is well above 32°C whereas in winter the mean minimum is below 10 zone C. The summer is dry, with a scorching westerly wind, but the rainy season is very wet, with 200 to 300 cm. of rainfall.

(D) ***North - Western :*** Except that the extremes are less and the rainfall is lower, this sub-zone is similar to C. The lower rainfall makes this area both atmospherically and pedologically drier. Meyer's N.S.Q. is mostly below 300.

(E) ***Western :*** This sub-zone comprises Rajshahi district (region) and parts of adjacent districts. This is the driest area in Bangladesh, with rainfall generally below 150 cm. and summer humidity less than 50%. In summer, it is the hottest and driest of all sub-zones. Mean summer maxima is over 35°C. Meyer's N.S.Q. is below 250.

(F) ***South - Western :*** Here the extremes of the sub-zones to the north are somewhat tempered. Rainfall is between 150 cm. and 180 cm. Mean summer maxima is below 35°C. Dew-fall is heavier than in sub-zone E. Meyer's N.S.Q. is slightly more than 300.

(G) ***South - Central :*** Rainfall here is again abundant, being above 190 cm. The range of temperature is, as can be expected, much less than to the west, but somewhat more than in sub-zone A. Meyer's N.S.Q. is between 300 and 350. This is a transitory zone between A, D, and F, and most of the severe hail storms, nor'westers and tornadoes are recorded in this area.

Chapter 5

Soils

The soils of Bangladesh have been classified in two different ways. The earlier method was by origin of deposition or parent material, whereas the more recent method had relied mainly on profile development. The earlier method provided a broad basis for initial work on agricultural improvement. According to this classification the soils were divided into three physiographic divisions and seven distinctive tracts (Islam 1967). The three physiographic divisions were hill soils, old alluvial soils and recent alluvial soils. The hill soils were generally neglected and lumped together as 'Tertiary rocks and unconsolidated Tertiary and Pleistocene sediments'. The old alluvial soils include two tracts of Pleistocene terraces, the Madhupur and the Barind. The recent alluvial division includes the Gangetic, Tista, Brahmaputra and coastal saline tracts.

The pleistocene terraces have soils of the Latosol group mainly clay, reddish to yellowish in colour, with numerous ferruginous concretions. Soil pH varies from 6 to 6.5. These soils are generally deficient in nitrogen., phosphorus, potassium and lime. The Gangetic alluvial tract (Map 5. 1) soils are comparatively rich in calcium, magnesium and potassium but deficient in nitrogen and phosphate. The parent material for much of these deposits is limestone and the soils can be described as lithomorphic. There is free calcium carbonate and locally strong alkalinity has been recorded. It is said that the pH varies from 7 to 8.5 (Islam 1967). In the Tista tract, the soils are sandy to sandy loam in texture, without any profile development, light grey in colour and deficient in lime (CaO). The pH varies from 6 to 6.5. The Brahmaputra tract soils are generally grey in colour, without developed profiles, and with pH from 5.5 to 6.8. For traditional low-yielding rice crops these soils are not deficient in Nutrients, but as with all other soils of Bangladesh, nutrients have to be added for high yields. In the coastal tract the soils appear to be developed in fine-textured tidal deposits and are comparatively rich in nutrients. In some restricted spots, usually recently cleared mangrove swamps, very acid sulphide soils, known as *Kosh*, have developed.

Nutrient status of the various soil tracts are given in Table 5.1. Since these soil tracts, as determined by the older classification, are large aggregates, the figures below serve merely as indicators.

Table 5.1
Nutrient Status in the Soil Tracts*
(Figures Represent Percentages)

Soil Tracts	N	PO_5	K_2O	CaO	Loss on Ignition
Madhupur	0.08	0.08	0.74	0.48	3.77
Barind	0.07	0.07	0.90	0.34	3.33
Gangetic	0.10	0.13	1.18	2.66	4.42
Tista	0.10	0.11	0.96	0.25	4.15
Brahmaputra	0.12	0.09	1.05	0.62	4.61
Coastal	0.11	0.12	1.40	1.00	5.44
Average	0.10	0.10	1.03	1.16	4.42

Source : Islam (1967)

* N =Nitrogen ; $P_2 O_5$ = Phosphorous ; K_2O = Potassium ; CaO = Calcium.

From 1961 to 1970 a number of reconnaissance soil surveys were carried out by the Directorate of Soil Survey with the help of the Food and Agriculture Organization (FAO) of the United Nations. These soil surveys covered over eighty percent of the country.

In these surveys the main soil unit recognized in the field was the Soil Series, which was defined to cover a range of soils derived from similar parent materials under similar condition of development and resembling each other closely in their major physical and chemical properties. Important subdivisions of the Soil Series was recognized as Soil phases. Instead of mapping individual soil units, which would result in very complicated patterns, the concept of Soil Associations was developed. It was found that most areas had only a few types of soils occuring in a definite relationship with each other. The relationship is usually topographical with soils of different types occuring at different levels. Though individual soil distribution therefore forms a very complicated pattern, the regular relationship of some soils made it possible for them to be grouped together in Soil Associations. Nevertheless the final picture is still quite complicated. In the Noakhali - Chandpur area (RSS 1966), for example, thirty three Soil Series were recognized and forty one Soil Associations were described. In addition to classification of soils the reconnaissance survey classified land according to its capability for agricultural production and also suggested crop suitability.

GENERAL SOIL TYPES

A general soil type is a group of soils formed in the same way, and which are broadly similar in appearance. The Soil Survey Project has identified 17 general soil types (FAO 1971) which are described below. The soil names in parentheses are those generally used by the FAO/UNESCO in the Soil Map of the world (FAO 1971). The information on soils has been rearranged and reinterpreted in the recently published "Land Resources Appraisal of Bangladesh for Agricltural Development" (FAO 1988).

The Black Terai soils (*Humic Cambisols*) have a very dark brown to black topsoil, one-third to one metre thick. These soils are medium to strongly acid in the upper layers, but less acid in the substratum. This soil type is found in the north of Physiographic sub-region 1 (Chapter 2), coincident with cropping pattern unit 1 (Chapter 13).

Noncalcareous Brown Floodplain soils (*Eutric Cambisols*) usually have a dark brown or dark greyish brown topsoil about 30cm thick and grades into yellowish-brown subsoil. The top soil is mainly medium to strongly acid but the subsoil is medium acid to neutral. This soil type is predominant in physiographic sub-region 1 (C.A units 2 and 3).

Calcareous Brown Floodplain soils (mostly *Calcaric Cambisols*) have developed in alluvium deposited by the Ganges river. Most topsoils are neutral to moderately alkaline. However, patches of strongly alkaline (pH 8.5-10.0) topsoils occur in western Jessore and southern Kushtia districts. These soils are called *Nonapanta* in Bangla.

Noncalcareous Alluvium (*Eutric Fluvisols*) comprise recent deposits of the Brahmaputra, Tista, Meghna and smaller rivers of the north and east. This soil type is mainly grey or greyish brown, silty or sandy, and neutral to moderately alkaline. Thick silty deposits of this alluvium suffers from slow permeability and poor aeration. This soil type is found mainly in the chars and diaras of the Brahmaputra - Jamuna.

Calcareous alluvium (*Calcaric Fluvisols*) comprises recent deposits of the Ganges and the Lower Meghna rivers. These soils are slightly to moderately calcareous and brownish grey to pale brown in colour.

Grey Flooplain soils (*Eutric Fluvisols*) are developed in non-calcareous alluvium and are among the most highly productive agriculturally. These soils are moderately acid to

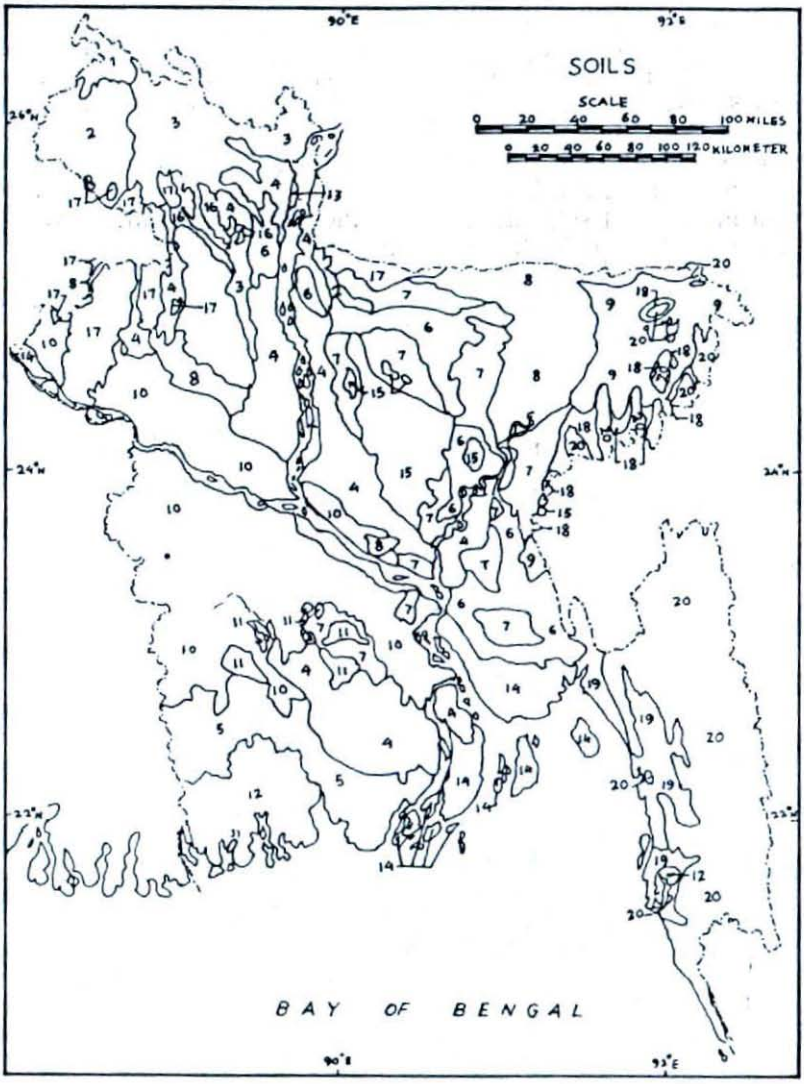
moderately alkaline. The cultivated topsoil and ploughpan are grey, with strong yellow or brown stains along root channels and some cracks. The subsoil is usually 15-50 cm. thick. The topsoil becomes near-neutral after continuous submergence for about two weeks, but becomes moderately to strongly acid on drying out. The subsoil is mainly neutral to mildly alkaline, but the subsoil of eastern Surma - Kushiyara floodplain, Chittagong coastal plain and some middle Meghna floodplain soils (Physiographic sub-regions XV, XXIV a/b, XVIIIb) are slightly to moderately acid. Soils in the Immature delta and on the Chittagong coastal plain often contain buried acid sulphate layers in the substratum which would become toxically acid if allowed to dry out.

Soil Tracts

1. Black Terai Soils
2. Noncalcareous Brown Floodplain Soils (dominant) and Grey Floodplain Soils
3. Grey Floodplain Soils (dominant) & Noncalcareous Brown Floodplain Soil
4. Grey Floodplain Soils, Nonsaline phase
5. Grey Floodplain Soils, Saline phase
6. Grey Floodplain Soils & Noncalcareous Dark Grey Floodplain Soils
7. Noncalcareous Dark Grey Floodpain Soils
8. Acid Basin Clays
9. Grey Floodplain Soils & Acid Basin Clays
10. Calcareous Dark Grey Floodplain Soils & Calcareous Brown Floodpain Soils
11. Peat
12. Acid Sulphate Soils
13. Noncalcareous Alluvium
14. Calcareous Alluvium
15. Red - brown Terrace Soils
16. Grey Terrace Soils & Deep Red - Brown Terrace Soils
17. Grey Terrace Soils
18. Grey Piedmont Soils
19. Grey Piedmont Soils & Grey Foodplain Soils
20. Brown Hill Soils

Source: Bangladesh Soil Resources, Soil Survey Project, Map 4, Technical Report 3 UNDP-FAO, Rome, 1971.

Map. 5.1


SOILS
SCALE
0 20 40 60 80 100 MILES
0 20 40 60 80 100 120 KILOMETER
90°E
92°E
26°N
24°N
22°N
BAY OF BENGAL

Clacareous Dark Grey Floodplain soils (*Calcaric Fluvisols*) occupy most of the Ganges river floodplain (Map 5.1) usually in association with calcareous Brown Floodplain soils. These soils are slightly sticky when wet. Basin soils, which are usually non-calcareous, crack widely when dry. Alluvial stratification is usually absent in the subsoil, which is usually 30 to 60 cm. thick. Some soils in central Rajshahi district contain a layer of hard lime Kankar (nodules) at a depth varying between one-third to two metres. The topsoil is near-neutral after submergence for about two weeks. On drying out it mainly becomes strongly acid, except on some calcareous ridge soils where it becomes moderately alkaline.

Acid Basin Clays (*Dystric and Eutric Fluvisols*) are grey to dark grey heavy clays, which are strongly to extremely acid. The topsoil is grey to dark grey, often strongly stained red or brown along root channels and cracks. It becomes hard and cracked when dry. There are peaty layers and silty substratum in some places. The topsoil becomes near-neutral after submergence of about two weeks, but is extremely acid on drying out. The subsoil is strongly to extremely acid. These soils occur mainly in the Haor Basin (Physiographic sub-region XIV).

Peat (*Dystric Histosols*) occurs extensively in the central Delta Basin areas (Physiographic sub-region XX). It may occur on the surface or be overlain by a clay topsoil. These soils are neutral when wet but become medium to strongly acid if allowed to dry out. Some soils near Khulna could become toxically acid (pH below 4.0) if drained.

Acid Sulphate soils (*Thionic Fluvisols*) resemble Grey Floodplain soils when wet, but become toxically acid (pH below 4.0) if allowed to dry out. They are characterized by high quantities of undecomposed organic matter, high proportion of Fe and Al salts in solution and a deficiency of phosphorus and nitrogen. Impeded drainage and undecomposed organic matter may contribute to their formation.

Such soils are mainly found in the Khulna and Chakaria (Chittagong), Sunderban tidal forest areas and some areas adjoining them. They are called *Kosh* in Chittagong, and the various types recognized are *Chuna* (Whitish yellow surface), *Tela* (black surface, with dense cover of *Scripes articulatus*), *Gubargia* (dark grey and waterlogged), *Ush* (dark grey, gelatinous surface), *Nuneya* (with a peaty layer), *Bhala* on which mangrove species grow) and *Hanga* (which can be cultivated with constant irrigation).

Grey Piedmont soils (*Eutric Gleysols*) are formed in hill outwash alluvium along the hill ranges of Sylhet (Physiographic sub-region XVI) and the plains of the Chittagong sub-region (Physiographic units XXIV a/b). These soils resemble Grey Floodplain soils, but are medium to strongly acid throughout, and are more prominently mixed with soils of redder colour in the subsoil.

Grey Terrace and valley soils (*Dystric and Eutric and Gleysols*) occupy most of the Barind Tract and the Susang Hills Peidmont (Physiographic sub-regions III and XII). On terrace and piedmont sites the grey, silty surface layer, 15 to 45 cm. thick, grades into grey clay. In valley soils the grey silty layer may be several metres thick. When dry the soils are slightly to strongly acid, but the topsoil becomes near-neutral after continuous submergence for about two weeks.

Deep Red-Brown Terrace soils (*Dystric nitosols*) are developed on the better drained parts of the Madhupur Tract, the north-eastern Barind, parts of the Lalmai Hills, and locally within the tila ranges of Sylhet and hills of the Chittagong sub-region. These soils comprise a brown loamy topsoil grading into a reddish-brown to yellow-brown friable subsoil, and then a strongly red mottled substratum several metres thick. Reaction is usually strongly to extremely acid throughout.

