

# 18

## CLIMATE AND VEGETATION IN INDIA

### 18.1 INTRODUCTION

In the previous lesson, we have noted the shape and size of our country along with its latitudinal extent. Not only its physiographic divisions are diverse but also far more contrasting in nature. Each one of these factors has an impact on climatic conditions of India, be it temperatures, atmospheric pressure, wind system or precipitation.

In this lesson, we will study regional variations in the climatic conditions of India. A search will be made to identify a series of factors responsible for these climatic variations both over space and time. A cycle of seasons would also merit our attention. As our climate is labelled "a monsoon type of climate" we would study the basic concept of monsoons and their typical characteristics. Since, in our country, the climatic variations depends more on rainfall rather than temperature, we would devote some time to study distribution of rainfall. The lesson would be concluded by presenting description of and explanation to the type of natural vegetation we come across in different parts of the country.

### 18.2 OBJECTIVES

After studying this lesson, you will be able to :

- explain with suitable examples the climatic variations in India (both seasonal and spatial);
  - name various factors which influence the climate of different parts of India;
  - explain the concept of monsoon and the way it is caused ;
  - discuss the typical characteristics of monsoons ;
  - state the climatic conditions during different seasons ;
  - describe the major natural vegetation belts in India and their relationship with climate;
  - show the distribution of annual rainfall and major vegetation belts on the outline map of India.
-

### 18.3 CLIMATIC VARIATIONS IN INDIA

You have studied the shape, size, location and latitudinal extent of India. Also you have noted the sharply contrasting relief features of India. This has created regional diversities in climatic conditions. The climatic conditions of southern India are a bit different from those of the northern parts with respect to temperature, rainfall and commencement as well as duration of different seasons.

Now, let us have a closer look at these climatic variations. During June, the north western plains experience high temperature around 45°C when areas of Rajasthan desert record day temperatures around 55°C, while the temperatures around Gulmarg or Pahalgam in Kashmir are hardly around 20°C. Similarly, in the month of December, the people of Kargil or Dras (in Jammu & Kashmir) experience biting cold because the night temperatures drop to -40°C, while the inhabitants of Thiruvananthapuram experience temperatures around 27° C (Table 18.1)

The range of temperature increases as one moves away from coastal areas to interior parts of the country. As a result, the people living along Konkan and Malabar coasts do not experience extremes of temperatures or marked change in seasons. On the other hand, people living in north western parts of India, experience sharp seasonal contrasts.

The diversity in rainfall distribution is equally striking. Cherrapunji in Meghalaya receives about 1080 cm of rainfall annually, while Jaisalmer in the desert of Rajasthan receives only 20 cm of annual rainfall. The north eastern parts and the coastal plains of Orissa and West Bengal experience spells of heavy rain during July and August while the Coromandel coast of Tamilnadu receive very meager rain during these months (Table 18.1)

Have a close look at fig. 18.1 and 18.2 which show the dates of onset and withdrawal of Southwest monsoons respectively. This will help you to understand the difference in the duration of rainy season in different parts of India. You will come to the conclusion that the duration of rainy season is the shortest in Northwest India and longest in the South and North eastern parts of India.

- \* The shape, size, location, latitudinal extent of the country and its contrasting relief have resulted in diverse climatic conditions in different parts of India.
- \* Climatic diversity is reflected in regional variations in temperature, amount of rainfall and commencement as well as duration of seasons.

