

CHAPTER - IV

C L I M A T E

4.1 CLIMATIC CHARACTERISTICS OF THE STUDY AREA

West Bengal's climate is influenced largely by its relative position to the eastern Himalayas and the Bay of Bengal. The State enjoys a typical tropical monsoonal climate. Agriculture in the State largely depends on the timely arrival of the monsoon inasmuch as irrigated area forms hardly a quarter of the total cultivated area in the State.

Temperature Condition

The average maximum temperature in the plains is attained in April and the highest maximum in May. The summer temperature in the plain varies from 80°F (26.7°C) to over 110°F (43.3°C). The proximity of the sea has a moderating effect on the temperature conditions particularly in the southern part of the State. The maximum mean temperature is 47°F (8.3°C) in Darjeeling and 74°F (23.3°C) in Jalpaiguri while the minimum mean temperature is 35°F (1.7°C) and 50°F (10°C) respectively. The average maximum temperature over the plains is attained in April and the highest maximum in May. Over the Darjeeling Hills the maximum temperature is attained during the month of June. During the month of January. West Bengal experiences the lowest temperature throughout the state. April is the hottest month of the year. The evening thunderstorms known as Kalbaisakhi or Norwestes (as they come from the north West) bring relief from the heat of the summer.

Rainfall

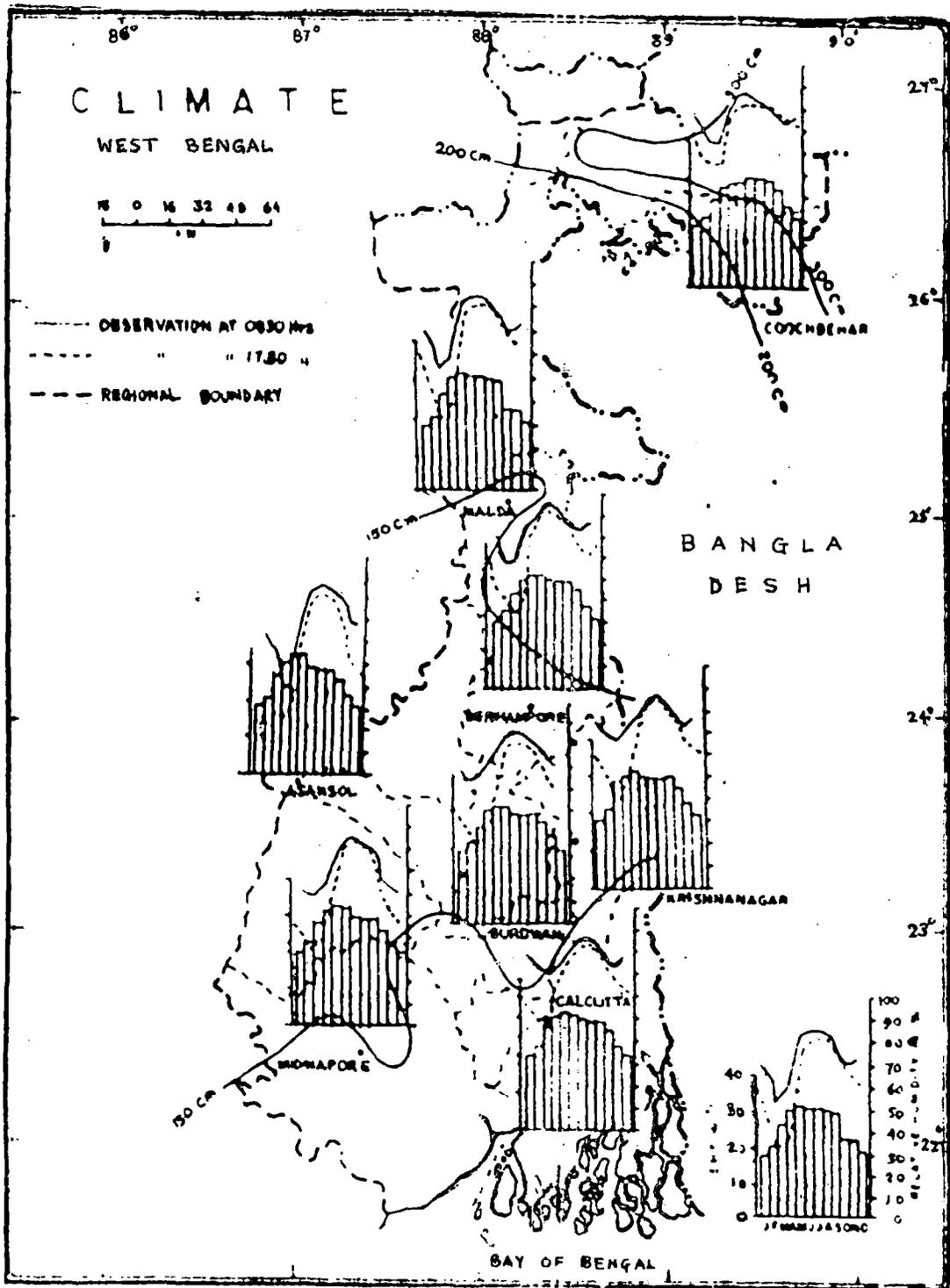
The State experiences an average annual rainfall of about 70" (175 cms.) about 80 to 85 per cent of the annual rainfall and rainy days occur during the south west monsoon season of June to October. Another 10 to 15 per cent of the annual rainfall and rainy days occur due to thunderstorm in the hot months of March to May. Rainfall in the hills