Shallow Red-Brown Terrace soils are widely developed on the Madhupur Tract (Physiographic sub-region XIII) and very locally in the north-west of the Barind Tract. These soils can mainly be classed as *Dystric Cambisols*, with very shallow soils as *Eutric Regosols*. The topsoil is usually grey and mixed brown, with a subsoil 30 to 60 cm. thick of firm clay in redder soils and porous loam in yellow-brown soils. The substratum is grey, partly mottled red or yellow-brown. With the exception of some very shallow soil with lime nodules in the substratum, most of these soils are strongly to extremely acid throughout.

Brown Mottled Terrace soils (*Dystric*, and some *Ferric, Nitosols*) are transitional between Grey Terrace soils and deep Red-Brown Terrace soils. The topsoil and ploughpan are mixed grey and brown with prominent red or reddish-brown mottles. The substratum, below 60 cm. is mainly red, mottled with pale brown and sometimes with black and grey. These soil are strongly acid throughout, but as with many of the other soils, the reaction of topsoils becomes near-neutral if submerged for about two weeks.

Brown Hill Soils (*Dystric Cambisols*) are found in the hills and mountain ranges of Sylhet and the Chittagong sub-region. These soils differ from Brown Floodplain soils in being more acid, and from Red-Brown Terrace soils in having broken rock or little mottled sand in the substratum. The properties of the topsoil vary according to the vegetation. Under forest, it is dark grey brown to grey-brown and consists mainly of earthworm casts for 5 to 7 cm. at the surface. Under tea, it is usually darker and thicker. Under arable crops or grassland, it is paler. The subsoil is one-third to one metre thick and strong brown to yellow-brown in colour, but often in patches which are quite red. These soils often include small rock fragments. In texture they are mainly silty clay loam throughout, but in some places may be silt loam or sandy loam. Reaction is mainly strongly acid throughout.

REGIONAL SOIL DISTRUBUTION

Northern Region

Black Terai soils occupy the Himalayan Piedmont Plains of Tetulia and Panchagar. In the Thakurgaon-Dinajpur area the ridges have mainly brown and dark brown loam, whereas the depressions have grey, dark grey and black loams. Most of the soils are permeable and puddling for rice cultivation is apparently diffcult. In the broad plain between the Dinajpur-Karatoa and the Tista rivers and along the Dharla and Dudkhumar rivers brown loamy soils occupy about 25 percent on ridges and in some areas they overlie sand at one third to one metre. These brown soils are permeable. Lower areas have grey to dark grey silty soils, which usually have a ploughpan impeding internal drainage. The same soils and ploughpan conditions obtain in the intermediate-level lands along the Brahmaputra-Jamuna and in the Little Jamuna valley in the Barind. In the Bangali-Karatoa floodplain, which is seasonally shallowly flooded, the ridge soils are grey and dark grey loams and the basin soils are grey and dark grey clays. The ridges here are flooded for a short period during the rainy season. Along the Atrai river silts predominate over clays in the upper reaches but, as is to be expected, clays predominate in the lower reaches. In the Atrai river valley, between the East-central and West-central Barind, the soils are mainly silty with about 20 percent sand. Further down the silts are on the swales and the basins have clays. In the upper part of the lower Atrai Bhar Basin the soils are mainly heavy clays, cracking

widely when dry and impervious when wet. In the lower part of the Bhar Basin, which is the lower course of the present Atrai, clays occupy about 80 precent, mainly in basins and the swales. The few higher ridges, which were levees of the Ganges when it flowed through this area, have calcareous loams. The basin clays here usually have an acid topsoil. The lower Mahananda floodplain and the high Ganges levee have soils similar to these above, but the proportions are different. Loamy, Calcareous ridge soils are more prevalent, though even here clays are predominant. The soils of the lower Purnabhaba valley are mainly heavy clays.

The north-eastern part of the Barind tract has deep red-brown, brown mottled and grey terrace soils, which are mainly silty. Permeability is moderate in red-brown soils but the other two have compact ploughpans. The rest of the Barind tract has mainly grey terrace soils with an impervious ploughpan and a slowly permeable substrata. The rolling, highly dissected areas of West-central Barind has clays on the hill areas.

Southern Region

Along the Ganges the chars and diaras have calcareous silts and sands with some loams in northern Faridpur. In the Moribund Delta clays occupy 60 percent in the west and 70 percent in the east, mainly in basins and the lower swales. The ridges have loams, with sand locally in the west. Small patches of high alkalinity occur on ridges in the west-central part. In the south-west there is often a peat layer in the sub-soil, and along the Immature Dela there are occasional patches of *Kosh (acid-sulphate)* soils. In the Mature Delta clays form about 80 per cent of the soils. In the Delta basins the soils are mainly peat and muck, sometimes with a clay topsoil. In the Active Delta the soils are mainly heavy clays with some loams on the swales. In the Immature Delta the soils are also mainly heavy clays and often acid sulphate.

The predominant soil of southern Bhola island and the numerous chars of the Meghna estuary is young alluvial silt. They usually become saline at the end of the dry season. The northeastern part of Bhola island has heavy loams. Further north the chars of the Lower Meghna (Mehendiganj area) have loams on the ridges and friable clays in the basins in the older formations and mainly silts in newer ones. The influence of the Ganges is seen in the calcareous nature of these soi.

Central Region

The active floodplain of the Brahmaputra-Jamuna has mixed sands and silts. In the intermediate-level land of the Old Brahmaputra floodplain the soils are mainly loams on the ridges and clays in the basins. On most of the soils a ploughpan impedes internal drainage. In the Susang Hills piedmont the basin clays are heavier and the ridge soils have a ploughpan. Along the channel of the Old Brahmaputra river the soils are mainly loams and sands on the ridges and loams in the swales with some clays in the basins. The soils are usually permeable. The floodplains along the Jamuna, Dhaleswari and Meghna have the usual combination of loams on the swales and clays in the basins, with heavy clays in the Arial Bil area. The Madhupur Tract has a complex soil pattern. Most of the upland has deep, moderately well-drained permeable clays, with heavy clays in the valleys. Some of the level uplands have impervious clay subsoil.

Eastern Region

The Haor basin has predominantly clays, both on the swales and in the basins. Further east, in the low and intermediate-level lands of east Sylhét the soils are mainly heavy loams and clays, with local areas of loamy ridge soils and peat in the deep basin centres. Permeability of the soils is low. In the lower parts of the Meghna river floodplain the soils are mainly light silts on swales with heavy silts and clays in the lower areas. On the Tippera Surface the soils are mainly silty in the north-west and a combination of loams and clays in the south-east. Permeability of these soils is mainly low. Along the Meghna estuary the soils are slightly calcareous silts in the south Noakhali and Hatia. The silts are finely stratified and permeability is likely to be low. In the dry season these soils become slightly saline. In the eastern plains the higher parts have light loams and the lower parts heavier loams. Compact ploughpans in the rice fields does impede internal drainage. In the coastal plains the soils are mainly loams, with some clays in basins and stretches of tidal clays along the rivers and along parts of the coast. In the Chakaria Sunderban area of the Matamori delta the soils are acid-sulphate with patches where nothing can grow. The hill areas of Chittagong sub region have mainly deep, well-drained loams derived mainly from Tertiary sandstones and shales. Some small areas are sandy or rocky. All the soils are fairly permeable, and are droughty in the dry season. The hill slopes are usually steep, with gradients often over 30 per cent, and soil erosion is a hazard in any exposed area.

Chapter 6

Vegetation, Forests & Fauna

The tropical climate and the fertile soil combine to clothe most of Bangladesh in an evergreen mantle. The greenery is very striking to the traveller from the western parts of the Indian subcontinent, who find the thick cover of trees and grasses and crops a delightful contrast to the dun and brown of the western semi-deserts. It is from the air that the vegetation looks its loveliest : the rows of graceful palms, the deep green masses of mango trees, the light green splashes of the clumps of bananas and the feathery bamboo, all arranged neatly around the huts and water tanks, make the countryside look like a garden.

The ten principal families of the plants found in Bangladesh, which has within it parts of the Gangetic plains and the Burmese botanical regions, are :

(1) Grasses *(Graminae)*
(2) Pulses, groundnut, tamarind etc. *(Leguminosae)*
(3) Sedges *(Cyperaceae)*
(4) Sunflower, gujitil etc. *(Compositae)*
(5) Some weeds of the rice field etc. *(Scrophulariaceae)*
(6) Cotton, lady's finger etc. *(Malvaceae)*
(7) Hargoza, basak etc. *(Acanthaceae)*
(8) Castor-oil, rubber, latkan etc. *(Euphorbiaceae)*
(9) Sweet potato, morning glory etc. *(Convolvulaceae)*
(10) Mint, basil and other herbs *(Labiatae)*

The following are also largely represented :

Bamboos *(Bambusae)*, Palms *(Palmeae)*, Garjan etc. *(Dipterocarpaceae)*, various vegetables *(Cucurbitaceae)*, Akanda etc. *(Asclepiadaceae)* and Champa etc. *(Magnoliaceae)*.

The most common tree of the countryside is the Mango *(Mangifera indica)*. This is a fruit tree, but often, when it does not fruit well, it is used for timber. Over most of north-central and north-western Southern Region it is the principal tree in the groves that surround the groups of huts (known as homesteads). For sheer numbers, the Betelnut palm *(Areca catechu)* ought to hold the second place. It is estimated that in Bangladesh there are 110 million of them. O.er

much of the Southern and the Eastern Regions, this palm is the most common tree of the groves. Along water courses and water tanks, the Madar *(Erythrina indica)*, Jiyol or Badi *(Lannea grandis)* and Hijol *(Barringtonia acutangula)* are the common trees. The Jiyol is a very common fencing as it grows readily from cuttings. Within the groves the Jak *(Artocarpus heterophyla)*, Jam *(Syzygium jambolana)*, Banana *(Musa sapientum and M. paradisiaca)* and in the south, the Coconut *(Cocos nucifera)* are the other common trees. Of bamboos, the Talla *(Bambusa tulda)* is the commonest. The Khejur palm *(Phoenix sylvestris)* and Tal palm Coconut *(Borassus flabellifer)* are generally grown at a distance away from the groves, around water tanks, along roads or on the narrow divides between the fields. The Rattan palm *(Calamus rotang)* grows in thickets in damp ground. Along the ditches and by the sides of the groves small flowering plants like *Homalomema aromatica, Crinum amoenum, Globba subulata, Alpinia bracteata* and *A. malaccensis, Hedychium flavum* and many others grow in crowded masses. In shaded damp corners, ferns such as *Actiniopteris flabellata, Hamionities cordata* and *Drymoglossum piloseloides* grow on trees and amongst the undergrowth.

Several varieties of orchids are common. Jibanti *(Desmostrichum fimbriatum)*, Budbar *(Eulophia muda)*, Rasna *(Vanda tessellata)*, Salibmisri *(Eulophia campestris)* and Shethuli *(Zeuxine strateurnatica)* are medical orchids used in the countryside. *Calanthe masuca* and *Dendrobium pierardi* are two of the most common orchids. Open spaces such as the edges of playgrounds, railway and road embankments, fallow fields etc. usually have a scattering of perennials like *Jatropha gossypifolia, Solanum indica, Argemone mexicana, Mimosa pudica,* and *Calotropis gigantea;* with the break of the monsoon rains these are almost choked with the rapid growth of various small Cassias *(sophera, tora and occidentalis)* and grasses, the most prominent of which are *Cynodon dactylon* and *Imperata arundinacea.*

Banyan *(Ficus bengalensis)* and Oshot *(F. religiosa)* are large trees, of the fig family, grown as shade trees. The rain tree *(Samania saman)*, another species which grows to a very large size, is also grown for shade. Some of the largest of these three species may be seen in the compounds of Government offices in the small towns, in whose shade there is usually a crowd of people. Trees of these species, measuring four and a half metre and more around the trunk (at one and a half metre from the ground) are fairly common. The swamps, ditches and many of the water tanks contain a rich variety of species. The water lettuce *(Pistia stratoites)*, duckweed *(Lemna minor)*, *Nasturtium palustre, Lepidium sativum, Vallisneria spiralis,* and the water-lily *(Nymphea stellata)* are common. Two of the most

interesting are the blue flowering *Euryle* ferox and the floating fly-trap *Aldrovanda vesiculosa.* The edges of the water courses and swampy areas usually favour the growth of reeds and large grasses, like *Arundo donax, Saccharum spontaneum* and various *Andropogons.* No account of the natural vegetation can be complete without mention of the Bengal Rose *(Rosa involucrata),* which is found in the Madhupur Tract. This white-flowering rose is remarkable in that it is the only representative member of a genus *(Rosaceae)* that is otherwise strictly extra-tropical. Various acclamatised garden roses also flower profusely.

Gardening has become quite popular in the urban areas and various strongly-scented flowers are widely grown. Among them the Queen-of-the-night *(Nyctanthes arbortristis),* Jasmine *(Jasminum officinale).* Rajanighandha *(Polianthes tuberosa).* Beli *(Tabernaemonta divaricata),* Bokul *(Mimusops elengi)* and Kamini *(Murraya exotica)* are common. Other common shrubs and trees grown are *Hibiscus rosa-sinensis, Hibiscus mutabilis, Gardenia florida, Michelia champaca, Saraca indica, Plumeria acuminata* and *Bougainvilla rosea.* Of seasonal flowers, the French and Indian Marigolds and the Cockscomb have been in favour for a long time. Pansy, Phlox and Snapdragon are not uncommon. Roses are favoured by the few discriminating gardeners. Of late flowers are being grown for commercial purposes and many florist have opened shops in urban areas.

FORESTS

Unlike most tropical areas, gregarious species are not uncommon in Bangladesh's forests. Sal *(Shorea robusta)* forms almost pure stands in the forests of the Central and the Northern Regions. In the Sunderbans, Gewa *(Excoecaria agallocha)* and Sundri *(Heritiera fomes)* grow in large gregarious stands. In the hill forests of the east, there are many stands of Garjan *(Dipterocarpus spp.)* only - a type of tree cover well known in Burma as Eng forest. These eastern forests are remarkable in possessing some species of tropical oaks and chestnuts.

In the past 20 years, the stock of trees in the forests have been depleted very rapidly. Large areas which were formerly forests have been illegally converted into crop land. The Forest Department has tried to establish plantations to recoup these losses but recent forest inventories have shown that more than half of these plantations have failed. Due to the rapid growth of population the pressure on forest resources has increased very substantially. The net result of all these is that the forest sector is in a state of crisis. The situation is particularly acute in the Madhupur Tract.

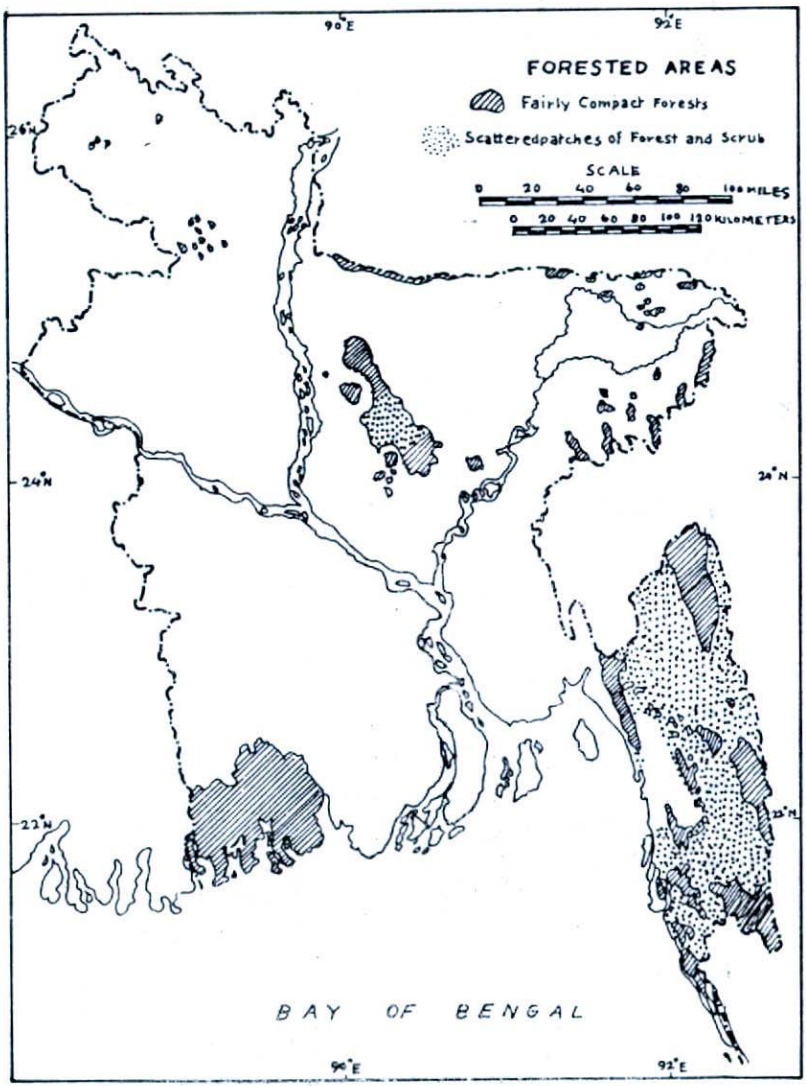
Table 6.1

Forest Areas by Divisions

(In sq. km.)