#### INTEXT QUESTIONS 18.1

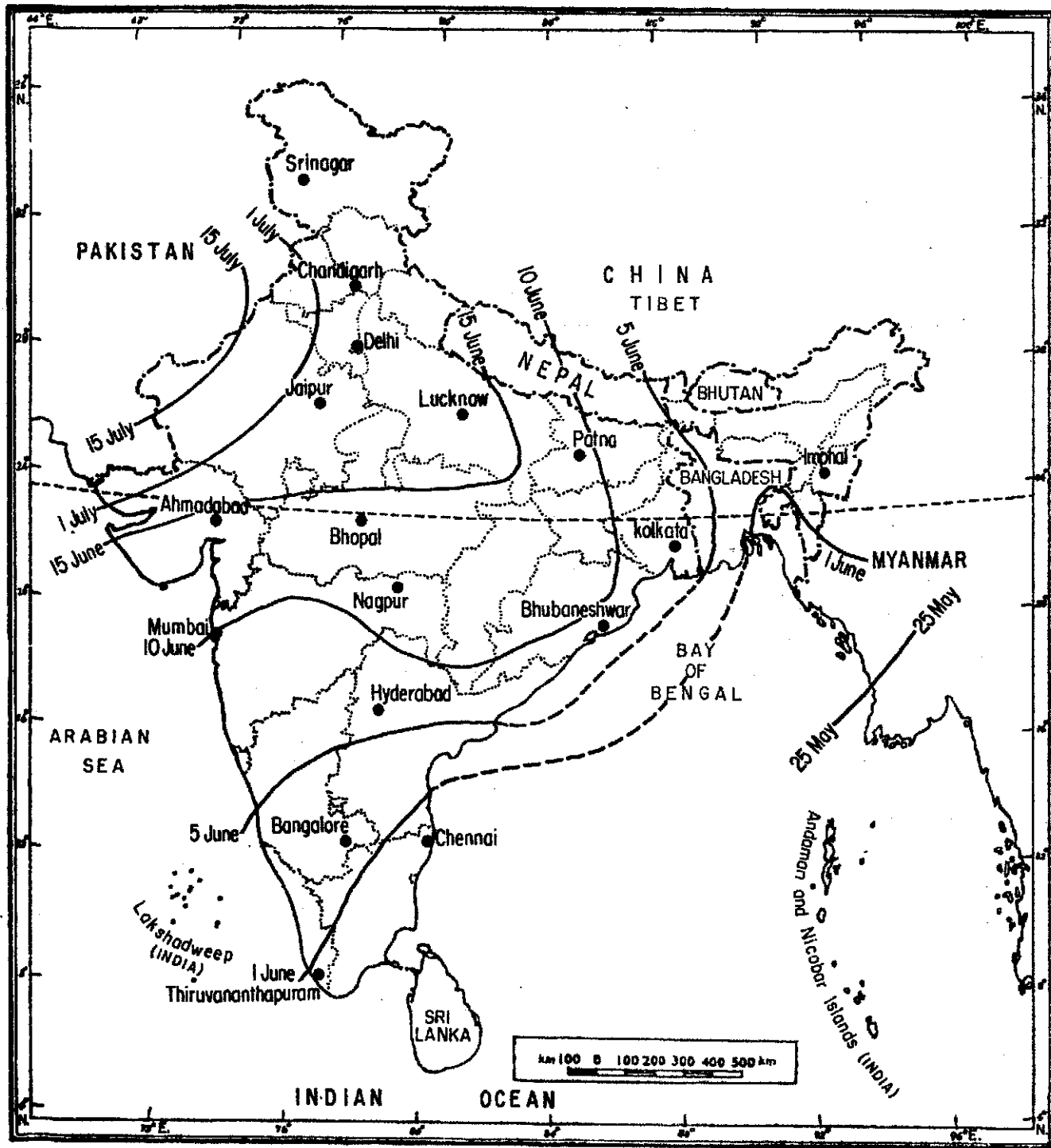
1. Name two places in India - one experiencing the highest and the other the lowest temperatures.

(a) \_\_\_\_\_ (b) \_\_\_\_\_

**Table 18.1 : Mean Monthly Temperature and Rainfall in Major Meteorological Centres in India**

T=Temperature (in °Celsius) and P=Precipitation (in cm)

Station		J.	F.	M.	A.	M.	J.	J.	A.	S.	O.	N.	D.
Leh	T.	-8	-7	-1	9	10	14	17	17	12	6	0	-6
	P.	10	8	8	5	5	5	13	13	8	5	0	5
Shilong	T.	10	11	16	19	19	21	21	21	20	17	13	10
	P.	14	29	56	146	295	476	359	343	302	188	26	10
Calcutta	T.	20	22	27	30	30	30	29	29	29	28	24	20
	P.	12	28	34	51	134	290	331	334	253	129	27	4
Delhi	T.	14	17	23	29	34	35	31	30	29	21	20	15
	P.	21	24	13	10	10	68	186	170	125	14	2	9
Jodhpur	T.	17	19	25	30	34	34	31	29	29	27	22	18
	P.	5	6	3	3	10	31	108	131	57	3	2	2
Mumbai	T.	24	24	24	28	30	29	27	27	27	28	27	25
	P.	4	2	2	2	18	465	613	329	286	65	18	2
Mahabaleshwar	T.	19	20	23	25	24	19	18	18	18	20	20	19
	P.	5	4	5	25	27	440	2546	1764	686	154	47	5
Pune	T.	21	23	26	29	30	28	25	25	25	26	23	21
	P.	3	1	2	14	27	107	169	97	130	76	31	4
Nagpur	T.	22	24	28	33	35	32	28	27	28	27	23	21
	P.	11	23	17	16	21	222	376	286	185	55	20	10
Banglore	T.	22	23	26	27	27	25	23	23	23	23	19	20
	P.	9	7	11	45	107	71	111	137	164	53	61	13
Chennai	T.	25	26	28	31	33	33	31	31	30	28	26	25
	P.	4	13	13	18	38	45	87	113	119	306	350	135
Thiruvananthapuram	T.	27	27	28	29	29	27	26	26	27	27	27	27
	P.	23	21	39	106	208	356	223	146	138	273	206	75



Based upon Survey of India outline map printed in 1979.

The territorial waters of India extend into the sea to a distance of twelve nautical miles measured from the appropriate base line.

The boundary of Meghalaya shown on this map is as interpreted from the North-Eastern Areas (Reorganisation) Act, 1971, but has yet to be verified.