and sub-mountain districts of West Bengal is much higher than in other parts of the State. Rainfall in the Himalayan region ranges from 100" (250 cms) to over 200" (500 cms) while the plain districts receive on an average 45" (125 cms to 75") (187.7 cms). The district of Bankura records the lowest rainfall (47" or 117.5 cms) and Jalpaiguri experiences the highest rainfall (156" or 390 cms).

4.2 DISTRIBUTION OF TEMPERATURE AND RAINFALL

The region experiences a hot and humid monsoonal climate. The proximity to the Bay of Bengal on the south, the alignment of the Himalaya in the north and that of the Meghalaya Plateau in the north east determine largely the climatic character, i.e., the distribution of the weather elements with respect to time and space. Irrespective of the general varieties and mechanism of the monsoon, the spatial and seasonal distributions of the elements such as temperature, rainfall and relative humidity are too uneven. (Map No. 6).

January invariably appears as the coldest month, the temperature ranging between 17 and 21°C and increasing southward (Sagar Islands 20.4°C). The regional variation is considerably low but becomes significant when analysed with respect to the occasional cold spells accompanied with the western disturbances. The lowest temperature has been recorded in the north (2.2°C at Jalpaiguri) but in the south it is as high as 7.2°C (Sagar Islands). The temperature starts rising gradually throughout the region from February but the rise is well marked (4° to 6°C) in March (Table 1) and it continues till the end of May; the rise like other monsoon regions is checked by the outburst of the monsoon which in this region becomes active by the first week of June. Except the northern part, i.e., the Barind tract and the Duars in the whole of the region, May records the maximum average temperature (29-33°C). The central part (Asansol and Krishnagar) indicates relatively lesser impact of the proximity to either the Bay or the Himalaya even in this region of near uniformity. Conspicuously enough, the average monthly temperature shows a range seldom exceeding 5°C over a span of seven months : April to October (Jalpaiguri 25.7°-27.85°, Krishnagar 27.8°-31.1°, Sagar Island 27.55°-29.7°). The only exception to this generality



Map No. 6

is presented by the western margin (Asansol) of the region where the bare rock exposure contribute to a little higher May average (32.7°C). In spite of this uniformity which partly owes to the premonsoon showers (nor'Westers), there are evidences of occasional high temperature rising sometimes to over 45°C (Table 1). Even these exceptional temperatures are lower in the Duars (Jalpaiguri 40°C) and the coastal regions (Sagar Island 40°C). Notably the range of temperature also corresponds with the general distribution. March and April are the months when the range is at the maximum though rarely exceeding 16°C (Jalpaiguri, 13.2°C, Malda 15.2°C, Berhampur 15.7°C and Krishnanagar 16.2°C all in March) except the coastal areas where January and December record the maximum range (Sagar Island 9.2°C and 8.9°C respectively). The temperature range is at its minimum during July and or August when atmospheric moisture imposes the moderating influences. The range for these months remains around 5°C and seldom exceeds 10°C during the five rainy months (June to October),

The gradual decline in average monthly temperature commencing often from June (September in case of Jalpaiguri becomes well marked when it falls by 3° to 5°C between October and November. This marks the start of the winter season.