Sl. No.	Division	Reserved Forest	Protected Forests	Vested Forests	Acquired Forest	Unclassed State Forests	Khas Forests	Private Forest	Total
1.	Sundarbans	3584.78	-	-	-	-	-	-	3584.78
2.	Northern Division	5.50	16.97	46.43	30.97		-	-	90.23
3.	Tangail Division	-	-	95.28	75.57	-	-	-	170.859
4.	Mymensingh Division	-	-	10.66	272.56	-	-	-	283.24
5.	Dhaka Division	111.00	-	-	51.92	-	-	-	162.926
6.	Sylhet Division	242.94	-	-	71.80	56.70	12.61	32.22	516.29
7.	Chittagong Hill Tracts (N)	1026.46	-	-	-	1075.89	-	-	2102.35
8.	Chittagong Hill Tracts (S)	512.33	-	-	-	4386.87	-	-	4899.21
9.	Cox's Bazar Division	812.49	77.23	-	7.70	-	-	-	897.43
10.	Chittagong Division	733.76	140.98	19.83	33.19	-	-	-	927.78
11.	Comilla Division	-	-	-	5.67	-	-	-	5.67
12.	Jhoom Control Division	-	82.30	-	-	-	-	-	82.30
13.	Coastal Afftn Chittagong	-	-	-	45.98		5.67	-	51.66
14.	Coastal Afftn Noakhali	-	-	-	-		3.62	-	3.62
15.	Coastal Afftn Barisal	39.53	-	-	-		3.67	-	53.20
16.	Forest Ext (North)	-	-	-	-		.16	-	.16
17.	Forest Ext (South)	.032	-	-	-		0.8	-	.11
18.	Silvicultural Research	-	-	-	-		2.60	-	2.60
19.	Forest Res. Instt.	-	-	-	-		.16	-	.16
		7069.02	317.48	162.52	595.42	5619.46	38.59	32.22	138 34.80

Map 6.1


90°E
92°E
FORESTED AREAS
Fairly Compact Forests
Scatteredpatches of Forest and Scrub
SCALE
0 20 40 60 80 100 MILES
0 20 40 60 80 100 120 KILOMETERS
26°N
24°N
24°N
22°N
22°N
BAY OF BENGAL
90°E
92°E

The total area of forest is not accurately known because of the rapidly changing situation and different definitions used by different sources. In 1981-82, for example, the Forest Department claimed that there were 6.162 million acres of Government owned forest, but the B.B.S reported the area to be only 5.298 million acres. On the other hand, a break-down of the forest areas by Forest Divisions totals only 5.5 million acres (Table 6.1) . It should be noted that not all of the area under control of the Forest Department is under tree cover. According to the findings of the UNEP/FAO Global Environment Monitoring System, the area with tree cover is only 2.225 million acres (927,000 ha.). Out of this relatively small area, half (460,000 ha.) is in the Sundarbans, which shows that the tree cover in the forest areas of the hill ranges in the east is indeed alarmingly low. The area of government managed forest shown in Table 6.2 is the total area as defined by the Department of Forest and not that under tree cover only.

FOREST DIVISIONS

Chittagong Hill Tracts North : This division comprise the Kasalong Reserve Forests which occupies the upper valley of the Kasalong river and the headwaters of the Maini river, and some USF. It is 3384 sq. km. (1306.62 sq. miles) in area. The forest here is mainly of two types : tropical wet-evergreen and tropical mixed-evergreen. There are some significant differences between the two types. The former has an upper storey some 30 metres (100 feet) in height, formed by trees such as Chapalish *(Artocarpus chaplasha)*. Chundul *(Tetrameles nudiflora)*, Telsur *(Hopea odorata)*, Narikeli *(Sterculia alata)*, etc. The second storey is formed by trees such as Pitraj *(Aphanamyxis polystachya)*, Nageswar *(Mesua ferrea)*, Gutgutia *(Bursera serrata)*, Toon *(Cedrala toona)* and others. The last and third storey consists of such growth as *Murraya exotica* (Kamini). *Micronneluna pubescens, Panicovia rubiginosa* (Horina), *Clausens excaveta, Musa ornata* and *Garcinia anthocym* is (Zahiruddin 1959).

The second type has the first storey at a height of 45 metres (150 ft). It consists of trees such as Chundul, Narikeli, Civit *(Swintonia floribunda)* and Garjan *(Dipterocarpus pilosus and D. turbinatus)*. Garjan often grows to a height of 60 metres (200 feet) and a girth of 3.6 metres (12 feet.).

The second storey is of trees such as Tali *(Dichopsis polyantha)*. Kamdeb *(Calophyllum polyanthum)*, Raktan *(Laphopetalum fimbriatum)*, Khoirjam *(Syzygium cymosa)*, Chapalish and Nageswar.

Table 6.2

Government Forest Resources of Bangladesh

Forest	Description	Area Thousand Hectare	Official Removals[1] Thousand		Potential Output[1] m^3 p.a.
Tidal Forest	Mangrove type spp; variable composition; low productivity.	450-750	513		440
Hill Forest	Tropical ever-green; high variability in quality and productivity	520	92 130	timber small-wood	(dependent on clear-fell area)
Hill Plantation	Slow growing hard wood spp on clear--fell sites of variable quality	90		negligible	265-400 based on 30% - 50% yield
Coastal	Immature Mangrove spp	25	nil		n.a.
Plain Land Forest	Primarily sal in poor condition	95	nil		100
Total		1180-1300	735		805-940

1 Timber and Pulpwood only

Source : UNDP/FAO amended in some cases according to more recent information obtained from Forest Department.

The third storey consists of smaller trees like Sutagula *(Machilus bombacyms)*, Jiyal *(Lannea grandis)*, Hargoza *(Dillenia pentagyna)*, Haritaki *(Terminalia chebula)*, Gamar *(Gmelina arborca)*, Jarul *(Lagerstoremia speciosa)* and Chhatim *(Alstonia scholaris)*. The tree-fern-like *Cycas revoluta* is also fairly common.

Besides the many Dhepas (Ox-bow lakes), there are a kind of swamp forest-and-cane brake, consisting of trees such as Kainjal *(Bischofia javanica)*, Raktan and Pitali, and a luxurious growth of the cane known as Jaitbeth *(Calamus vininalis)*. As the Dhepas get silted up, Jarul and Jam tree spread into them. Scattered bamboo

brakes are common. In all the forests of the Chittagong Sub-region, micro-climatic and edaphic factors determine the vegetation to a very large extent.

Though it is fairly big, this forest division is usually third in the production of timber and sixth in the production of fuel amongst the nineteen division. This is due to its inaccessibility. Tucked away as it is, far in one corner of the Hill Tracts, a lot of obstacles have to be overcome before it can be more fully exploited.

Chittagong Hill Tracts South : This division consists of the Rangkhiang (Rinkheong), Sitapahar and Barkal Reserves. The Rangkhiang Reserve Forest occupies the upper valley of the Rangkhiang river and the left bank of the Upper Thega river and the headwaters of the Subalong streams. A steep ridges - Saichal Mual - divides this Reserve into two distinct parts.

The smaller Sitapahar Reserve is on both banks of the Karnafuli river about 72 km (45 miles) up-stream from Chittagong City. The Barkal reserve is situated on the left bank of the river Karnafuli, opposite Barkal Toll Station, 48 km (30 miles) from Rangamati.

Table 6.3

Estimated Current Production of Wood & Bamboo

	Timber (million cft)	Pulpwood (million cft.)	Fuelwood (million cft)	Total	Bamboo (million stems)
Hill Forests	4.77	0.71	8.43	13.91	81
Sundarbans	5.60	4.29	10.55	20.44	-
Other (approx)	3.00	-	7.00	10.00	-
Homesteads (approx)	50.63	-	177.02	227.65	830
Total	64.00	5.00	203.00	272.00	911

These forests include both types of evergreen forests and also some tropical, moist, deciduous riverain and open deciduous forests, along with bamboo brakes and patches of savannah. The main trees in the moist deciduous riverain type of forests are Kadam *(Anthocephalus cadamba)*, Banderholla *(Duabanga sonneratoides)*, Pitali and Shimul *(Salmalia malabarica)*. The ground is usually covered by Khagra *(Phragmites spp)* grasses. In the open deciduous forests the main trees are Champa *(Michelia champaca)*, Chikrasi *(Chukrassia tabularis)*, Koroi, Simul, Hargoza, Pitali, Banderholla and Toon. The Muli bamboo *(Melocanna baccifera)*

is also plentiful. In the open patches a weed, Assam Lota *(Eupatorium odoratum)* usually establishes a very strong hold.

The bamboo brakes are mostly of the secondary serial type, since they spread only where the forest cover has been removed by over-cutting or buring. Seven varieties of bamboos are found : Muli, Orah *(Dendrocalamus longispathus)*, Mitenga *(Bambusa tulda)*, Dalo or Dalu *(Teinostachyum dulloa)*, Kaliserri *(Oxyteranthera auriculata)*, Kali *(Oxytenanthera nigrociliata)* and Bazali *(Teinostachyum grifithii)* Muli and Mitenga are the commonest species.

The large patches of savannah consist either of Shon grass *(Imperata arundinancea)* or Khagra grass *(Saccharum spontenearn)*. In the Shon savannahs there are scattered trees, but none in the Khagra savannahs.

In the moister localities, there are small cane brakes. The main types of canes found are Gallak *(Calamus flagellum)*, Kerak *(Calamus talifolum)*, Jaitbeth *(Calamus viminalis)* and Bandari or Kiris *(Calamus tenuis)*.

The big-leaved mahogany *(Swietenia macrophylla)* was first tried out in a plantation at Dhamaiserra near Kaptai, in 1891. It proved to be a most successful exotic. Plantations of mahogany have now been made at other places. Among other exotics which seem to have a future in these areas are Padauk *(Pterocarpus dalbergioides)* Pyinkado *(Xylia dolabriformis)* and Black Wattle *(Acacia mollisecina)*.

The most successful exotic in these areas is, of course, Teak *(Tectona grandis)*. The first teak plantations were started at Kaptai in 1871. Since then plantations have been established in many areas, mainly in the Chittagong Region. Since it proved such a successful introduction, Chittagong teak is classed as better than South-Indian teak and just a little inferior to the best Burmese teak. The only serious drawbacks to its growth are the Teak Canker Borer *(Dihamus cirvinus)* and Teak Defoliators *(Hyblea puera)*.

JHUM (SWIDDEN) CULTIVATION

Apart from the reserve forests, there are large tracts of unclassed state forests in the the Hills of the Hill Tracts. More than half of the output of the Hill Tracts South Division comes from the unclassed state forests. The Unclassed State Forests are very badly exploited. Of the 5462.76 sq. km. said to be under this class of forests, it is estimated that only a quarter is under trees, the rest being bamboo, scrub and fields of imperata grass. The rapid deterioration of these "forests" is due

living memory is directly attributable to the shifting cultivators *(Jhumias)* common in the Hill Tracts. The Swidden system of cultivating (Slash-and-Burn) is common to all south-east Asian countries. It is called *Chena* in Ceylon, *Lading* in the Phillippines, and *Taungya* in Burma. Within Bangladesh it is called *Jhum* by the Chakmas and Bengalis, and *Lubueya* by the Mru. In this system of cultivation, a new plot is laid out when the Jhumia clears a patch of forest or scrub by cutting down the smaller trees and burning the under-growth. This is usually done in January and February. In the ash, rice (High land Aus), Maize, melons, cotton, seasum and several types of vegetables are all planted together in drill holes. The maize, melons, seasum and vegetables are ready from July onwards, the varieties of rice (High land Aus) are ready in September and October, while cotton in harvested in October and November. It is estimated that a small family can jhum, on an average, 5 acres of land, from which a favourable harvest is 3,000 lbs. of rice, 800 lbs. of cotton, 900 lbs. of seasum and a good crop of maize and vegetables (Hutchinson 1906).

Yields have, however, declined greatly in recent years, as the old ten-year rotation (i.e. jhuming on the same plot once every ten years) has been replaced almost all over by a three year cycle.

The shortening of the rotation is due both to the rapid increase in population and the creation of Kaptai Lake. Many Chakmas who were formerly plough-cultivators in the Karnafuli Valley had to resort to jhuming when the lake was formed. When the fertility of an area is exhausted, the jhumia moves on to a new place. The old area is quickly taken over by Assam Lota *(Eupatorium odoratum)*, bamboos or Shon *(Imperata arundinacea)*. It is obvious that this type of cultivation destroys the higher forest, spreads weeds, intensifies erosion and is not amenable with better methods of agronomy. In areas of gently undulating topography and low population density Swidden cultivation is acceptable, but in an area with very steep slopes and a high density of population in non-forested part, Swidden is definitely sub-optimal. A project to settle the jhumias on holdings based mainly on horticulture was begun in 1966 but has not progressed very far. (Rashid 1966). Terracing to hold up the steep hillsides can be seen at Barkal, but terracing is not common for want of material to hold them up. Bamboo stakes and mats to hold up the terrace sides are being experimented with. However, the solution seems to be in orchard and plantation-type cultivation, which usually does not require any terracing. Efforts should be made to expand horticulture by selected development of the more favourable slopes in the unclassed state forest area. Otherwise soil conservation will become a major problem in the not very distant future.

Cox's Bazar

The Cox's Bazar Division includes the forests reserves of Matamori, Chakaria, Teknaf, Razu, Garjania, Harbag and Khuntakhali. The Chakaria forest is in the delta of the Matamori (or Matamuhari) river. The species in it are more or less the same as in the Sunderban (described under that Division) except for the abundance of Chulia Kanta *(Dalbergia spinosa)* and Nunia *(Aegialites rotundifolia)* (Ghani 1954). The Teknaf forest occupies most of the Teknaf Peninsula. The large Matamori Reserve is the head-water of the Matamori river. The other forests are on the long ranges of hills that stretch from the Sangu to the Naf rivers. As in the other forests of the Chittagong sub-Region, the forest on the western faces of the hill ranges are usually open deciduous in type, and those in the vallys and eastern sides are Tropical Wet Evergreen or Tropical Mixed Evergreen in type. Garjan forests are characteristic of this Division. There are especially fine stands near Dulahazara, Idgaon and Maricha. Joseph Hooker described the Garjan as "the most superb tree we met within the Indian forests" (Hooker 1897).

There are beach forests of Jhau *(Casuarina equisetifolia)*. Kankra and Madar, with *Ipomoea biloba* undergrowth along the Southern Beach Plain. Rubber *(Hevea brasiliensis)* has proved a successful introduction some-what unexpectedly, and one of the oldest plantation is near Ramu.