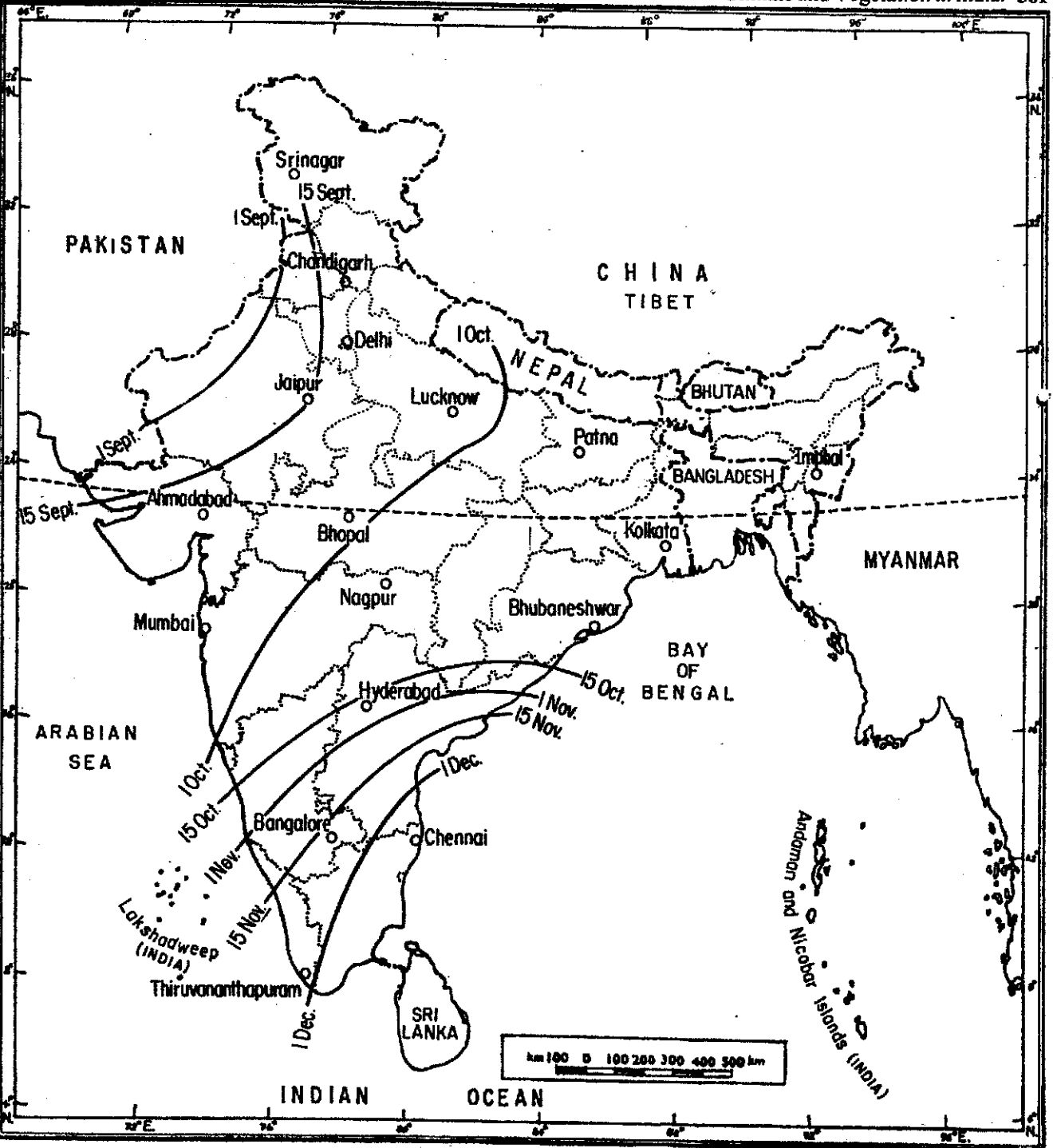
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2. Study the table 18.1 and answer the following questions :
- (i) Name the station which has the most equable climate.  
\_\_\_\_\_
  - (ii) Which station has the highest range of temperature ?  
\_\_\_\_\_
  - (iii) Which station has the highest temperature in
    - (a) February \_\_\_\_\_ (b) April \_\_\_\_\_
    - (c) June \_\_\_\_\_ (d) August \_\_\_\_\_
  - (iv) Name the four most rainy months in India.  
(a) \_\_\_\_\_ (b) \_\_\_\_\_ (c) \_\_\_\_\_ (d) \_\_\_\_\_
  - (v) Name a place in India which has the lowest rainfall.  
\_\_\_\_\_

#### 18.4 FACTORS INFLUENCING THE CLIMATE OF INDIA

The factors influencing the climate of India are given below :

##### (i) Location and Latitudinal Extent

India lies roughly between 6° N to 37° N latitudes. The Tropic of Cancer passes through the middle of the country. The southern parts being closer to the Equator, experience high temperatures throughout the year. The northern parts on the other hand lie in the warm temperate zone. Hence they experience low temperatures particularly, in winter. Water bodies surrounding peninsular India make climatic conditions mild along the coastal areas.

##### (ii) Distance from the Sea

Southern or peninsular India is surrounded by the Arabian Sea, the Indian ocean and the Bay of Bengal, hence the climate of coastal regions of India is equable or maritime. Contrary to this, the climate of the regions located in the interior of the country are cut off from the oceanic influence. As a result, they have an extreme or continental type of climate.