The average relative humidity is generally high (over 50%) throughout the region except in the western fringes where for about two months, March and April, it is less than 40%. This is also the period of lowest RH all over the region except the Sundarbans. December and January however, show the minimum in the coastal tract (Sagar Island 68.5 and 69.5% respectively). It can well be observed that during July, August and September the average RH remains over 80% which spatially decreases westward (Krishnanagar 84.2% and Asansol 82.7%). The relative inland belt away from the Himalaya and the Bay is again quite well defined. From the monthly RH pattern the oceanic influence is also distinct (range at Sagar Island 17%; Asansol 47.5%). Mornings are invariably damper with usual regional variations. The diurnal range is maximum in the month of February (30%) and minimum in August (7% when the monsoon is at its climax.

The rainfall (120 to more than 400 cm) is fairly widespread in the region though with uneven seasonal and spatial distribution characteristic of the monsoonal condition. Out of the four sources of rainfall, i.e., westerly disturbances of winter, convectional overturning of air resulting in local depression (Kal Baisakbi) during March May causing pre-monsoon showers, cyclonic disturbances of the monsoon and post monsoon periods and the monsoon currents occurring along the convergence lines of the sea level monsoonal troughs, the last two account for the major precipitation received in the region (Sagar Island about 85% Krishnanagar about 80%, Asansol about 85% and Jalpaiguri about 85%). But for the southern beld, i.e., the active delta, where August is the wettest month (41.0 cm.), July emerges as the wettest month of the region with rain varying between 28 cm in the Bhagirath-Padma fork to 77.6 cm in the Duars. December undoubtedly is driest though with relatively damper atmosphere (RH more than 55%).

Spatially the northern and southern parts, owing to the proximity of the Himalaya and the Bay respectively, experience relatively more annual rains (Jalpaiguri 335 cm and Sagar Islands 190 cm) than the central part. It is the area bordering the Chotanagpur Highlands that experiences minimum rainfall (Asansol 139.22 cm).

The erratic nature of precipitation is evident by the fact that even the watter months receive sometimes rain below 20 cm, e.g., Asansol 5.71 cm in July, 1918; Jalpaiguri 11.43 cm, in August, 1896 Krishnanagar 8.59 cm in August, 1992 and Sagar Islands 11.45 cm in July, 1919; while their averages for the respective months are 34.44, 66.28, 27.11 and 40.94 cm. Similarly the heavy downpours of 64.92, 151.76, 71.43 and 96.42 cm have also been recorded for stations in the respective months in the years 1943, 1958, 1909 and 1913. Even the drier months sometimes record exceptionally heavey downpours (Jalpaiguri 57.0 cm in December, 1932). Heaviest downpours within 24 hours ever recorded are at Calcutta 369.1 cm on September 20,1900; Sagar Islands 359.2 cm on June 5,1927 and Jalpaiguri 390.4 cm on July 8,1892.

The overall impact of the climatic elements can be interpreted in terms of water surplus and deficit in the region which have direct correlations with the agricultural economy. The seasonal surplus period, often between mid July and end of October, is a common feature all over the area except in the Duars where due to the early commencement of the monsoon it starts from May end. Depending on the amount of rainfall the Duars show maximum surplus equivalent to about 60 cm of rain in July/August which aggravates the work of running water resulting in floods, shifting of river channels, etc. Elsewhere, it is below 20 cm rain equivalent being the lowest in central part (Krishnanagar about 10 cm). It is also evident that there is a general water deficiency period from January to mid June, being shortest in the Duarsa (January-April). The soil moisture in the Active Delta is sufficient for about three months to get evaporated while in the remaining parts it can stand only for two months.

The position though relatively better than the other parts of the country, calls for irrigation measures to be developed to ensure more intensive land utilisation and better yield in the region.

The dry summer is characterised by three air streams, i.e., the northwesterly current from the west, a shallow southerly stream from the Bay of Bengal and a feeble easterly to north-easterly current through the Assam valley resulting in a marked instability in the atmosphere accompanied by thunder storms, dust storms, squalls, etc. Out of the 74 instances of squalls at Alipur during 1948-52 as many as 57 were recorded during March-May. Rainfall is associated with afternoon or evening thunder showers and squalls. Hailstorms (upto 3) during the season occur in the SW part. High temperature (23-33°C) and low humidity (up to 40%) are the characteristic features. The temperature range is also the highest (16°C).