Chittagong

The Chittagong Division consists of the large Sitakund, Patiya, Jaldi and Sangu forests. The Sitakund Reserve forest is on the Sitakund Range; the western side of it is open deciduous and the eastern Mixed Evergreen in type. Within this range is located the Silvicultural Garden at Hazarikhil. Among the various species which have done well in the garden are Rubber *(Hevea brasiliensis)*, Padauk, Pynkado, Bijosal *(Pterocarpus marsupium)*, Rosewood *(Dalbergia Latifolia)*, Majri *(Anogeissus acuminata)* and Sandalwood *(Pterocarpus santalimus)* Plantation of all these species, if successful, will greatly increase the forest wealth. Rubber has proved a success at several other places in the Chittagong Region and its cultivation on a large scale is being undertaken, mostly near Raozan. The forests of the Chittagong Division are composed of the same different types as found in other parts of the Chittagong Region.

Sylhet

The reserve forests of the Sylhet Division are divided into four sub-divisions (Ahmed 1959). The Habiganj Sub-Division contains the

forests of Raghunandan Hill and parts of Tarap Hill, Satgaon-Dinajpur Hill and Uchail. The total forests area here is 77.82 sq. km. The Moulvi Bazar Sub-Division contains the forests of West Bhanugachha (Lawachera), Borshijhura, Bhattera, Harargaj and part of Patharia and Satgaon-Dinajpur Hill. The total area here is 135.40 sq. km. The North Sylhet Sub-Division contains the Tilagarh, Bateshor, Ranikhai, Ratargul, Khadimnagar, Shari and Jaflong forests, with a total area of 12.97 sq. km. In the Sunamganj Sub-Division are the Lourgarh and Dipchor forests with an area of 5.30 sq. km. The private and the unclassed state forests adjoin these reserve forests. The forests of southern Sylhet (Habiganj and Moulvi Bazar) are tropical evergreen in type, with the forest cover in three storeys. The upper storey is composed of Garjan, Chapalish, Koroi, Chundul, Raktan and Banderholla. The middle storey has Chikrasi, Toon, Nagesher, Gamar, Rata *(Amoora Walichii)* and Gondori *(Cinnamomum cecidodaphne)* trees. Whilst the lowest one is composed of Jarul, Kanchon *(Buhinia spp.)* and bamboos. The bamboos found are Daral *(Melocalamus compactiflorus)*, Parua *(Bambusa teras)*, Pecha *(Dendrocalamus hamiltonii)*, Dallo, Orah, Bazali, Kali, Mitenga and Muli. The Muli bamboo of this place is of a poorer quality than that of the Chittagong Region. In North Sylhet and Sunamganj the forests are composed of Hijal, Jam and Jarul trees, and Nol, Khagra, and Ekra *(Erianthus revaneae)* reeds. The canes found in the Sylhet forest are Galla *(Damaenorps Jenkinsiana)*, Horna *(Calamus latifolius)*, Sundi *(Calamus guruba)* and Jaitbeth. These are much exploited. Another important product is the leaf of the Chhatipata *(Licuala peltata)* used in the making of wide brimmed hats (Jhapa).

Dhaka, Mymensingh and Tangail

These three Divisions can be considered together because most of their forests are contiguous. The main forested areas of these Divisions are in the Madhupur Tract, and are known as the Bhawal, Atia, Kagmari and Madhupur Garh forests (collectively called Garh Gazali). Each of them has numerous outliners, and are themselves cut into by fields and settlements. Most of the Atia and Kagmari forest no longer exists, having been converted to agricultural use by squatters. In the better forested tracts, such as Madhupur Garh, the main tree is Sal. Salcoppices are known as Gazari, and actually the Sal forests here consist almost entirely of the latter. Gajari does not grow to the height or the thickness of Sal. The Sal (Gazair) of this area is of third quality as far as growth is concerned. Besides Sal, the other trees are Ajuli *(Dillenia pentagyna)*, Kumbhi *(Careya arborea)*, Bahera *(Terminalia belerica)*, Jival *(Lannea grandis)*, Didha *(Laegerstroemia)*, Kaika (Adina *cordifolia)*, Gandhi Gajari *(Miliusa velutura)* and Chaplash. Undergrowth is scarce in stands

of pure Sal (Gajari) but is plentiful in other places. It consists of Fulkuri, Sotti (*Pennisetum setosum*), Sarpagandha, Kalomegh, Basak, Katakhai (*Bridelia retusa*), Cane (*Calamus tenuis*), Bon-Am (*Mangifera oppositifolia*), Chirata, Shonalu, and obnoxious weeds such as *Spatholobus, roxburghil, Entada ascandens, Mucana pruriens* and *Cuscuta reflexa* (shornolata). Bengal coffee (*Coffea bengalensis*) is also found, especially at Gupta Brindabon. In the poorer forested areas there are large tracts with Korii as the main species and an undergrowth of Kurchi, Akanda, Mankata (*Randia dumetorum*), Thatch grass (*Arundinacea cylindrica*) and *Mimosa pudica*. There is an almost complete absence of bamboos in these forests of the Madhupur Tract.

Along the Susang Ranges in the north, there are small strips of forests scattered in a thin line, 112.63 km. long. Only in Gazni Beat are the Sal trees good. At other places, the forest consists mainly of Fulkuri and Bamboos. Sal plantations here, however, show great promise since most of the mature Sal are of first quality in growth. Sir H. Champion classified this Sal as of the same quality as found in Gorakhpur in northern India (Choudhury, M.R. 1955).

Garjan, Cashew nut, Rubber, Coffee and Tendu (Disopyros *melanoxylon*) are being tried out in these forests. Possibly Coffee and Tendu have a good future here. Besides man and wild fires, the two most serious enemies of these forests are the defoliators - *Dasyichira horsfieldi* and *Antheraea paphia* (Tassar silk moth).

Northern

The Northern Division consists of patches of forests in the Northern Region. There are twelve scattered bits of forests in Dhamoirhat, Gobindaganj, Nawabganj, Dinajpur, Khansama, Birganj and Haripur Thanas. Most of the species here are common to the previous zones. The growth of trees here, is, however of third quality. Most of forest trees are Sal, a few Shonalu and *Hollarhina antidysenterica* are found (Choudhury, A.M. 1953). There are possibilities of good Shisham (*Dalbergia sissoo*), Kath (*Acacia catechu*) and Tendu plantations. Teak seems to do well in the rainier northern parts. These forest patches have been over-exploited and they are impoverished. Formerly they were private reserves but now they are under government control. Many small blocks of waste land are being taken under forest management and are being replanted, mainly by Simul, for the demand for softwood greatly exceeds the supply.

Sunderban

The Sunderban forest at the southern end of the Ganges-Brahmaputra delta streches from the Hoogly river to the Rabnabad islands, and extends inland, in places, as far as 160 km. Two-thirds of this forest (or more correctly, forested area) is within Bangladesh. The Bengali name for the Sunderbans is Shunder-Bon "Beautiful Forest". The derivation of the name is not quite certain. It may be a corruption of Shundri-Bon (Forest of Sundri trees), Samudra Bon (Forest near the sea) or Chandrabandha (a tribe that inhabited this area). The most likely explanation is its derivation from Samudra-Bone, but the generally accepted one is that it has been named after the Sundri tree (Pargiter 1985). When seen from the many waterways that crisscross the lower delta, it is indeed a luxuriant forest, with the forest trees in triple storey, palms growing in thickers and surprisingly trim grassy glades. The whole of the Sunderban forest are is in the "Reserved" category. In those blocks, where the trees are fully mature, the thickness of the forest over is surprising. From the air it resembles the Amazon selvas. The forest cover varies considerably from east to west, since the nature of the delta changes quite rapidly west of the Haringhata river. Two fairly distinct regions can be demarcated. The forest east of a line drawn from Kobadak Forest Station to Kata Khal near the mouth of the Haringhata river is the "freshwater" forest, whereas that west of it is the "moderately saltwater" forest. These terms are relative since even in the "freshwater" zone the salt content in the water is fairly high in summer. The water in rivers has a dominating effect since the land is below the mean high tide level. The main characteristics of this forest is that it is both estuarine and swampy.

The "freshwater" zone results from the larger quantities of water which flows down the Pussur, Haringhata and Burishor rivers and thus maintains the surface water at a lower level of salinity than is the case further west. In this zone, the main tree is Sundari *(Heritiera fomes)*, which yields a heavy but excellent timber. It comprises over 70 % of the forest cover between Haringhata and Pussur rivers, but diminishes to 50 % along the Arpangasia river. The Gewa *(Excoecaria agallocha)* is the next most important tree. It comprises 20 % of the forest in this zone. It yields a soft timber which is being extensively used in the newsprint factory in Khulna and in various match factories. It is the hardiest of all the Sunderbans species, flourishing in waterlogged areas, on dry river levees, and also right along the seaface. It is the first tree to appear when a towhead forms on the seaface.

Other trees associated with this area are Dhundul *(Carapa obovata)*, Amur *(Amoora cucullata)*, Pasur *(Carapa Moluccensis)*, Bain *(Avicennia tomentoa)*, Kankra *(Brugniera gymnorhiza)*, and Sondal

(Afzelia bijuga). All these trees are non-gregarious in character. Along the streams the common trees are the two palms, Hantal *(Phoenix paludosa)* and Golpata *(Nipa fruticans)*, the willow-like Keroa *(Sonnteratia apetala)*, and such small trees as Kirpa *(Lumnitzera recemosa)*, Shingra *(Cynometra remiflora)*, Sing *(Cynontetra bijuga)* Parash Pipal *(Thespesia populnea)*, and Ora *(Sonneratia acida)*. The most important weeds in this type of forest are Bhola *(Hibiscus tiliaceus)*, Kewa Kanta *(Pandanus odoratissimus)*, Hodo or Tiger Fern *(Achrostichum aureum)*, and Sundri-lota *(Browntonia lanceolata)*.

In the "moderately saltwater" zone, the Gewa becomes increasingly important. Sundri diminishes, Gewa increases and Goran gradually predominates as one goes south-west wards (Ahmed 1957). The Sundri remains fairly common as far west at the Khulna-Jamuna river. Goran *(Ceriops roxburghiana)*, Dabur *(Cerbera odallam)*, Karanj *(Pongamia glabra)*, Dimal *(Salacia prinoides)*, Kenkti *(Acanthus ilicifolius)*, Khalsi *(Aegiceras corniculata)*. Baen, Pasur, Bhola and Hantal are the other common trees in this western zone. Goran is the most common under-storey.

Along the sea-face and lower estuarine reaches in the west, four types of mangroves are found : Bhara *(Rhizophora mucranata)*, Goria *(Kandelia rheedii)*, Goran and Kankra. In the extreme south, amidst the sand-dunes, various species, common along the western coasts of the Bay of Bengal, such as *Mitreola oldenladiodes* and *Mitrascame alsinoides*, have established themselves (Fawcus 1927).

The main agents of destruction in these forests are man, wind, rivers and animals. But for the timely protection of these forest, beginning in 1875, most of them would have disappeared by now, due to excessive felling. Typhoons with wind speeds up to 200 kmph, can also do a lot of damage, as happened in 1965 and 1970. The shifting of the delta rivers is of course, an ever-present menace, but most of them being of a decaying nature, cause little damage. Probably the most destructive agents are the animals. The Chital Deer *(Axis axis)* is very fond of Keora leaves and fruits, and also cuts the young shoots of Sundari, Gewa, Amur and Golpata. Wild pigs and crabs too damage a lot of seedlings.

Recent resource inventories show that Government forests are being cut down at a rate greatly exceeding the cut allowable in the working plans. The result is that today's demand is being met at the cost of the crisis tomorrow. Much of the forest resources of the country is in the villages, where every homestead has trees and bamboos around it. It is estimated that the total volume of timber and fuel wood in the homestead forest is about 75 million cubic metres. But because of the

Table 6.4

OUTPUT OF FOREST PRODUCTS

Product	Unit	1974-75	1979-80	1980-81	1981-82	1982-83	1983-84	1984-85	1985-86	1986-87	1987-88	1988-89
Timber	Million cft.	7.6	13.7	15.3	17.3	15.4	19.7	17.4	19.8	12.8	10.1	13.3
Firewood	Million cft.	10.9	22.8	24.0	26.3	30.5	31.9	31.4	35.0	23.7	17.7	20.7
Golpata	Million mds.	1.8	1.8	1.8	1.8	1.7	1.7	1.6	1.7	1.9	2.1	1.8
Bamboo	Million nos.	67.0	78.1	74.0	77.9	92.3	92.0	76.9	75.8	92.6	100.3	117.6
Sungrass	Million bundles	1.6	3.7	6.7	2.4	1.4	1.3	1.3	0.9	1.7	1.5	1.7

population pressure this is a diminishing resourse on a per capita basis. The total volume of timber and fuel wood in the Government forest is only about 50 million cubic metres, much of which is in areas difficult of access in the hill tracts. These forests provide only a small part of the current consumption of wood and bamboo, as may be seen from Table 6.3. The protection of the beautiful Chital Deer vis-a-vis the protection of the forest is a difficult problem. These deer must on all account be protected, since they are the most beautiful of the larger animals in Bangladesh and their disappearance will be aesthetically most unpleasant, yet they have to be controlled so that they do not seriously affect the regeneration of the useful species.

Since the Sunderban forest is in the 'Reserved' category, the entry of wood-cutters and fishermen is strictly regulated. There are Forest Offices at Kaikhali, Kadamtala, Burigoalini, Kobada, Kasiabad, Baniakhal, Kalabogi, Nalianala, Sutrakhali, Dhangmari, Chandpai, Jewdham, Dhansagar, Sarankhola, Bogi and Supati. This forest was worked by a 20-year felling cycle but recent doubts about the rate of growth has led to a reduction of the annual cut till further research results are available.

FOREST PRODUCTS

Land hungry farmers and unscrupulous timber merchants have greatly depleted the Government forest land in the past two decades. Now the Homestead forest (Table 6.4) is being rapidly depleted because the demand for furniture, construction timber, fuelwood for cooking and for brick making has increased rapidly. The Forestry sector is in a state of crisis because the gap between demand and supply will be so large in the next ten years that, either all the Government forest will be depleted, or else economic development will slow down. There is a growing awareness of this crisis situation and with implementation of the Social Forestry Project the homestead forest area may be augmented. However, the pressure on Government forest land is ever-increasing and it will take a strong political will to reverse the present trend.

In the government managed forest the most important product is timber. Amongst the timbers of the Chittagong and Sylhet and ones most in demand are Teak, Jarul, Gamar, Chapalish, Gondroi, Boilom, Garjan, Kamdeb, Champ, Tali, Telsur, Toon, Chikrasi, Pitraj, Banderhulla, Chundul, Shimul and Civil, generally in that order. The main timbers of Dhaka, Mymensingh, Tangail and the Northern Division are Sal and some Koroi. The timbers of value supplied by the Sunderbans forest at Sundri, Keora, Baen, Pasur, Dhundul and Amur.

Table 6.5

Homestead Gardens & Woodlots
(excluding Hill Tracts Region)

Total Area under gardens & woodlots in villages	476,711 ha (1,177,377 acre)
Of which	
Area under trees	329,408 ha
Area under bamboos	147,303 ha
Total Number of trees in village area	312.30 million
Of which	
Fruit and nut trees (excluding banana)	220.38 million
Fuelwood and timber trees	109.92 million

Main fruit & nut trees (excluding banana)	**Number in millions**
Betelnut	109.76
Mango	33.30
Jackfruit	17.84
Coconut	17.37
Khejur	16.85

Main fuelwood & Timber trees	
Koroi spp. and Raintree	18.43
Madar (coral tree)	13.62
Shal / Gajari	8.96
Jiyol	8.88
Babla	5.73

Note : a) Banana is cultivated on about 50,000 ha.
b) Including the three districts of the Hill Tracts Region would probably increase the area under trees and bamboos by about 2 percent.

Source : Report on Survey of Farm Forestry, 1988 : April 1990, BBS, Dhaka

Timber is, of course, used in the manufacture of a large number of articles, more so because of the high price and scarcity of metal goods. The important timbers for furniture making are Teak, Jarul, Gamar, Chapalish, Boilom, Garjan, Kamdeh, Champ, Tali, Telsur, Toon, Chikrasi, Pitraj, Banderhulla, Chundul and Sal. The village groves supply a lot of mango, Jam, Jak and Koroi timber for the cheaper varieties of furniture.