##### (iii) The Northern Mountain Ranges

The Himalayan and adjoining mountain ranges which extend from Kashmir in the Northwest to Arunachal Pradesh in the Northeast, separate India from the rest of Asia. These ranges protect India from the bitterly cold and dry winds of Central Asia during winter. Further more, they act as an effective physical barrier for the rain bearing southwest monsoons winds to cross the northern frontiers of India. Thus, these ranges act as a climatic divide between Indian Sub-Continent and Central Asia.

##### (iv) Physiography

The physical features influence the air temperature, atmospheric pressure, direction of winds and the amount of rainfall in different parts of the country. Study the map showing physical features given in the earlier lesson and find out yourself, the relationship between the relief, temperatures, direction of winds and amount of rainfall with the help of climatic maps given in this lesson. This will help you to understand why western coastal plains receive more

rainfall than the interior parts of Karnataka and Tamilnadu lying east of the Western Ghats. You will also understand why Bay of Bengal branch of Southwest monsoon is bifurcated into two parts - one moving along the Ganga Valley to the west and the other along the Brahmaputra Valley to the east. Locate on your Atlas the funnel-shaped Cherrapunji Valley along the steep southern edge of the Meghalaya Plateau. This would give you a clue why Cherrapunji happens to be the rainiest spot in the world.

#### (v) Monsoon Winds

The complete reversal in the direction of winds in India brings about a sudden change in seasons - the harsh summer season suddenly giving way to the eagerly awaited monsoon or rainy season. These winds which change their direction completely are called monsoon winds. The word 'monsoon' is derived from the Arabic word 'Mousim' which means 'season'. These winds have such a far reaching influence on India's climate that it is termed as 'monsoon type of climate'. The nature of these winds can be described with reference to the surface distribution of pressure in different regions of India during winter and summer seasons.

**(a) The Northeast Monsoon and its Effect :** During Winter, the weather conditions are generally influenced by the high pressure area developed over Northwestern part of the sub-continent. This results in the blowing of cold dry winds from this regions towards southern low pressure areas lying over water bodies surrounding peninsular India. Since these winds are cold and dry, they do not cause rainfall and weather conditions under their influence remain cold and dry. However, wherever these Northeast monsoon winds collect moisture while passing over the Bay of Bengal, they bring rain along Coromandel coast. Strictly speaking these winds are planetary winds known as Northeast Trades. In India they are essentially land bearing winds. But for the complete reversal in the direction of these winds during summer monsoon India would have little rain to enjoy.

**(b) The Southwest Monsoon and its Effect :** During Summer, the north-western parts of India become very hot due to very high temperatures. This is ascribed to the apparent shift of the sun in northern hemisphere. This results in the reversal of pressure conditions not only in northwestern India but also on water bodies surrounding the peninsular. As a result, Northeast Trade winds are replaced by Southwest monsoon winds. Since these winds are sea bearing and blow over warm water bodies before reaching land they are moisture laden, causing wide spread rain over the most parts of India. This period of southwest monsoon from June to September, is known as the rainy season for most parts of the country.

#### (vi) Upper Air Circulation

The changes in the upper air circulation over Indian landmass is yet another cause for sudden outbreak of monsoons in India. Jet streams in the upper air system influence the climate of India in the following ways :

**(a) Westerly Jet stream and its Impact :** During Winter, at about 8 km. above sea level, a westerly jet stream blows at a very high speed over the sub-tropical zone. This jet stream is bifurcated by the Himalayan ranges. The northern branch of this jet stream blows along

the northern edge of this barrier. The southern branch blows eastwards south of the Himalayan ranges along 25° N latitude. It is believed by meteorologists that this branch of jet stream exercises a significant influence on the winter weather conditions in India. This jet stream is responsible for bringing western disturbances from the Mediterranean region into Indian sub-continent. Winter rain and hail storms in northwestern plains and occasional heavy snowfall in hilly regions are caused by these disturbances. These are generally followed by cold waves in whole of northern plains.

**(b) Easterly Jet and its Influence :** During summer, due to the apparent shift of the sun in northern hemisphere, the reversal in upper air circulation takes place. The westerly stream is replaced by easterly jet stream which owes its origin to the heating of the Tibetan plateau. This leads to the development of an easterly cold jet stream centered around 15°N latitude and blowing over peninsular India. This helps in the sudden onset of Southwest monsoons.

**(vii) Western Disturbances and Tropical Cyclones**

The inflow of western disturbances which move under the influence of Westerly jet streams from the Mediterranean Sea influence winter weather conditions over most of Northern Plains and Western Himalayan region.

The tropical cyclones also develop in the Bay of Bengal. The frequency and direction of these cyclones influence weather conditions during Southwest monsoons over most parts of India and along the eastern coast during retreating monsoon season i.e. in October and November.