The Bay depressions bring in the monsoon by the first week of June. Series of such depressions sweep over the region during June-October and Cause heavy to moderate rainfall with July-August emerging as the rainiest months. The withdrawal of the monsoon by mid-October is followed by a short transition between the rainy and the cold season

(post-monsoon season). The commencement (June) and the end of the rainy season (September/October) are associated with more thunderstorms than the rainy months of July and August. High relative humidity (70% and above) alongwith high and almost uniform temperature (26-31°C) and heavy downpours are the characteristics of the season. The climate is often sultry during rainy season.

The winter season is characterised by the sweep of northerly or north westerly winds. The weather changes are associated with the occasional western disturbances causing some rainfall, but cold waves are rare. Low average temperature (17-24°C) increasing southward and moderate relative humidity (50%) mark the characteristic of the season.

Agro-Climate of West Bengal

The Indian sub-continent of which West Bengal is a state belongs to the northm-hemisphere of the earth. The sun crosses the equator twice in a year (i.e. 21st March and 23rd September) during its journey from south to north and north to south. The sun reaches tropic of cancer and tropic of capricon on 21st. June and 22nd December respectively. The periodic shifting of the position of the sun with reference to the earth mainly controls the seasons and whether conditions. However, other major factors viz. monsoon wind, western disturbances, presence of the Himalayas in the north and Bay of Bengal in the south influences the periodic weather conditions substaintailly.

During the period from 21st. March to 23rd. September, the northern hemisphere not only receives more amount of sun rays but a also the length of the day becomes 12 hours or more. Whereas the same hemisphere not only receives less amount of sun rays from 24th September to 20th March, but also the length of the day becomes less than 12 hours. However, the shifting of vertical rays to oblique rays and again back to vertical rays and increase or decrease of day length occures very slowly. Due to all these factors, we generally experiences three major seasons viz., winter from November to February, summer from March to May and monsoon from June to October. However we have also other three minor seasons of short duriation viz. Basanta (Spring) in

between winter and summer, Sarat and Hemanta (autuma) in between rains and winter, and they have mixed characteristics of major seasons.

The topic of cancer runs almost across the the middle of southern part of West Bengal. The areas lying north of this line fall within the north temperate zone and the southern portion within the equatorial zone. Though the lower position lies within the equatorial zone. The presence of Bay of Bengal, innumerable river systems, canals, tanks forest cover, orchard around homestead areas etc. do not allow extreme climatic conditions to prevail upon at any time of the year in this area.

The climate of West Bengal ranges from subhumid (moist and dry) and humid to per humid. Crop production in the state is influenced significantly by the highly varying weather conditions during monsoon and post monsoon period. The normal on set of southwest monsoon in the state is from 7th June. After the monsoon sets in it gradually extends northward and north west ward by the end of June. The monsoon begins to retreat by the fourth week to September and the withdrawal is completed by the middle of October. In the monsoon period (Kharif season) the state receives 78 to 90 percent rain of annual rainfall which not only varies from year to year but also from place to place. During monsoon period again one cannot expect continuous rain in any part of the state. Hence breaks of longer or shorter duration prevail during the monsoon period. These 'breaks' of longer duration are known as periods of drought. Studies conducted to quantity drought in the form of an index taking into account of rainfall, evapo-transpiration and soil moisture show that on an average, droughts occur in 20-25 per cent of the period of the kharif season. The state experienced drought in the past and during the recent years, viz. 1966, 1972, 1976 and 1981 when the winter rice (aman) production fell much below the normal production.

The state also suffers from flood due to heavy rainfall in the monsoon period (kharif season). Occurences of flood cannot be fully controlled in the basin areas of larger river systems. Due to the

occurrence of flood, life, property and field crops and damaged severely, since very often in it is accompanied by cyclonic storm. In coastal areas, severe damages are caused by cyclonic storm accompanied by high tide. Not very long ago some great floods occurred in North Bengal (in the year 1968) in south Bengal (in the year 1978) and in coastal areas (in the year 1981).