For house posts Sunderi, Goran, Kandra, Pasur, Dhundal, Amur, Sal, Koroi, Civit, Garjan and Nageswar are used. Boats and parts of boats are generally made from Sunderi, Gamar, Raktan, Garjan, Kathal, Shal, Shonalu, Jarul, Chalta, Tamarind, Jam, Poreshpipol and Toon timbers. Tea chests are made from Shimul, Chundul, Uriam *(Mangifera longipese)* and Bahal *(Cordia dichotoma)*. Gewa, Shimul, Chatim and Kadam *(Anthocephalus cadamba)* are being used by the match industry. Dhundul is mainly used in pencil making. The large newsprint factory at Khulna uses Gewa wood as the main raw material. Its requirement are 90,000 air-dry tons a year. Hookah stems from Amur wood are made in Daulatpur. Sieve frames, brush-backs, ploughs, yokes, cartwheels, frames for ekka carts, handles of hoes and axes, paddy huskers (Dheki), [illegible] and toy boats are some of the other things made from timber. The bark of the Bhara *(Rhizophora mucronata)*, the bark and leaves of Genwa, the bark and fruits of Gab, the bark, fruits and roots of Goran, and parts of various other trees have a lot of tannin and are used to tan fishing nets and lately, leather. Firewood is a very important product. [illegible] there is a scarcity of fuel everywhere. Special firewood plantations are being planned at present.

Among the many other products from trees are Sal-Damar from Sal trees, an oleo-resinous substance used in making shoe polish, carbon paper etc.; Agor from Agar trees, used in making Agar Ater (scent); Gamboge, the gum resin from Tamal trees *(Garcinia morella)* utilised in dyeing the yellow silk cloth worn by Buddhist Priests and in making the Tilak powder used by Hindus in marking their foreheads the poison from the fruits of *Sapium indicum* used to poison fishes; and Garjan-oils used in making varnishes, and lithographic inks.

The leaves of the feather-leaved Golpata palm are extracted in large quantities and used as roofing material throughout the delta and also further afield. Only the outer fronds are allowed to be extracted. The stems of the slender fan-leaved Hantal palm are used as walking-sticks when thin, or as rafters when thick. The leaves of the Chhatipata palm are woven into large hats (Jhapas). Grasses, bamboos and canes form a very important part of the forest products. Shon grass, Khagra and Kash *(Saccharum spontaneum)* are extracted from all the forests with exception of the Sunderbans. They are used for thatching roofs. Thirty thousand tons of Muli bamboo is used in the large Chandraghona Paper and Rayon Factory as raw material. It is also very much in demand for making split bamboo mats. Of the other bamboos, Orah, Mitenga, Daloo, Katiserri and Kali are used for making the frames of rural houses, mats, water-pipes, masts for boats, cart-shafts, hand-fans, charcoal and a hundred other things. The Bazali bamboo is used in

Table 6.6

Quality of Some Common Timbers (Troller 1941)

(The Standard is Burmese Teak, compared to which the Chittagong Teak is slightly inferior)

		Weight	Strength as Beam	Stiffness as Beam	Suitability as post	Shock-resisting ability	Retention of share	Shear	Hardness
TEAK	(Tectona grandis)	100	100	100	100	100	100	100	100
JARUL	(Lagerstroemia Speciosa)	95	80	85	75	85	65	100	105
CHAPALISH	(Artocarpus Chaplasha)	75	80	75	80	75	85	100	90
CHIKRASI	(Chukrassia tabularis)	95	75	80	70	90	75	120	110
SAL	(Shorea robusta)	130	120	125	115	115	55	145	160
JAM	(Syzygium cumini)	115	90	100	95	100	60	130	120
JAK*	(Artocarpus heterophylla)	85	75	75	75	75	85	120	110
SUNDRI	(Heritiera minor)	150	110	130	110	130	45	150	175
PASUR	(Avicennia alba)	115	95	95	100	95	80	100	130
MANGO	(Mangifera indica)	95	75	80	75	100	95	105	90
GAMAR	(Gmelina arborea)	75	55	60	55	65	85	90	70
KAINJAL	(Bischofia javanica)	110	70	80	70	65	35	110	95
CIVIT	(Swintonia floribunda)	95	75	95	80	80	75	110	70
TOON	(Cedrela toona)	70	55	65	60	60	65	100	65
KADAM	(Anthocephalus indica)	70	65	75	65	80	75	85	60
KOROI	(Albizzia procera)	95	85	80	85	140	75	130	105
GARJAN	(Dipterocarpus turbinatus)	110	95	115	100	100	50	105	90
NAGESHOR**	(Mesua ferrea)	140	145	150	150	160	55	145	215
SHIMUL	(Salmalia malabaricum)	55	45	45	45	55	90	55	35

* Kanthal ** Nageswar

making umbrella handles. All types of canes are used in making furniture; Jaithbeth and Kris are also used in making baskets, and Kerok is turned into walking sticks and umbrella handles.

Honey and wax are collected in the Sunderbans mainly in April and May from wild bees' combs. The honey differs in taste depending on the flower from which it has been collected : that from the small yellow flowers of the Baen is probably the best in flavour. Some honey is collected from the forest of the Chittagong Region.

FAUNA

Animal life is fairly abundant. Not only the forests but the country side as well swarms with many different species of beasts, birds, reptiles and insects, but biodiversity is being reduced through damage to the environment. Bangladesh falls wholly within the oriental Zoological region. Within its bounds there are nearly 200 species of mammals, 650 species of birds, 150 species of reptiles and batrachians and over 300 species of marine and freshwater fishes.

Of **Primates**, there are monkeys, gibbon and lemur. The Rhesus Monkey *(Macaca mulatta)* is fairly common. The larger Hanuman *(Simnopithecus entellus)* is not common, but is found in the western and eastern border areas. Two other species of Hanumans are found in the areas bordering Burma. The crab-eating macaque is found along the Chittagong coast. The Hoolock gibbon *(Hylobates hoolock)* is found in the Chittagong sub-region. The curious Slow Loris *(Nycticebus coucang)*, a Lemur, is found in the densest forests of the east.

Of the **Carnivora**, there are six species of Felidae. The tiger *(Panthera tigris)* is the most famous and most feared of all. Those of the Sunderbans forests (known as the Royal Bengal Tiger) are notorious as man-eaters. There are few of them in the Chittagong sub-region. The leopard *(Panthera Pardus)* is much more common. It is remarkable that some of them manage to survive in thickly populated areas, far from forests, such as in Pabna District. The leopard cat *(F. bengalensis)* is common in all areas : it is a notorious poultry stealer. Three more species, the clouded Leopard *(F. nebulosa)*, the Marbled Cat *(F. marmorata)*, and the Golden Cat *(F. tenmincki)*, are found in eastern Chittagong sub-region. Melanism among the Felidae is not uncommon : Chittagong is probably the only place where a black tiger has been recorded. (Imperial Gazetteer 1909)

Of **Viverridae**, two Civits the large *(Viverra zibetha)* and the small *(Viverricula malaccenis)* are common in forested areas of the Eastern Region. There are two species of Mongoose, the common *(Herpestes*

edwardsi) and the small *(H. auropunctatus)*. Two uncommon and interesting animals are the Palm Civet *(Paradoxurus hermaphroditus)* and the Bintarong *(Arctictis binturong)*.

Of **Caninae**, the jackal *(Canis aureus)* is the most common. Its unearthly cry is a familiar sound in the countryside. A species of wild dog *(Cyon alipnus)* is found in the eastern forest: it hunts in packs and destroys numbers of deer and hog. The small Bengal fox *(Vulpes bengalensis)* is common. Two species of Otter *(Lutra macrodus and L. cinerea)* are found. Of bears, the Malayan Black Bear *(Ursus torquatus)* and the Sloth Bear *(Melursis Ursinus)* are found rarely, in the remoter parts of the Chittagong forests.

Of the **Insectivora**, there are many species of hedgehogs, tree shrews and shrews. The Chiroptera consists of many species, of which the large Flying Fox *(Pteropus giganteus)* is note-worthy not only for its size and its large roosts but also for the damage it does to fruits. The Rodentia are especially plentiful. There are five species of squirrels, of which the Malay *(Sciuropterus bicolar)* is the largest. The Mole-rat *(Nesocia bengalensis)* and the Bandicoot *(Nesocia nemorivaga)* are large rats. The Northern Indian hare *(Lepus ruficaudatus)* and the Hispid hare *(Caprologus hispidus)* are two fairly common species.

Not many species of **Ungulates** are found in Bangladesh nowadays. They used to be much more varied and plentiful till the beginning of this century. Two species of rhinoceros, the Malayan and the Sumatran, used to be found. They became extinct in this area hardly fifty years ago. Elephants *(Elephas maximus)* are found in the Chittagong sub-region and north-eastern Sylhet only. Some of the herds migrate into the higher mountains of Burma and India in the rainy season, but others remain within Bangladesh. They are strictly protected by law, but a few are probably killed by the tribes near the border. In the past there was a Khedda, or the catching of elephants in stockades, every few years : some of the animals were retained by the Forest Department and the rest were sold, mostly to foreign zoos. This has been discontinued and there is now a special reserve for elephants, near Teknaf. Of wild cattle, the wild buffalo has disappeared only recently, though it used to be plentiful in the Sunderban hardly 50 years ago. The Bon-goru or Banteng *(Bos sondaicus)* is a reddish brown wild oxen, sometimes tamed by the hill tribes. It is found mainly in the southern and eastern parts of the Hill Tracts District. The Magnificent Gaur or Asian Bison *(Bos gaurus)* is now almost extinct : it has been lately been reported only from Naikhongchari area of the Hill Tracts District. Formerly they used to range the whole of the Chittagong Region. The largest one shot in the area was eight feet seven inches in height (O' Malley 1908). Other rare and interesting animals are the Gooral

(Cemas goral), and serow *(Capricornis sumatrensis)* known locally just as 'wild goat'. These are varieties of goat-antelope. These have been found only in the southern parts of the Hill Tracts, Chittagong and on the steepest hill slopes.

Of **Antelopes**, only the Nilgai *(Boselaphus tragocamelus)* has been seen in Tetulia, in the extreme north-west, where these large animals came in the harvest season from the Nepal Terai but none have been sighted for two decades.

Of the **Cervidae**, the Chital *(Axis axis)* is plentiful in the Sunderbans, where it is protected. It has been introduced in Madhupur National Park, Mymensingh and also in the Pablakhali Game Sanctury in Chittagong Hill Tracts. The Barking Deer *(Muntiacus muntjac)*, is a small animal, fairly common in the forests of the Chittagong and Sylhet.. The large Sambar *(Cervus unicolor)* is found in the same area, but is becoming rare. The Hog Deer *(A. porcinus)* was found formerly in the Sunderban. The wild boar *(Sus scrofa)* is common in many parts of the country and is frequently met with even in densely populated areas. They are especially troublesome during the Amon rice harvest in the piedmont areas of the eastern hills.

The **Edentata** is represented by the Pangolin or Bonrui *(Manis pentadactyla)* which is, unfortunately, an ingredient of village medicines and is relentlessly persecuted.

Of **Cetacea**, the most common is the Gangetic Dolphin *(Platanista gangetica)* which is an interesting species confined to freshwaters. It is thought to be decreasing in numbers and may be endangered. The blunt-nosed Porpoise *(Orcella brevirostris)* is fairly common in the Bay of Bengal, and the large Fin Whale *(Balaenoptera indica)* and the Sperm Whale *(Physeter macrocephalus)* has been seen in the upper Bay. The curious Dugong *(Halicore dugong)* was known to have been fairly common along the coast in the early years of this century. There were reports of some having been seen at Mognama on the Chittagong coast in the 1960's, but with the destruction of the Chakaria Sunderban in the early 1980's, is unlikely that any survive.

Of over 900 species and sub-species of birds likely to be found in Bangladesh, only 220 are seasonal migrants and the rest are residents (Rashid 1967). Of the resident birds, 220 are confined to forests, so that deforestation is endangering a very large segment of the avi fauna (Harvery 1990). Among the resident birds, six are ubiquitous in the cultivated and urban areas. These are the House Crow *(Corvus Splendens)*, House Sparrow *(Passer domestieus indicus)*, Shalik *(Acridotheres tristis)*, Black Drongo *(Dicrurus macrocercus albirictus)*, Redvented Bulbul *(Pycnontus cafer bengalensis)* and the Pariah Kite

(Milvus migrans govinda). Nearly as common as these are the Doel *(Copsychus saularis)*, Tailor Bird *(Orthotomus sutorious guzerate)*, Pied Myna or Shalik *(Sturnopaster contra)*, common Weaverbird *(Ploceus phillippinus)*, White-eye *(Zosterops P. palpebrosa)*, Green Bee-Eater *(Merops leschenaulti)* and the common Kingfisher *(Alcedo athis bengalensis)*. At the time of the rice and chilli harvests, parakeet are a great nuisance. In the Chittagong Region, the Redbreasted Parakeet *(Psittacula alexandri fasciatus)* gather in flocks ranging upto ten thousand birds and swarm over the fields in October and November. In contrast, the vultures, though ugly, are very useful as they are scavengers. As can be expected in a country with so many water bodies, kingfishers are plentiful. So are other fishing birds, such as the Brown Fish Owl *(Ketupa zeylonensis leschenaulti)* and the Pallas Fishing Eagle *(Haliaetus leucoryphus)*. This latter bird is closely related to the Bald Eagle of North America. Of the winter migrants from Tibet, China and Siberia, the most notable are the ducks (gadwall, widgeon, sheldrake, pochard, etc.). In the Haor Basin, flocks of several thousand ducks are quite common. Of geese, the bar-headed *(Anser indicus)* is not uncommon along the larger rivers from November to March.

Of **Charadridae**, the Fantail and Pintail snipes *(Capella gallinago and C. stenura)* are very common in marshy areas. Lapwings, Plovers and Sandpipers are also common in many areas. The main game birds are the ducks, of which the Balihans or Cotton Teal *(Nettapus coromandelianus)* is the commonest; the Red Jungle Fowl *(Gallus gallus)* which is found only in the eastern forests; the common Green Pigeon *(Crocopus P. Phoenicopterus)*, and various Charadridae. The most-shot birds are, however, the Spotted Dove *(Streptopelia chinensis)* and the Paddy Bird *(Ardeola-grayii)*. The richest avifanua is found in southern Chittagong-Cox's Bazar area, Sylhet and the north Northern Region (with more than 1905 m.m. rainfall).

Among the **Reptilia**, the crocodiles are obviously the biggest. The swamp crocodile *(Crocodilus palustris)* was very common till the beginning of this century and was greatly feared as a man-eater. It is said to be extinct in Bangladesh but may still turn up in the Sunderban. The larger marine crocodile *(Crocodilus porosus)*, is found along the sea shore of Barisal and Khulna. They have not been reported from the Chittagong coast, except for one that was shot at Cox's Bazar in 1966. Around the Rabnabad islands they are not yet uncommon. The Gharial *(Gavialis gangeticus)* is a fish-eating crocodile, which never attacks people. It is an endangened specie.

Of the **Chelonia**, there are 18 freshwater species and 4 marine (found in the Bay). The Squamata are far more common. There are 21 species of

lizards, of which the House Geckoes or Tik-tiki *(Hemidactylus spp.)* are definitely the most common and best known. The larger Tokkay *(Gecko verticillatus)* is also well known because of its loud call of Tok-kay on hot summer afternoons and evenings. The various Varanus lizards, which grow up to 2.5 meters in length, are prized for their skins, and have been relentlessly hunted.

There are many species of snakes but none are very common. The most snake-infested area are the Rajshahi, Kushtia and Jessore districts. In most places, however, snakes are far from being common. The smallest is the Atal-Kuicha *(Typhlops braminus)*, barely seven inches long, and the biggest is the Reticulated Python *(Python reticulatus)*, upto seven meters in length. The Dhamon *(Zamenis mucosus)*, which grows upto seven feet, is the common Rat Snake : it is rarely disturbed by the farmers though it lives very close to the dwelling huts. The most dangerous species are the Cobra *(Naja tripudians)*, King Cobra *(Naja bungarus)*, Krait *(Bungarus caeruleus)* and Raj-shap or King Snake *(Bungarus fasciatus)*. The King Cobra and Raj-shap live largely on other snakes. Possibly a couple of hundred deaths are caused each year by snake-bites.