**(viii) El-Nino Effect**

Weather conditions in India are also influenced by El-Nino which causes wide spread floods and droughts in tropical regions of the world. El-Nino is a narrow warm current which some times appears off the coast of Peru in South America during December. It is a temporary replacement of the cold Peru current which normally flows along this coast. Sometimes, becoming more intense it increases the surface water temperatures of the sea by 10° C. This warming of tropical Pacific waters affects the global pattern of pressure and wind systems including the monsoon winds in the Indian Ocean. It is believed that the severest drought of 1987 in India was caused by El-Nino.

**(ix) Southern Oscillation and its Effect**

The southern oscillation is a pattern of meteorological changes which are often observed between Indian and Pacific oceans. It has been noticed that whenever the surface level pressure is high over Indian ocean, it is low over Pacific Ocean and vice-versa. When the pressure is high over the Pacific Ocean and low over Indian Ocean, the Southwest monsoons in India tend to be stronger. In the reverse case, the monsoons are most likely to be weaker.

\* The factors affecting the climate of India are : location and latitudinal extent, distance from the sea, the northern mountain ranges, physiography, monsoon winds, upper air circulation, western disturbances and tropical cyclones, formation of El-Nino and southern oscillation.

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**INTEXT QUESTIONS 18.2**


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1. Name the mountain range which acts as a climatic divide for the entire Indian subcontinent  
\_\_\_\_\_
  2. Why is the climate of Mumbai equable and that of Delhi continental?  
\_\_\_\_\_
  3. Name the Jet Stream which brings Western disturbances in India.  
\_\_\_\_\_
  4. Why do Northeast Monsoons cause no rainfall in most parts of India ?  
\_\_\_\_\_  
\_\_\_\_\_
  5. Why does reversal of winds take place in India before the onset of southwest monsoons?  
\_\_\_\_\_  
\_\_\_\_\_  
\_\_\_\_\_
- 

**18.5 THE CONCEPT AND MECHANISM OF MONSOON**

Monsoons refer to a system of winds in the tropical regions under which the direction of the winds is reversed completely between the summer and the winter seasons. Under this system, the winds blow from land to sea in winter and from sea to land in summer. Therefore, most of the rainfall in the regions influenced by the monsoons is received in the summer season while the winter season is generally dry.

\* Monsoon implies the system of tropical winds with complete reversal in their direction between winter and summer seasons.

According to the traditional belief, the monsoon is caused by the differential heating of land and sea. Due to a higher temperature over the land mass in summer, a low pressure area develops over the continents and the winds blow from neighbouring oceans towards the land. These winds are of maritime origin and hence cause ample rainfall in summer. On the other hand, the continents become colder than the neighboring oceans in winter. As a result a high pressure area is developed over the continents. Therefore, winds blow from land to sea in winter. These winds being of continental origin, are dry and do not cause rainfall. This traditional theory of monsoon has been criticized by the German meteorologist Flohn. He argues that the differential heating of land and sea is not enough to cause a seasonal reversal of winds at a global scale. He has explained the origin of the monsoon on the basis of seasonal shift of the pressure and wind belts under the influence of the shift of the vertical rays of the sun.

According to this theory, as the vertical rays of the sun shift northwards over the Tropic of Cancer in summer season, the Inter-Tropical Convergence zone (ITCZ) also shifts to north. This results in the formation of a low pressure area over the northwestern parts of India. This low pressure is further intensified by the high temperatures in this region. This low

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pressure area sucks the air from the Indian Ocean towards the Indian land mass in the form of Southwest monsoons. In winter season, the ITCZ shifts southwards and a mild high pressure is produced over northern parts of India. This high pressure is further intensified by the equator ward shift of the sub tropical high pressure belt. Due to this high pressure over northern India, the winds start blowing from northeast in the form of northeast monsoons. According to recent observations, the origin of Indian monsoon is influenced by a number of other factors, besides the differential heating of land and sea and the seasonal shifts of pressure and wind belts. One of the most important factors among these is the system of sub-tropical westerly and tropical easterly jet streams. The sub-tropical westerly jet streams blowing over India in winter cause a high pressure over northern India. It thus intensifies the northeast monsoons. This jet stream shifts northwards beyond India in summer season and tropical easterly jets develop over India in this season. The behaviour of these jet streams is partly responsible for the variations in the time of onset of southwest monsoons over India.

- \* According to the traditional belief, monsoon is caused by the differential heating and cooling of land and sea.
- \* Flohn, a German meteorologist opined that monsoon originates due to the shifting of planetary pressure and wind belts,
- \* According to modern scientists, the origin of Indian monsoon is influenced by a number of factors the important among these is the system of jet streams.