Generally, before or after the monsoon season, the thunder and hail storms are the predominant weather phenomena. Thunder storm with associated squalls (locally known as Kal--Baisakhi) are of short duration but some are very violent and destructive. One of such storms occurred over Calcutta in May 1945 when the wind speed was as high as 128 km per hour. Post monsoon storms occur when the S-W monsoon recedes and N-E winds comes forward. A great storms occurred in the month of October, 1942 and we faced a grave famine afterwards. In West Bengal, heat wave, cold wave and frost hazards generally do not occur excepting in some smaller specific areas.

Geographically, the state of West Bengal can be divided into five broad regions, viz., north hilly, North Bengal Plain, Central Plain and western undulating. Approximate locations of these regions have been given in the following Table. Moreover, in respect of latitude and longitude the boundary line of each region is not sharp but gradual in nature. Each of these regions has its own independent seasonal weather characters (viz. summer, rainy and winter) as shown by its rainfall, air temperature humidity and dew fall. These seasonal weather characters are clearly depicted in the following table as far as practicable. The weather characters of one region very slowly change towards another region in a season and hence the said character are shown on a mean annual basis.

If the weather of each of the above geographical region is studied in respect of moisture and temperature indices values it is found that the three regions of South Bengal and one region of North Bengal tally well with the climatic zones. Only the North Bengal plain region has a different climatic zonal picture in respect of moisture and temperature indices values. Hence, the North Bengal plain is again divided

into three zones, viz., tropical per humid, tropical humid and tropical moist sub-humid. These climatic zones are shown in the accompanying map along with the other climatic zones. So, the state of West Bengal has been divided into five broad agro-climatic zones. viz. sub-tropical per humid, tropical per humid, tropical humid, tropical moist sub-humid and tropical dry sub-humid. (Map No 7)

Agro-climate (All figures are mean of annual normals)

Sl. No.	Geographical regions with approximate latitude and longitude	Weather Factor	Weather Character (Major seasons)		
			Summer March to May	Rainy June to October	Winter November to February
1.	North Hilly 26°50' to 27°14'N 88°00' to 88°55'E	Rainfall (mm)	398.5	2,637.5	68.5
		Max	17.0	19.5	12.0
		Air temp. °C Min	10.5	14.3	4.8
		R.H. (%)	74.0	88.0	77.0
		Dew fall	S	N.S.	V.S.
2.	North Bengal Plain 24°40' to 26°50'N 87°48' to 89°53'E	Rainfall (mm)	371.6	2,134.0	42.6
		Max	32.3	31.3	26.0
		Air temp. °C Min	20.5	24.5	12.8
		R.H. (%)	60.0	81.0	70.0
		Dew fall	L.S.	N.S.	V.S.
3.	Central Plain 22°40' to 24°40'N 87°45' to 89°06'E	Rainfall (mm)	233.8	1,206.0	67.8
		Max	35.0	32.2	27.4
		Air temp. °C Min	23.4	25.6	15.6
		R.H. (%)	58.0	80.0	65.0
		Dew fall	N.S.	N.S.	S.
4.	Coastal plain 21°32' to 22°40'N 87°30' to 89°06'E	Rainfall (mm)	195.0	1,475.2	82.8
		Max	34.0	32.0	28.2
		Air temp. °C Min	24.8	26.0	16.0
		R.H. (%)	72.0	82.0	68.0
		Dew fall	N.S.	N.S.	S.
5.	Western undulating 22°40' to 24°40'N 85°51' to 87°45'E	Rainfall (mm)	137.0	1,224.4	66.0
		Max	37.0	32.4	27.2
		Air temp. °C Min	23.7	25.0	14.8
		R.H. (%)	44.0	78.0	55.0
		Dew fall	N.S.	N.S.	S.