The **Batrachians** are not rich in species, but very much so in numbers. As soon as the first heavy showers of the rainy season commence, their cacophony from all low-lying swampy areas seems unending. Two of the more interesting species are the small greenish *Rana cyanophlyctis*, which jumps along the surface of the water when alarmed, and the huge *Rana tigrina* with a body nearly seven inches long (and much longer legs), and mouth so big that it is generally believed that it devours ducklings and small chickens occasionally. In the past decade frogs-leg have become an export item, and consequently some species of larger frogs have been decimated. This is having a detrimental effect on the environment, since natural control of insects is being reduced.

No attempt will be made to consider the legions of moths and other insects that abound, for the simple reason that there are more than ten thousand species of them, of which several hundred are beautiful and interesting. Mention must however, be made of the extraordinary Hawk-moths *(Sphingidae)* which resemble humming birds, when they hover over flowers for their nectar.

There are many types of fishes, and they have been considered in Chapter 12. Molluscs are abundant. Millions of fresh-water mussels are fished in inland waters. Along the coast, especially south of Cox's Bazar, molluscs are plentiful. The most common types are the Clams *(Meretris)*, Tops *(Trochidae)*, Horns *(Cerithilidae)*, Screws

(Turritellidae), Olives *(Olividae)* and Cowries *(Cypracidae)*. Quite rare species like the pearly Nautilus *(Nautilus pompilius and Amussium pleuronectes)* are sometimes dredged up.

Recently there have been moves to establish Biosphere Reserves. These are very necessary. Within the last half century the rhinoceros, wild buffalo and Barasinga deer have been exterminated from Bangladesh, and the Gaur and Sambhar are well on that way. The Barking-deer is ruthlessly hunted and may soon become rare. Destruction is not confined to larger animals. Hornbills and pangolins are in demand for their fat, which is used in village medicine. Young snipe and ducks are netted in large numbers. The highly interesting king-crab *(Tachyplues gigas)*, a living fossil, is sold for souvenirs. The government has notified the creation of four National Parks, seven Wildlife Sanctuaries and one Game Reserve, but these areas are not adequately protected due to lack of resources. At present, IUCN is working out a National Conservation Strategy with the government and it is expected that a Protected Areas System will be properly developed soon.

Chapter 7

Historical Background

The earliest references to areas in Bangladesh are mythological rather than historical. The Aitareya Aranyaka, Ramayana, Mahabharata, Vanaparvan, Samyutta Nikaya, Milindapanho and other works refer to the Vangas, Suhmas, Pundras and others living in the delta of the Ganges or to the east of it (Roy Chaudhuri 1943) : but none of these furnish any solid historical or geographical information. It is only from the first quarter of the fourth century B.C. that reliable accounts are available. The historians of Alexander became acquainted with accounts of a people called Gangaridai inhabiting the country around the lower course of the Ganges. Curtius, Plutarch, Solinus and Diodorus, all agree in placing the kingdom of this people beyond (east of) the Ganges. Diodorus states that, 'India is inhabited by very many nations among which the greatest of all is that of the Gandaridai, (Gangaridai) against whom Alexander did not undertake an expedition, being deterred by the multitude of their elephants'. Whether Alexander was really deterred by the elephants is open to doubt, but that the Gangaridai were one of the leading nations of the sub-continent cannot be doubted. The country of the Gangaridai can probably by identified with Purvadesa (Eastern country), inhabited by the Pundra. This country is mentioned in the Periplus of the Erythrean Sea as the Prasii. Recent research indicates that the capital city of the Gangaridai may have been at the present site of Berachampa, 30 km. N.E. of Calcutta and 20 km west of the Bangladesh border at Benapole (Banarjee 1985).

In his geography, Ptolemy refers to the five mouths of the Ganges : Kambyson, Mega, Kamberikhon, Pseudostomon and Antibole. The Kamaberikhon most likely followed roughly the present course of the Kobadak : the Pseudostomon may be identified with the branch that joined the ancient Brahmaputra near the present Bhola Thana : and the Antibole was probably the course of the Buri Ganga (Ray Chaudhuri 1943). The town of Tilograma, located by Ptolemy between the Kamberikhon and Pseudostomon, may probably be indentified with either Kotalipara or Gaurnadi Upazila (Map 7.1). This port was probably one of the two major ones in Bengal, the other being Tamralipti (Tamluk), in West Bengal. Tamralipti was one of the few places where Greek and Chinese traders and seamen met as early as the 1st century A.D. (Cary & Warmington 1929). It must be borne in mind

that the delta sea face nearly 2000 years ago was probably 50 to 100 miles further inland from where it is now.

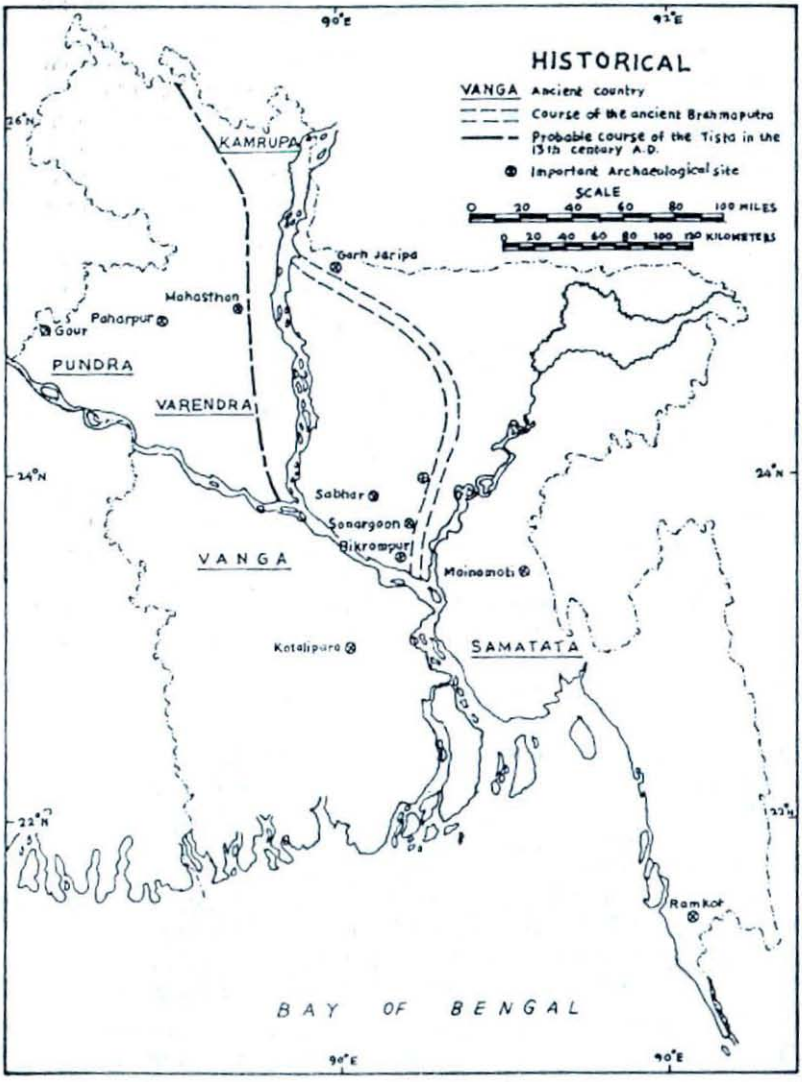
Till the coming of Muslim rulers in the thirteenth century, the various main divisions of the country were Varendra (North Bengal), Vanga (South Bengal) and Samatata (Most of Eastern Bengal). Central Bengal (Central Region) seems to have changed hands between these three. It is interesting to note that for over 1000 years the most powerful Kingdoms in the subcontinent were in the east. The Gangaridai, the Mauryas, the Guptas and the Palas all had their power base in the Benga- Bihar area. The latter three and probably all four, had very considerable cultural influence all over the sub-continent and far beyond.

The Indian sub-continent was to a large extent dominated by the Mauryan empire from the 4th to the 2nd century B.C. This empire had its base in the Bihar-Bengal region and most of Varendra formed the province (Bhukti) of Pundra Vardhana, with its capital at Pundranagara (present day Mahasthan). From various references it seems that this area was a stronghold of the Jains during the Mauryan period. However, Asoka tried to propagate Buddhism, and on the later evidence of Hiuen Tsang it seems that the stupa of Vasu Vihar near Pundranagara was constructed during Asoka's reign. Hiuen Tsang also wrote that Buddha preached in Pundranagara for three months. From this indirect evidence it may be surmised that Pundranagara was probably the oldest urban centre in Bangladesh, and dates back to at least the 6th century B.C. Northern Black Pottery sherds dating back to the 4th century B.C. have already been excavated and possibly much older material will come to light with further systematic work.

The next major empire in the north of the subcontinent was that of the Guptas, which flourished in the 4th and 5th centuries A.D. and declined in the 6th century. Varendra and the western part of Bengal seems to have formed a part of the Gupta empire throughout these three centuries. The area of origin of the Gupta dynasty is not known and there has been some speculation that they may have belonged to Gauda (present-day Murshidabad) area in West Bengal. Of the rest of Bengal Samatata seems to have been independent throughout this period, but Vanga and other areas were within the Gupta empire in the 4th and 5th centuries.

Several important sculptural pieces found in Bangladesh date from the late Gupta period (Ray 1943). These are the statues of Buddha in chunar sandstone from Biharail in Rajshahi district, an image of the sun-god Surya in basalt from Deora in Bogra district, a gold-plated statue of Manjusri from a place near Mahasthan (Bogra district), and a miniature of Surya in a chariot pulled by seven horses, from Deulbari in Comilla district. Architecture, too, was a flourishing art and Hiuen Tsang

Map. 7.1


HISTORICAL
VANGA Ancient country
Course of the ancient Brahmaputra
Probable course of the Tista in the 13th century A.D.
Important Archaeological site
SCALE
0 20 40 60 80 100 MILES
0 20 40 60 80 100 120 KILOMETERS
90°E
92°E
26°N
24°N
22°N
KAMRUPA
Garh Jaripa
Mahasthan
Paharpur
Gour
PUNDRA
VARENDRA
Sabhar
Sonargaon
Bikrampur
VANGA
Maimamati
Kotalipura
SAMATATA
Ramkot
BAY OF BENGAL

describes the monastery at Vasu Vihar as having "Spacious halls and tall storied chambers". (Saraswati 1943). The Mahasthan area, near Bogra town, is as yet full of unexplored sites and it can be expected that properly supervised excavations will reveal a great deal more about the history of urban civilization in Bengal. Another great site that has been only partially studied lies on the borders of Bangladesh and West Bengal. Here, at Gaur, the ruins of several ancient cities can be traced above ground, and excavations may reveal older ones beneath. Of this area Brown (1956) says : 'Within an area of several square miles in extent are strewn the concrete evidences of a paramount power's continuous occupation of these parts, as shown by the character of the remains, now grown over by rank vegetation, or submerged by the silt and the swamp. There can be few other sites in India containing such a wide expanse of noble ruins, of fortresses, palaces, citadels, immense causeways and embankments, towering city walls and trimphal archways, mosques and tombs, besides scores of derelio sculptures, all indicating that here was the common graveyard of several civilizations which have had their day and are now forgotten".

Early in the 6th century A.D. Vanga became independent and possibly dominated the whole of Bengal except the north-west. This may account for the general acceptance of Vanga-desa (Bangladesh) as the name of the country, even though Pundravardhana was the most advanced part of the country for many centuries. Late in the 6th century the north-west also became an independent kingdom, with the name of Gauda. This kingdom is memorable for two reasons : the reign of Sasanka (603-630 A.D.) and the development of the old Bengali language. Sasanka was one of the few rulers in the sub-continent to have successfully resisted Harsha, then the emperor of northern India. As for old Bengali, it developed during the Gupta period from the Eastern Prakrit and is today known as Gauriya. The script too, changed from Gupta Brahmi to Gauriya. Hiuen Tsang, the famous Chinese pilgrim, visited Bengal between 639-645 A.D. and wrote of the flourishing state of Buddhism in Samatata and Pundravardhana (Majumdar 1943a, Banerjee 1943). The Gupta period was undoubtedly one of the finest in the art of the subcontinent and much of this art originated in Bengal region. Gupta art influenced the later Pala art of Bengal, and all of south-east Asia during the period of their initial 'Indianization'.

Samatata and Vanga, situated on the Bay of Bengal, took part in maritime activities. There is considerable evidence that traders, merchants and missionaries journeyed to the south-east Asian mainland and the Indonesian islands (Bernet 1937, Coedes 1968, Ganguly 1943, Majumdar 1944). One of the earliest epigraphic record of Indian influence in these area is the Buddhaghosa tablet from the Kra

penisula (Thailand), dated about the 6th century A.D. (Indian Museum, Calcutta). The Sanskrit of the inscription is written in the Gupta Barahmi script. The earliest examples of inscriptions (on seals) from Oc-eo the part of Funan (Cambodia), are also in Gupta Brahmi. The flow of Brahmanism, and later of Buddhism, was accompained by the transmissal of architectural and iconographic ideas which found favour among the ancient Combodians, Chams, Mons and Javanese. The influence of Bengal grew over time, leading to the transmissal of Mahayana Buddhism, Tantric practices, sculptural forms and, most lasting of all, architectural forms. Whereas the period of transmissal began in the Gupta period, or even earlier, it reached its the peak during the Palas, and seems tohave ceased almost abruptly in the 13th century with the invasion of the Muslims (Rashid : 1974, 1977, 1979).

The century before the rise of the Palas was time of considerable political upheaval. Tsrong-san Gampto (c.600-650 A.D.) had made Tibet powerful enough to conquer Kamarupa (Majumder 1943a) and Samtata probably paid him tribute. Yasovarman of Kanauj also invaded Bengal and conquered all of it except Samatata. Most of Bengal was without peace till the Election of Gopala.

From the 8th century A.D. onwards we have a far better record of the history of Bangladesh than before it. About the middle of the 8th century, an obscure person named Gopala was raised to the throne of Pundra by the popular consent of lesser princelings. This Gopala seems to have been from Varendri, of noble lineage and a local hero. Apparently, to bring a semblance of order to the chaotic conditions prevailing then, he was placed on the throne (c 750-770 A.D.). Unfortunately very little is known of this memorable episode, which resulted in a long line of Kings, some of whom attained the status of emperors. Gopalas son, Dharmapala (c. 770-801 A.D.), embarked on an imperial course. He was helped by the mutual destruction of Rashtrakutas and the Pratiharas, two great powers, and managed to secure the acclaim of kingdoms as far as the Indus as the paramount monarch in the north of the sub-continent. Dharmapala was succeeded by Devapala (c. 810-850 A.D.) who not only defended empire against the powerful Rashtrakutas and Pratiharsas, but also managed to expand it, especially towards Orissa. After Devapala, the empire was whittled down by incessant uprisings and the rising of new important powers, the Chandellas and Kalachuris, in the Ganges Valley. Five rulers, between c. 850 and c.988 A.D. could not arrest the process. The Chandras and the Devas, set up independent kingdoms in the eastern and the southern region. There was a rally under Mahipala (c.988-1038 A.D.).. who, despite the alleged tour de force of the powerful Chola army, managed to restore most of the lower and middle Ganges valley to the Pala Empire. His son,

Nayapala (c.1038-1055 A.D.), managed to hold on to this, but after him came the final break-up, hastened by the invasions of the Kalachuris and Chalukyas. Even in its death-throes, the remarkable Palas managed a slight revival under Ramapala (c.1077-1120 A.D.). After him, there were four more Pala kings till the end of this noteworthy dynasty in 1160 A.D.