### INTEXT QUESTIONS 18.3

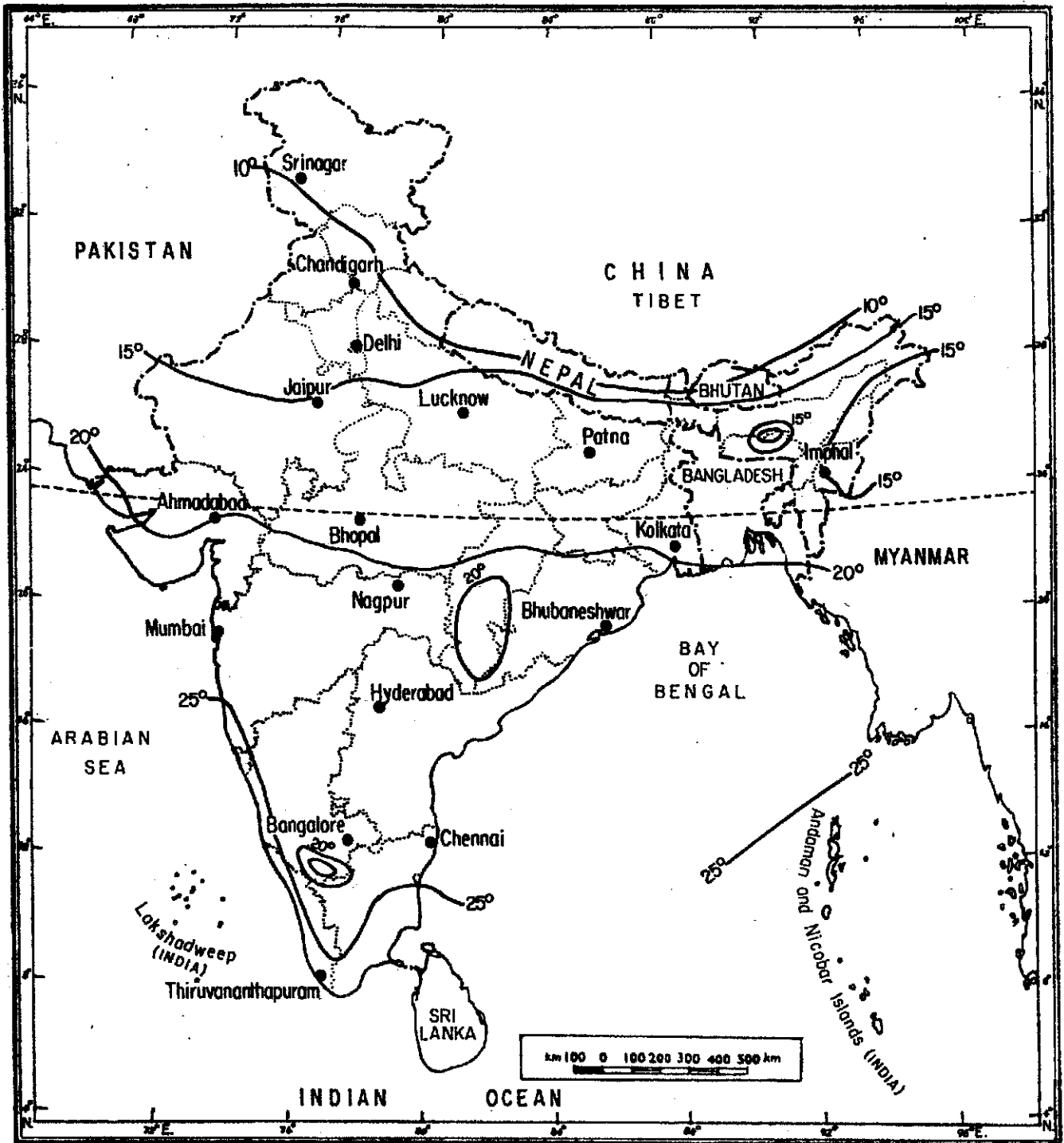
1. Define monsoons.  
\_\_\_\_\_
2. What is the main cause of the origin of monsoons according to Flohn?  
\_\_\_\_\_
3. List three important theories explaining the origin of monsoon in India.
  - (i) \_\_\_\_\_
  - (ii) \_\_\_\_\_
  - (iii) \_\_\_\_\_

### 18.6. CYCLE OF SEASONS IN INDIA

By now, you have understood that the complete reversal of direction of winds, is the most striking feature of the monsoons. These changing monsoon winds result in the change of seasons over the year. It is, therefore, important to understand in detail, the prevailing weather conditions throughout India during different seasons.

Climatically, the year is divided into following four seasons in India :

- (i) The cold weather season - December to February;
- (ii) The hot weather season - March to May in south and upto June in the north;
- (iii) The advancing Southwest monsoon season - June to September;
- (iv) The retreating Southwest monsoons season - October and November.



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The boundary of Madhya Pradesh shown on this map is as interpreted from the North-Southern Areas (Reorganisation) Act, 1971, but has yet to be verified.