N.B.: V.S. - Very significant; S - Significant; L.S. - Less Significant; N.S. - Not Significant; R.H. - Relative Humidity

CLIMATIC REGIONS

(WEST BENGAL)

scale
16 0 16 32 miles

N

LEGEND CLIMATIC ZONES

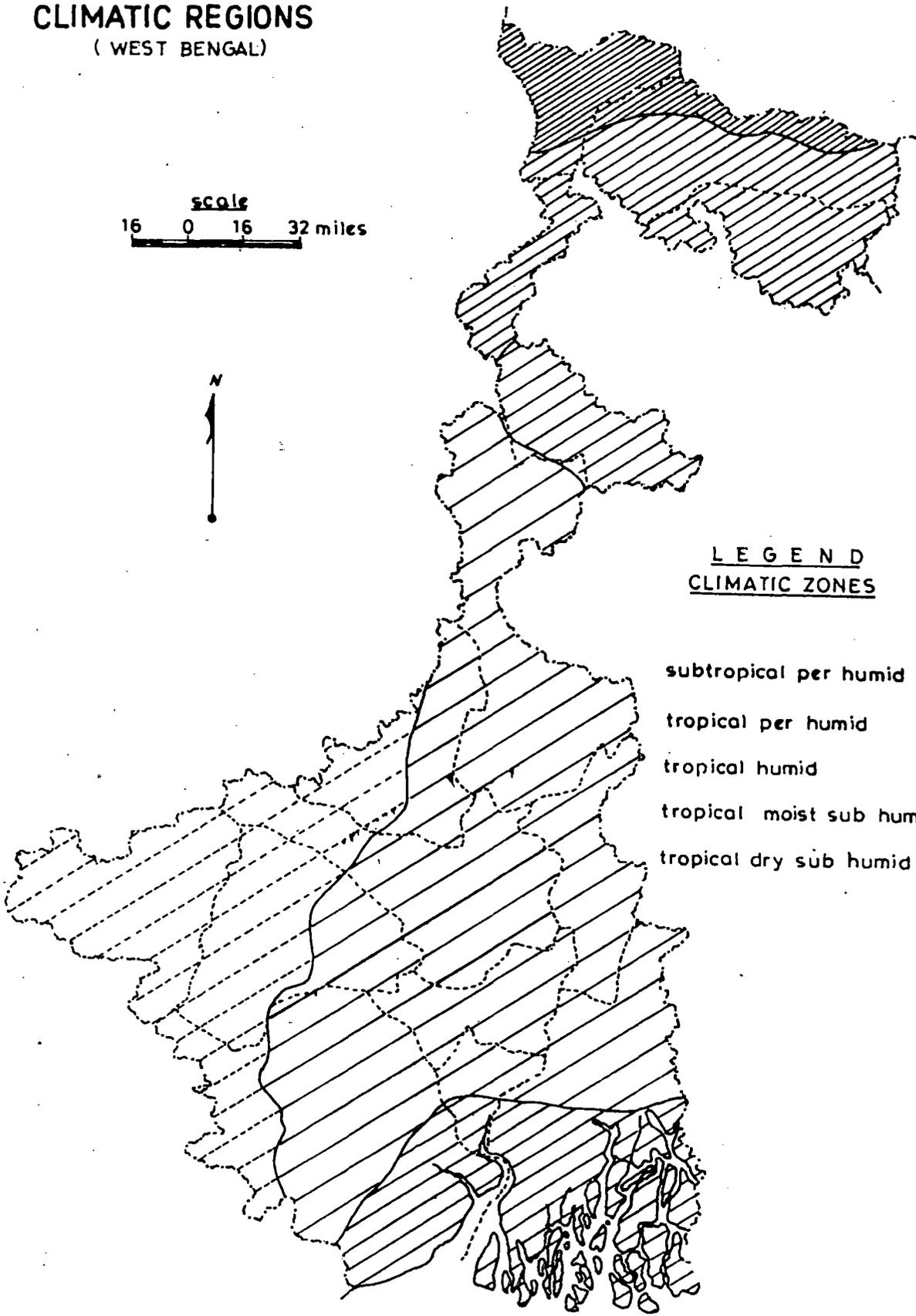
subtropical per humid

tropical per humid

tropical humid

tropical moist sub humid

tropical dry sub humid



L E G E N D

Climatic Zone	Temperature Index T° Max- T° Min	Moisture Index $\frac{PPT-PET}{PPT} \times 100$
Sub Tropical Per Humid	4.0 to 8.0	50
Tropical Per Humid	5.5 to 15.0	50
Tropical Humid	5.5 to 13.0	20 to 50
Tropical Moist Sub Humid	3.5 to 17.0	1 to 20
Tropical Dry Sub Humid	6.0 to 15.0	1

MEAN OF ANNUAL NORMALS

P.P.T - Precipitation

P.E.T - Potential Evapotranspiration

T - Summation of Temperatures

Agro-climatic zones of West Bengal

The year is divided into three distinct crop seasons viz.