Vincent Smith says, 'The Pala dynasty deserves rememberance. No other royal line, save that of the Andhras, endured for so long, for four and a half centuries' (Smith 1914). The Palas did more than just endure : their patronage nurtured the arts and sheltered the remnants of the Buddhists in the sub-continent. The Palas were the last powerful Buddhist monarchs in the sub-continent. It was during their time that Santarakshita and Atisha Dipankoor taught in the monsteries on Nalanda and Vikramashila and later as missionaries, influenced the Buddhism of the Tibetans. Santarakshita, along with Padmasambhaya, was responsible for setting up the order of Lamas (Ganguly 1943). Buddhism was also actively propagated in south-east Asia. There was close contact between the Pala Kingdom and that of the Sailendra's in Suamatra. Pala-Sena art had immense influence in Orissa, Kashmir, Nepal, Tibet, Burma, Thailand, Sumatra and Java (Goetz 1964). The temples of Kalasan, Sewu, and Mendut (Java) and temples at Pagan in Burma are closely modeled on Gupta-Pala temple type (Goetz 1964). The influence of Pala art has been traced to Nepal, Tibet and the Tang art of China (French 1928) and the bronzes of medieval Java are very similar to their Bengal models (Goetz 1964). Of notable sculptures, there are few extant examples from Bangladesh : of these, the stone figures of Buddha from Ujani in Faridpur District and Varaha-Avatara from Salimpur in Bogra District are from the 10th century A.D.; the Vishnu Stela from Baghura in Comilla district is from the 11th century ; and the Chandi image from Dalbazaar in Dhaka District is from the 12th century (Ray 1943). There are several very good images of the Hindu goddess Tara in the Dhaka Museum, dating from the 9th to the 12th century. A.D. Besides these, there are interesting examples of Pala Buddhist sculpture in Dhaka, Mahasthan and Varendra Museums. There are also some extant examples of the painting of that period, some of which are in the Varendra Museums in Rajshahi.

The Pala period was one of extensive conquests, considerable developments in art and architecture and widespread trade and missionary activities. The very period known as the Dark Ages in Europe was certainly one of the brightest in Bangladesh and its adjacent regions. During the Pal period, several minor dynasties managed to flourish in the periphery of their empire. Two of them, the Chandras and the Varmans, ruled over parts of south-eastern Bangladesh and probably

the Arakan too. There were Chandra kings in Arakan from A.D. 788 to 957 (Phayre 1967). Lama Taranath, in his History of Buddhism refers to Chandras who ruled in the east of Bengal, from the 6th to the 8th century. Their capital was at the northern end of the Lalmai Hills. The Varmans succeeded the Chandras and ruled from the early 11th to the middle of the 12th century, till ousted by the Senas (Majumdar 1943b).

The Sena dynasty succeeded the Palas. They were originally from Karnata (in south India) but were settled a couple of generations in Rarha (part of the Indian State of West Bengal), before Vijayasena (1095 to 1158 A.D.) began his conquests. He seems to have quicky subjugated most of the Southern, Central and the Eastern Regions, for all their early land-grants were issued from Vikramapura (the present Bikrampur in southern Dhaka District). The long reign of Vijayasena is memorable in that it turned the tide against Buddhism, which had managed to flourish under the patronage of the Palas. From this period, Buddhism disappears from most of Bangladesh and a strong Brahmanical Hinduism, with considerable emphasis on caste distinctions, was fostered. Vijayasena was succeeded by Vallalasena (1158 to 1179 A.D.), who initiated 'important social reforms' amongst the Hindus, and enforced the ' 'revival of orthodox Hindu rites'. It was during his reign that the Pala Empire was finanlly extinguished. His son, Lakshmanasena (1179 to 1205 A.D.), began his reign by invasions of the middle Ganges valley (up to Beneres) but lost more than half his kingdom to the first Muslim invasion in 1204 A.D. The Senas managed to keep their hold on parts of the Southern, Central and Eastern Regions till well into the second half of the 13th century. Their rule saw a certain degeneration of the arts : 'sensuousness and grace were properties of earlier periods of Bengali art as well, but it was left to the Senas to allow them to degenerate into mere worldly lavishness' (Ray 1943).

At the beginning of the 13th century, the history of Bengal took a radically new course with the coming of Muslim conquerers. Muslim Arab traders had been trading and prosetelysing along the coast of Noakhali and Chittagong from as early as the 8th century, but they did not attempt to seize political control. More impetuous and imperious were various Turkic tribes of Central Asia, who had begun a series of invasions towards the end of the 10th century. In the course of one such invasion, the forces of Mohammad Ghori were defeated at Tarain by a Rajput confederacy. To avenge this, Mohammad Ghori came down from the mountain fastness of Afghanistan and on that very field of Tarain won a decisive victory in A.D.1192. (Prasad 1939). This was one of the greatest battles fought in the sub-continent. In 1204, Ikhtiar-Uddin Bakhtiar Khilji, an intrepid general of Mohammad Ghori, led an army into Bengal

and captured Nadia, the capital. Lakshmanasena fled east to Bikrampur (near Dhaka), where his descendents ruled for another half a century. During the region of Firoz Shah (1301-1322), most of Bengal came under Muslim control. On his demise his sons fought over the throne, thus affording Ghiasuddin Tughluk, Sultan of Delhi, an opportunity for invading and subjugating Bengal in 1328. The domination of Delhi was very short-lived. Three Governors were placed in charge of three parts of Bengal : all of them declared their independence, beginning with Fakhruddin Mubarak Shah (reigned 1338-46), the erstwhile Governor of Eastern Region. In 1352, Shamsuddin Ilyas Shah, the Governor of the Western Region, managed to conquer the Eastern Region, and thus establish the Ilays Shahi dynasty, which lasted a century and a half. There was, however, an interregnum, of great interest : a Hindu prince, Raja Ganesh, captured the throne and ruled for three years (1414-17). His son, Jalaluddin Shah (reigned 1417-31) was, however, converted to Islam. This interesting and unlikely interregnum was terminated on the death of Raja Ganesh's grandson, Shamsuddin Ahmad (1431-1442). Half a century later, a new dynasty was started by Hussain Shah (1493-1519), which lasted till the Mughal conquest in 1576.

The period 1338 to 1576, is known as that of Independent Bengal. Politicially it was an era of Turkic domination. Most of the rulers (and the armies) were Turkish in origin but became increasingly Bengali with the passage of time. The 28 years interregnum has, however, 'a special niche in the history of Bengal literature for the revolution that took place both in the sphere of politics and in the realm of literary and cultural activities' (Haq 1957). *Krittivasa*, the composer of the Bengali *Ramayana*, was Patronised by Jalalauddin, and it is very likely that *Chandidas* was patronised by Shamsuddin. There had, however, already been a literary revolution before the rise of Raja Ganesh, for Shah Muhammad Saghir, the earliest muslim Bengali poet, had written his 'Yusuf-Zulaikha' sometime between 1389 and 1409 (Haq 1967). The widespread acceptance of Bengali shows an early fusion of Islamic and local cultures.

Throughout the six centuries of muslim domination in Bengal, people immigrated from all the muslim lands to the west. Turks, Arabs, Pakhtuns, Persians and muslims of many other extractions came and settled down. Much of the east and south was at that time a fairly thinly populated frontier area. New settlements were made and old ones expanded. Sonargaon, on the course of the old Brahmaputra, grew into one of the largest cities of the sub-continent, and was the centre of a large trade of muslins cloth. The centre of muslim power in Bengal was, however, further west, on the borders of the present Rajshahi district, where Firozabad, the capital of the Northern and the Western Regions

for a long period, was situated. These places were visited by the famous traveller Ibn-Batuta in 1345 and by the Chinese ambassador M'Huan in 1406. The latter's account of the Kingdom of Bengal is very interesting, and a small part may be quoted here : "The Kingdom of Pang-ko-la (Bengala) is reached by ship from the Kingdom of Su-men-Ta-la (Sumatra). A course is shaped for the Maoshan and Tsuilan (Nicobar) islands. These being reached, the vessel has to steer north-west and being favoured by a fair wind for 21 days, arrives first at Cheh-ti-gan (Chittagong) where she anchors. Small boats are then used to ascend the river up which at a distance of 500 ft or more, one arrives at a place called Sona-urh-kong (Sonargaon) where one lands. Travelling from this place in a south-westerly direction for 35 stages, the kingdom of Pang-ko-ta is reached. It is a kingdom with walled cities and in the capital, the king and officials of all ranks have their residence. It is an extensive country, its products are abundant and its people numerous : they are Mohammedans and their dealings are open and straight forward. The rich built ships, in which they carry on commerce with foreign countires. Many are engaged in trade and a goodly number in agricultural pursuits. They are a dark-skinned race, although you occasionally see among them light-skinned persons. The language of the people is Bengali. Persian is also spoken here. Not having tea, they offer their guests betelnut in its place. They manufacture a white paper, from the bark of a tree, which is smooth and glossy like deer's skin. The currency of the country is silver coins, but for small purchases they use sea-shells called Kaoli (Cowrie)" (Taifoor 1952).

This was a period of vigorous architecture. The Satgumbaz mosque of Bagherhat, the mausoleum of Shah Ali Baghdadi at Mirpur, the mosque of Rasti Khan at Hathazari, the large Adina mosque at Pandua (Malda, West Bengal) and many other monuments of this period have massive arches and bold clean lines with the minimum of ornamentation ; the keynote was utility and simplicity, for this was one of the marches of medieval Islamdom. In building these early structures, however, immense damage was done to the Jain, Buddhist and Brahmanical structures. Referring to the Adina mosque, Brown (1956) says : 'Many temples and palaces appear to have been dismantled to provide the amount of stone required and it is not improbable that the finest monuments of the Hindu capital of Laknauti were demolished in order to produce this one Mohammadan mosque'.

From early 16th century, began the stream of European travellers, traders and pirates, which was to grow rapidly in size and importance. Nuno da 'Cunha initiated Portuguese trade with Bengal in 1529 (Hunter 1899). Portuguese piracy in the Bay of Bengal and along the Bengal coast began with the visit of Joao de Barros' 'Asia', published in

the 1550s contains much information and a map of Bengal, which has the distinction of being the first published after Ptolemy. The first Bengali printed books (in Roman characters) were brought out in Lisbon in 1743. The wealth and beauty of Bengal had already caught the imagination of these adventurers. In Os Lasiadas we hear Camoes praise Chittagong and Bengal :

> Ve Cathigao, Cidade das Melhores,
> De Bengala, provincia que se preza,
> De abundante; mas olha que esta posta
> Para O Austro d'aqui virada a costa.*

* Chittagong is the most beautiful city of Bengal, the provice of abundance, and there is no other city to compare with it on that coast

To the Portugues also goes the distinction of having attempted the first scientific classification of the flora : the first botanical names of some plants collected in Bengal were published by Garcia de Orta in his Colloquios in 1563 (Campos 1919).

Among other European travellers notable are Ludovico Varthema of Bologna, who visited in 1507, and Le Blanc of Marseilles, who visited in 1576, the year the fortunes of the independent muslim kingdom of Bengal took a new turn.

In 1526, the sub-continent had experienced an invasion by a new confederacy of Chagtai Turks under Zahiruddin Muhammad Babar, who was to lay the foundation of the Mughal empire, which fostered one of the greatest of the late-medieval civilizations. The Mughal Empire-building was almost extinguished by the meteoric career of Sher Shah Suri, an Afghaan chieftain of Bihar and Bengal, who expelled Babar's successor, Humayun, from the throne. Unfortunately, he died within five years of his accession to the throne and his empire dissolved in anarchy within a decade, enabling the Chagtais, with help from the Persians, in restoring the dynasty of Babar to the throne. Though his reign was very short, Sher Shah proved himslf one of the greatest of medieval monarchs. He reorganised the civil administration, initiated an extensive land survey, reformed the revenue system, greatly improved the road system, and enforced law and order with a great measure of justice and religious toleration. He showed a greater concern for the common man than any other medieval ruler in the sub-continent and, rightly believed that 'it behoves the great to be always active' (Prasad 1939).

In 1556, Akbar acceded to the throne of the small Mughal Empire, and rapidly enlarged it to one covering almost the whole of the sub-continent. In 1576, the last King of independent Bengal, Daud Khan, was defeated by Akbar's generals and Bengal was made a province of the

empire. The last of the independent chieftains, of whom Isa Khan is the most famous, was not reduced till 1612, when Osman Khan Ghuznin Lohani was defeated at Nekujhail in the Madhupur Tract. One effect of Mughal domination was the transmissal of Bengali architectural forms to northern India. The Ain-i-Akbari states that within the Agra fort there were built 'upwards of five hundred edifice of red stones in the fine styles of Bengal and Gujarat '(Brown 1956). Structures, with the typically Bengali curved cornice, were built by the Mughals throughout their empire.

The three great Mughal emperors kept Bengal within the pale of their empire, but on the death of Aurangzeb, in 1707, there was soon semi-independence. During the Mughal period there were four outstanding governors (Subedars) of Bengal. Islam Khan, who was governor from 1606 to 1613., raised Dhaka (Dacca) to the status of the capital of Bengal in 1608. He managed to consolidate Mughal rule. The next outstanding governor was Shaista Khan, who held the post twice (1664-77 and 1679-89). He crushed the Portuguese pirates and wrested Chittagong from the Arakanese in 1666 (Sarkar 1919). The rapid disintegration of order in the Mughal Empire since 1707 was hastened by the rise of the Mahratta freebooters and hordes of armed Sannyasis and Fakirs (Ghosh 1930). In this troubled period, Murshid Quli Khan gave thirteen years of peace (1714-1727) to Bengal. The tide of disintegration and chaos, which led to foreign domination, was kept in check by Aliverdi Khan from 1740 to 1756. But his was rearguard action, for within a year of his death the English armed-traders were in control of the country.

In the millenium from the 8th to the 18th century, Bengal was the goal of many immigrants, who considerably altered the physical stock of many parts. Arabs settled in the south-eastern coasts. From the 11th century, there had been a steady inflow of persons of Turkic extraction. The Ghaljis, Ghoris and Mughals were all Turkic. A good many of those who passed as Persians were in fact Afshar Turks from north-eastern Persia (Khan 1902). The largest Afghan tribe, the Ghalji (or Khilji) are of Turkic origin, and many of the Pakhtun tribes are part-Turkic (Caroe 1958). There was considerable immigration of Pashtu-speaking people (Pakhtuns) in the 16th century when Bengal was one of their strongholds. During Mughal times, Afshar Turks and Persians (Iranians) found much favour and large numbers came from the Persian Empire to seek their fortune. Not all of this immigration was direct. Much was of second and third generation Turks and Persians from the Punjab and Delhi. It is an interesting reflection of the Mughal times that Murshid Quli Khan, though he had a unimpeachable 'Pathan' name, was the son of a Brahmin brought up as a Muslim.

The Mughals were great builders, but Bengal severely restricted their genius. There is little stone at hand and the mighty rivers flood almost every other year. The luxuriant vegetation swallows up whatever is neglected for only a few seasons. Even thus restricted, the Mughals have left some worthy structures, of which the Boro and Choto Kattra, Hussaini Dalan and mausoleum of Bibi Peri are the best examples. The best of the Muslim poetry of that age was however written at the court of the Arakan Kings, who, till 1666, ruled upto the Feni river. Daulat Qazi (1600-1638) and Alawal (1607-1680) held posts in that court and also composed some of the best Bengali literary works extant. The eclipse of Bengali at the court of Bengal was due to the enforcement of Persians as the court language and the continual encouragement of Persians by the imperial monarchs. This does not mean that education was hampered : it was estimated by F. Max Muller that in pre-British times Bengal had 80,000 schools, or one for every four hundred persons.

From the coming of the Portuguese, the overseas trade expanded as rice, cloth, timber and slaves were shipped out. The slave trade of the regions around the Bay of Bengal is as yet a subject not well documented. That there was large-scale slave trade cannot be doubted. Bernier stated that 42,000 slaves were shipped out in the period 1621-1624 (Campos 1919). The Dutch shipped rice and slaves to Java (O'Malley 1925) and many Jakartans are said to be descended from 'Indians' of that time. Slaves were also shipped to the south and west coast of India and even to the Persian gulf ports. This nefarious practice was greatly restricted after 1666.