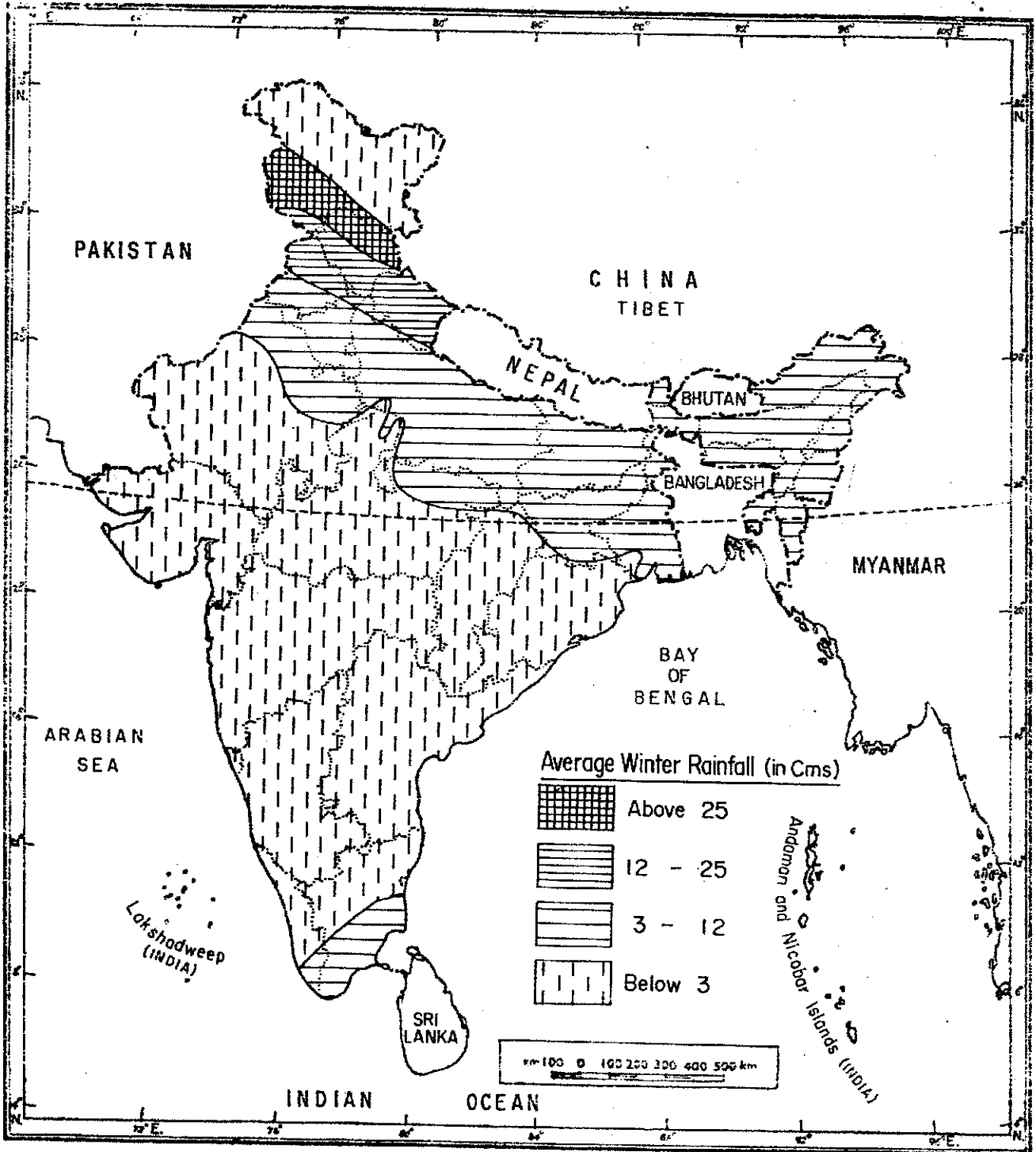
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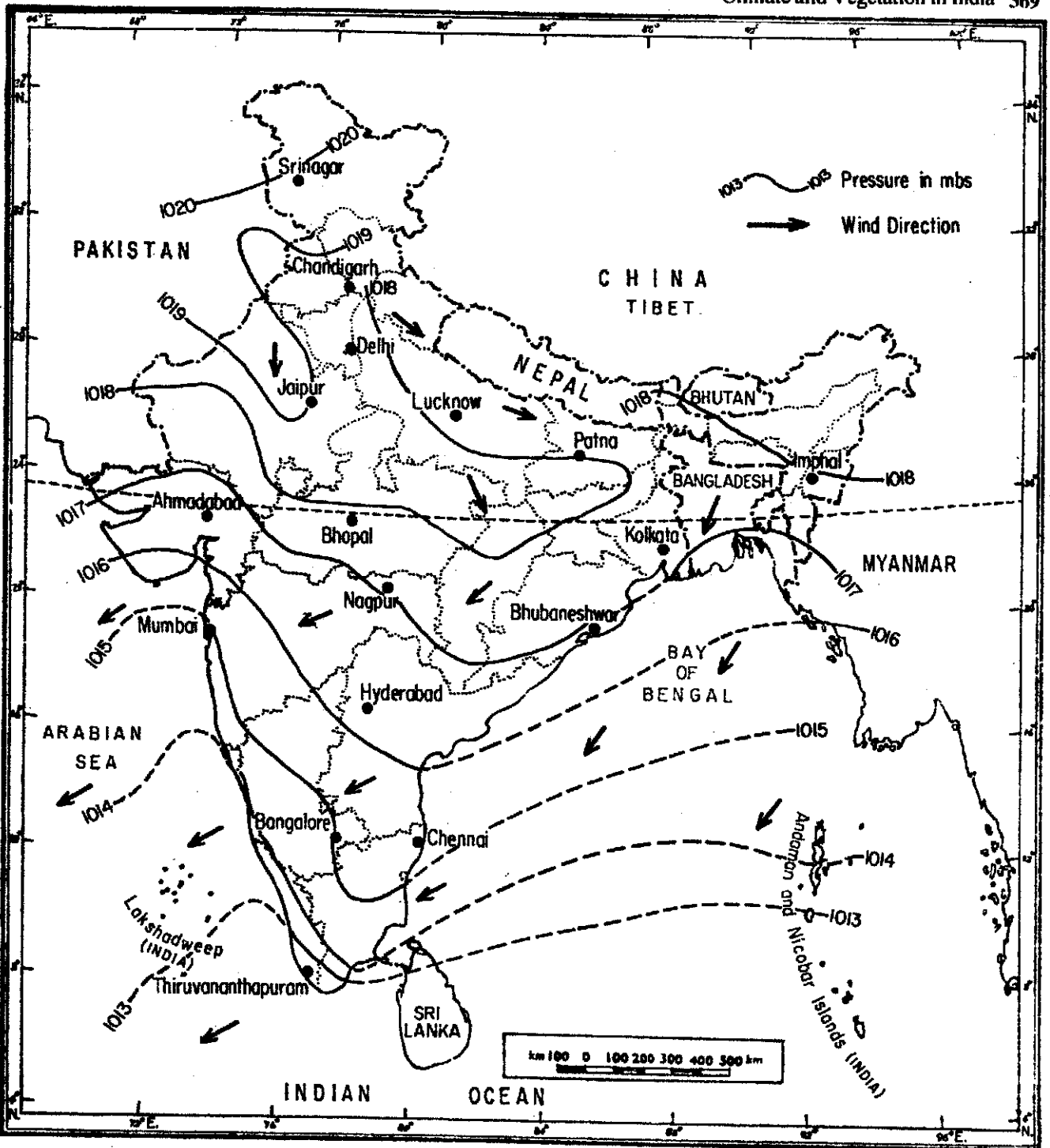
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**(i) The Cold Weather Season**