1. Kharif (Rainy Season) June to October
2. Rabi (Cold and dry season) October to February and
3. Summer (Hot and dry season) March to June

The seasonal variations due to different climatic conditions depending upon rainfall, temperature humidity and altitude accompanied by various complex soil groups and its physiography and types have great influence on farming systems in West Bengal. Depending upon the soils and climatic variation, the State is broadly divided into following six agro-climatic regions (Map No. 7).

1. Hill Region

Darjeeling district excluding Siliguri sub-division and northern fringe of Jalpaiguri district.

Climate

	March to May	June to October	November to February
Rainfall (mm)	398.5	2,637.5	68.5
Air temp. °C Max	17.0	19.5	12.0
Min	10.5	14.3	4.8
R.H. (%)	74.0	88.0	77.0
Dew-fall	Significant	Not Significant	Very Significant

Soil

Soil in general is shallow, coarse textured, high in organic matter content, low in bases and phosphate, acidic in nature. Due to high run-off rate and scope for vertical and lateral seepage, moisture stress frequently occurs. Area is mostly bench terraced on high slope.

2. North Bengal Plain

Plains of Jalpaiguri and Coochbehar, Siliguri sub-division of Darjeeling district and Islampur sub-division of West Dinajpur district.

Climate

		March to May	June to October	November to February
Rainfall (mm)		371.6	2,134.0	42.6
Air temp. °C	Max	32.3	31.3	26.0
	Min	20.5	24.5	12.8
R.H. (%)		60.0	81.0	70.0
Dew-fall		Low Signi- ficant	Not Signi- ficant	Very Signi- ficant

Soil

Deep, light texture, high permeable porous soil with water regime fluctuating within 1 metre depth relative to river flow level; moderate level of organic matter content with appreciable mineralisation highly acidic low in bases, phosphate, potash and micro nutrient. Area is mostly flat with 0-1% slope having low height field bund.

3. Western Undulating Region

Part of Birbhum, Burdwan, Bankura, Midnapore and Purulia districts with pockets of Malda and West Dinajpur districts.

Climate

		March to May	June to October	November to February
Rainfall (mm)		137.0	1,224.4	66.0
Air temp. °C	Max	37.0	32.4	27.2
	Min	23.7	25.0	14.8
R.H. (%)		44.0	78.0	55.0
Dewfall		Not Signi- ficant	Not Signi- ficant	Significant

Soil

Shallow to deep soil with light texture surface with heavy sub-surface, somewhat well drained due to deep placement of water table

and scope of lateral seepage. Acidic in soil reaction, low in base status, low in organic content, phosphate, moisture stress frequently occurs. Area is mostly banded and bench terraced on moderate slope.

4. Central Plain

Nadia district, part of Malda, West Dinajpur, Murshidabad, Burdwan, Hooghly and 24 Parganas district.

Climate

		March to May	June to October	November to February
Rainfall (mm)		233.8	1,206.0	67.8
Air temp. °C	Max	35.0	32.2	27.4
	Min	23.4	25.6	15.6
R.H. %		58.0	80.0	65.0
Dew-fall		Not Signi- ficant	Not Signi- ficant	Significant

Soil

Deep, moderately well drained light texture soil, having neutral to alkali soil reaction, moderately high in base saturation NPK status is medium to medium low. Area is mostly flat having close net work of irrigation system of different types.

Average Monthly Temperature in °C

Station	Jan.	Feb.	Mar.	April	May	June	July	Aug.	Sept.	Oct.	Nov.	Dec.
Jalpaiguri	17.1	18.95	23.0	26.0	26.9	27.45	27.8	27.85	27.55	25.7	21.95	18.55
Asansol	18.95	21.5	26.9	31.15	32.7	31.25	28.8	28.55	28.6	26.8	22.55	19.3
Krishnanagar	18.95	21.65	26.9	30.65	31.1	30.15	28.95	29.05	29.2	27.8	23.45	19.75
Sagar Island	20.4	22.85	26.95	28.9	29.7	29.55	28.5	28.45	28.55	27.55	24.1	20.85