The visits of Europeans had gradually increased from the early 16th century. Notable among these travellers from the west were Le Blanc of Marseilles (1507), Linschoten (1583-89), Ralph Fitch (1586), Melchior de Fonseca (1599-1600), Tavernier (1641 and 1666), Sebastian Manrique (1628-41), Bowrey (1640) and Bernier (1666). The abundance of goods in the flourishing markets of Bengal was a constant source of wonder to all of them. Manrique wrote: 'Money is so plentiful in Dhaka, that it is seldom counted, but always weighed.* There is a profusion of food and other articles in the numerous bazaars of the city. The vastness of wealth in the city is stupifying'. A few years later, Thomas Bowrey stated that, 'Dhaka is an admirable city for its greatness, for its magnificent buildings and multitude of inhabitants' (Bowrey). Even the hardbitten Bernier was moved to say that, 'In a word, Bengal is a country abounding in all things'. Before the British times, Bengal (especially the part in Bangladesh) was very prosperous but its halcyon

* That was probably because cowrie shells were also used as money.

days were almost over. Thomas Roe, at the court of Emperor Jehangir in Delhi, remarked, "That Bengala should be poor, I see no reason : it feeds this country with wheat and rice: it sends sugar to all India ; it hath the finest cloth and pintadoes, musk, civet and amber' (O'Malley 1917). Roe's information concerning the state of Bengal was incorrect, for it was then the wealthiest part of the subcontinent and one of the most prosperous lands in the world, but his words were prophetic, for soon that wealth was drained to enrich others and leave the source impoverished.

The testimony of traders and travellers in the seventeenth century are alike in that they considered Bengal a very prosperous land. It had a flourishing trade in muslin cloth, silk and coarse cottons. As early as 1680, the English merchants trading with Turkey and the Levant complained : "We export woollen manufactures and other English wares, and import raw silk, drugs, cotton, and the like, which are all manufactured in England, and afford bread and employment to the poor. But this East India Company is sending away precious metal out of the Kingdom in return for a deceitful kind of raw silk which will destroy the Turkey trade' (Wilson 1895). The ugly cloud of early industrial capitalism and economic imperialism was growing bigger. The desire to import cheap raw materials and export expensive manufactured goods was one of the strongest factors working for the growth of British power in Bengal. The temptation was strong and at the accession of the weak and vacillating Sirajuddaulah, to the governorship of Bengal, the British contrived to win the upper hand at the Battle of Polashi (Plassey) in 1757. The issue was, however, not clearly decided till they had won the hard-fought battles of Katwa and Buxar in 1764. In 1757, the British obtained Calcutta free and secured the revenue of the 24 Parganas (revenue units) around it. In 1760, they secured the revenue of Chittagong. Five years later they finally got the Diwani (revenue administration) for the whole of Bengal from the Emperor Shah Alam. This was quite unnecessary since they had been in effective possession of Bengal from 1760.

The period from 1760 to about 1820 is one of the darkest in the history of this region. The country was bled white. The British traders of that age were imbued with a "spirit of plunder" and a passion for the rapid accumulation of wealth" that led to extreme misgovernment and much misery to the common man. In this half-century, the old prosperity of Bengal was battered and her wealth drained out. So callous were the new administrators that, during the terrible famine of 1772, the land revenue was, in many cases, increased instead of being remitted altogether. This scourge carried off a third of the population and large tracts were abandoned to the jungle. Far worse than this terrible calamity was the

continued flow of tribute (in different forms), which drained the capital wealth of the country and chained it to the rising industrial capitalism. There is a strong case for the argumment that, the wealth drained out of Bengal and the lure of the Bengal market both contributed to the capital accumulation during the Industrial Revolution. The so-called reforms of Clive were not to ease the oppression on the "natives", but to prevent the East India Company's servants from appropriating the Company's share. After his "reforms" the annual "remittance" to Britain was more than ninety-six million rupees - very much more than before (Dutt 1906). The author of the Seir Mutaquerin lamented : " The vast exportation of coin which is carried every year to the country of England : it being common to see every year five or six Englishmen or even more, who repair to their homes, with large fortunes" (Khan 1902). Not that the more nobleminded among them did not know it. Edmund Burke rebuked : "The Tarter invasion was mischievous, but it is our protection that destroys India" (Dutt 1906).

The textile industry of Bengal (especially of Rajshahi and Dhaka in Bangladesh) was in a flourishing state for several centuries prior to the British invasion. It was, in fact, the textile trade which was the prime motive for the later armed aggressions. Immediately after the defacto control of Bengal in 1760, the British trader-officials began a systematic plunder of the country through their Gamashtas (agents), who compelled the weavers to accept very low prices for their goods. The vast drain of wealth may be judged by the fact that, in the years 1766-1768, exports were valued ten times more than imports : all the surplus was naturally the 'legitimate gain of laissez faire'. Every obstruction was put in the way of the cotton cloth manufacturer and yet the cheaper and better material from Dhaka competed with mill-made cloth till 1813, when the imposition of a very heavy duty killed the trade (Dutt 1906). In a similar fashion, the sugar industry and trade were strangled later. Till 1846, Bengal sugar competed favourably with the West Indies product in Britain : in that year ' with a view to protecting the home-refiner and West India proprietor from the effects of the full development of skill in the manufacture of the East' highly discriminatory duties were imposed and the trade declined (Haq 1939).

Meanwhile another, and more damaging, development had taken place. The rent-collectors were created into hereditary landlords by the Permanent Settlement of 1793. Under the Mughals, the Zamindar was not a landlord but the rent-collector ; Zamindari was an office and not a property (Haq 1939). Yet the Act of 1793 brought in : 'feudalism on the one hand, serfdom on the other' and by 1827 in may parts of the country 'the resident cultivators' were the actual slaves of the landholders. '(Haq 1939). Though attempts were made in 1859 and 1885 to redress

the wrong done, it was not till the Act of 1952, abolishing Zamindari, that most of the wrongs were righted. One of the worst effects of the revenue policy of the British was to elevate the unscrupulous Banias (brokers), Mahajans (money lenders) and Gomashtas (tax-collectors) to the status of hereditary landlords, by the simple process of auctioning estates which could not pay the heavy rents imposed upon them. Within a couple of decades of the Permanent Settlement, most of the old land-owning families had been dispossed by newcomers who terrorised the tenants and reduced them to serfdom (Haq 1939). One of the worst agrarian features - absentee landlordism - developed to an extent possibly never reached anywhere else.

As soon as cotton declined as the main cash crop of Bengal, indigo took over. As with the cotton industry, force was applied : this time on the farmers to grow indigo on the best lands for hardly any remuneration. The Indigo Inquiry Commission of 1854-60 found that the prevalent system of obtaining indigo from the farmers was ruinous to them. The Judge of Nadia observed that, 'it is no longer enough to measure the advantages of European capital and energy by the value of our exports of indigo : the effect of the system upon the people should also be considered' (Khan 1960). In 1860, Lieutenant-Governor J.P. Grand went to Sirajganj from Calcutta and on his way up 'numerous crowds of Ryots (tenants) appeared at various places whose sole prayer was for an order of the Government that they should not cultivate indigo'. On his way back, for nearly seventy miles there were continuous rows of people 'claiming justice and freedom from a bondage scarcely distinguishable from slavery'. Yet nothing was done till the uprising in 1872 in Yusufshahi Pargana of Pabna. Even then redress was delayed many years. The growth of jute as a cash crop and the discovery of the synthetic dye at last released the Bengal peasantry from more than a century of grave misery.

A very important development of the rise of British power was the patronage afforded to the Hindus and deliberate fostering of their hostility to the Muslims. The battle of Plassey was, in effect, won by the combination of the British and Hindu traders against the Muslim rulers (Spear 1961). Soon after the Permanent Settlement, the old-established Muslim and Hindu landed gentry were largely displaced by *parvenues*, almost all of them Hindu traders. These latter eagerly absorbed a veneer of western culture and, exploiting the greater trust placed in them by the British, soon controlled the inland trade and the lower Government Services. The effect of this was succinctly put by W.W. Hunter when he wrote about the muslims of Pabna, who were : 'rapidly declining in position owing for the most part to their conservative habits which prevent them from studying English or from progressing in any way

beyond the condition of their forefathers : and partly, also, to the jealousy shown towards them by educated Hindus who monopolize all or nearly all Government appointments' (Hunter 1876). The bigotry of the new class of Hindu traders and landlords reached its climax in the writings of Bankim Chandra, who did more to spread the poison of communalism, through his popular novels, than any other Bengali. Herein lay the *leitmotif* for Pakistan : the bigotry and intolerance of educated and high-caste Hindus towards the Muslims. This is not to say that, throughout their 600 years of dominance, the Muslims did not continually, and often deliberately, aggravate the sensibilities of their Hindu neighbours.

The period of British rule, is from the geographers point of view, of considerable interest. Indigo supplanted cotton and sugarcane as the main cash crop in the first decade of 19th century. Seventy years later jute supplanted it, and still holds much of the economy in its grips. Whereas the economy of Bengal was well-balanced between industry, agriculture and commerce before the British era, the growth of Calcutta and the drain of wealth to Britain made it heavily dependent upon a single cash crop and the vagaries of a world market. The domination of the industrial and commercial interest of Calcutta had a most deliterious effect upon the growth of a healthy and balanced economy in its hinterland. From 1947 to 1970 the role of Calcutta was taken over by Karachi, and the economy of Bangladesh stagnated.

The most notable contribution of the British period was the introduction of modern science. In 1770, Major James Rennell carried out the first-ever accurate cadastral surveys and laid the basis for the geographical study of Bengal. In 1784, the Asiatic Society was founded by William Jones and others. In the years to come, a considerable amount of research has been carried out under its auspices. Natural historians, such a Stuart Baker, Temminck, Vieillot, Blyth, Jerdon, Gmelin, Hooker, Prain, Heinrich, Heinig and others greatly enlarged the knowledge of the flora and the fauna. The rivers of Bengal have had their own specialists, men such as Hirst, Ascoli and Fergusson. Archaelogy and the study of the art and architecture of the ancient Kingdoms was stimulated by Buchanan-Hamilton, Cunningham and Beveridge. The study of the history of Bengal was also not neglected : Taylor, Colebrooke, Wilson, Hunter and several others have left ample proof of scholarship in this field. It may be fairly assessed that though the period from 1757-1947 was immensely harmful to the economy, it was a time of valuable progress in many fields of scientific study.

The religious revival of the early nineteenth century received a set-back from the failure of the War of Independence of 1857-58. The shock of this made the muslims even more distrusted by the British.

but also opened the way to some changes within muslim society. Nawab Abdul Latif (1828-93) was prominent among the many who were to direct the new muslim movement in Bengal, which was later led and inspired by the eminent historian, Sayyed Amir Ali (1847-1929). What began as an intellectual movement soon became the handmaiden of politics. In 1906, the All India Muslim League was founded in Dhaka at Shahbagh and for the next 40 years Bengal was in the forefront of Indian muslim politics. At first the Muslim League strove for some form of autonomy within a independent India, but later they demanded a separate country. The hindus of Bengal in the meantime, not only fostered what has been called the Indian Renaissance, but also began a phase of physical struggle against the British. In 1905, the province of Bengal was partitioned, and the muslim-majority eastern parts were joined with Assam to form a new province. Through acts of terrorism and mass political agitation the Hindus managed to annual the partition in 1912. Terrorism against the British was used continuously since then, the most notable feat being the short lived capture of Chittagong in 1932. A logical outcome of this was that during the Second World War a Bengali, Subhas Chandra Bose, sought Axis (Japanese) assistance and led the Indian National Army against the British.

With the close of the Second World War, the agitation for independence gathered momentum. For some time it seemed as if Bengal would emerge as an independent country, along with India (Bharat) and Pakistan. Indeed, as originally conceived by Choudhury Rahmat Ali (1936), Pakistan would consist of the northwest part of the sub-continent and Bengal would be a independent country called Bangistan. It may well have been so. The Lahore Resolution of the All India Muslim League - moved by a famous Bengali, Sher-e-Bangla Fazlul Huq - in 1940, can well be interpreted on these lines. The idea of national self-determination, along non-communal lines was, however, endorsed by the September 1942 Resolution of the Central Committee of the Communist Party of India, which stated: "Every section of the Indian people which has a contiguous territory as its homeland, common historical traditon, common language, culture, psychological make-up, and common economic life would be recognized as a distinct nationality with the right to exist as an autonomus state within free Indian Union or federation and will have the right to secede from it if it may so desire....free India of tomorrow would be a federation or union of autonomous states of the various nationalities...etc. throughout the sub-continent '.

Sensing the depth of the challenge, the British showed more political sagacity than the French or the Dutch by withdrawing from India in 1947. Whether India was to remain one, or be divided, remained

in the balance until almost a month before the British withdrawal in August of that year. The Hindu and Muslim communities in Bengal tried half-heartedly to form an independent Bengal. Jinnah, for one, agreed to an independent, undivided Bengal and even had the concurrance of prominent political Hindu and Muslim leaders of Bengal. But then Congress, led by Nehru and others, were vehemently opposed to any such suggestion. As it was, communnalism had poisoned both sides, and the elite of both communities felt threatened. Independence meant the partitioning of Bengal. Two-thirds of the province of Bengal and most of the Sylhet district of Assam became the province of East Bengal, in Pakistan. The principle for the division was to link together muslim majority, contiguous areas but this was not adhered to. The Partition lines as drawn both in Sylhet and between West and East Bengal, were largely arbitrary, in violation of the stated principles and almost uniformly to the detriment of the muslim majority areas. The reasons for this have never been clearly explained and the most important documents relating to these momentous changes (the Radcliffe papers) have still not been made public. Within a few months, Bengali nationalism was needlessly agitated when Urdu was declared the only national language of Pakistan.. This lead to the historic Language Movement of 1952.

In 1954, Maulana Bhashani, then President of the Awami League, called for an autonomous East Pakistan. Only in 1956 was Bengali accepted as a national language along with Urdu. To forestall the inevitable growth of Bengali power within Pakistan, a military putsch was staged in 1958 by the Army Chief, General Ayub Khan with the active abetment of the higher bureaucracy which was entirely non-Bengali. Increasing economic disparity between East and West Pakistan led to the movement for autonomy from 1965 onwards. Sheikh Mujibur Rahman, a devoted follower of H.S.Suhrawardy, who had been the Chief Minister of Bengal (1946 - 47), became the focus for this demand for provincial autonomy as articulated by the Six Point Movement of the Awami League. His trial in the so-called 'Agartala Conspiracy Case', on patently trumped up charges, in 1968 further angered the Bengalis and led to the mass movements which overthrew of the Ayub government. In the national elections, which followed in 1970, the Awami League won a clear majority of seats in the National Assembly (Parlement) and legitimately claimed the right to form the government in Pakistan. Again a conspiracy was to deny the Bengalis their aspirations for a legitimate voice in the government. This denial led to the a movement for independence when the Pakistan army attacked the civilian population on March 26, 1971. Major (later President) Ziaur Rahman announced, over radio from Chittagong, the beginning of the War of Liberation. Though Sheikh Mujib was to be arrested and jailed in Pakistan,

his compatriots - Nazrul Islam, Tajuddin Ahmed, Kamaruzzaman, Kh. Mustaque and Monsur Ali - got together to form the first Government of Bangladesh, in the mango grove of Mujibnagar, near Meherpur in Kushtia district, on April 17th, 1971. * Within ten months the rest of the country was Liberated, both by the increasing guerrilla activity of the Mukti Bahini (a irregular force composed largely of students, some professionals and government officials) and the actions of the Bangladesh and Indian regiments under a Joint Command. The defeated occupation Pakistani armed forces surrendered in Dhaka on December 16th, 1971. Sheikh Mujib was then released from jail in Pakistan and returned to Bangladesh, in triumph, on January 10th, 1972.

* In March 1971, the author flew to Calcutta from Washington DC on his way to Mujibnagar. He was privileged to be able to witness and participate in the historic events that took place - leading to the formation of the Government in Mujibnagar - during the first fortnight of April 1971.