This season usually begins with late-November in northern India. January and February are the coldest months over most parts of the country as sun shines vertically over the Tropic of Capricorn in the southern hemisphere. During these months, the mean daily temperatures remain below 21°C over northern plains and northern mountain regions. The night temperatures some times fall below freezing point resulting in wide spread damage to the standing crops due to frost. The temperatures increase as one moves from north to south (Fig. 18.3). As a result of low temperatures, a feeble high pressure area develops over northern parts of India (Fig. 18.4). This mild high pressure causes the off-shore Northeast Monsoon winds. Their direction in Northern Plains is westerly owing to the relief. These land bearing winds being cold and dry don't give rain over most parts of the country. However, these winds cause rain along the Coromandel coast since they collect moisture on their way over the Bay of Bengal.

The succession of depressions is another feature of this season. These low pressure systems are called "Western disturbances" as they originate in the Mediterranean region. These depressions move with the westerly jet streams. Covering a long distance over Iraq, Iran and Pakistan, they reach India around mid December. Their arrival results in the increase of temperature and in light rains over northern plains. They cause wide spread snowfall over western Himalayas and the adjoining ranges. At times hail storms cause widespread damage to the standing rabi crops in northwestern plains. The meager rainfall caused by these disturbances is of great importance to the standing crops, particularly the wheat, in unirrigated areas. These depressions are followed by cold waves which bring down the temperatures considerably.

The peninsular India has no well defined winter season. The mean monthly temperatures in the month of January is above 20°C in this part. Moreover, the coastal plains hardly experience any seasonal change as is clear from the mean monthly temperature of above 27°C at Thiruvananthapuram. But Chennai records a temperature of 25°C during December and early January owing to the rains caused by Northeast monsoon winds (Table 18.1)

The important characteristics of cold weather season are:

- \* Low temperatures in the north and their gradual increase towards southern parts of India;
- \* Blowing of cold and dry northeast monsoons resulting in dry weather conditions in most parts excepting the Coromandel coast which does receive rainfall.
- \* Western disturbances cause light rain in northern plains and snowfall over the Himalayan ranges.

**(ii) The Hot Weather Season**

The apparent movement of the sun towards the north increases the temperatures in the northern plains. As a result, the spring sets in, soon giving way to the hot weather season which lasts till end of June in this region. The temperatures increase northwards and reach around 45°C in mid May in most parts of the northern plains. The characteristic features of this season in India are afternoon dust storms and 'Loo' which is a hot dry wind which blows during May and June mainly over the northern plains. These winds cause heat strokes

resulting in deaths of hundreds of people every year. The day temperatures at times rise above 45°C in some northwestern parts of the country.

The wind direction is variable during this season. The weather conditions are generally hot and dry throughout the country. However, dust storms cause drizzle in Northern Plains. Light showers are also experienced in Kerala, West Bengal and Assam. In Kerala, these premonsoon showers are popularly known as "Mango Showers". In West Bengal and Assam, they are called Norwesters or *KalBaisakhi*. Some times, due to high velocity of winds, these Norwesters cause heavy loss of life and property.

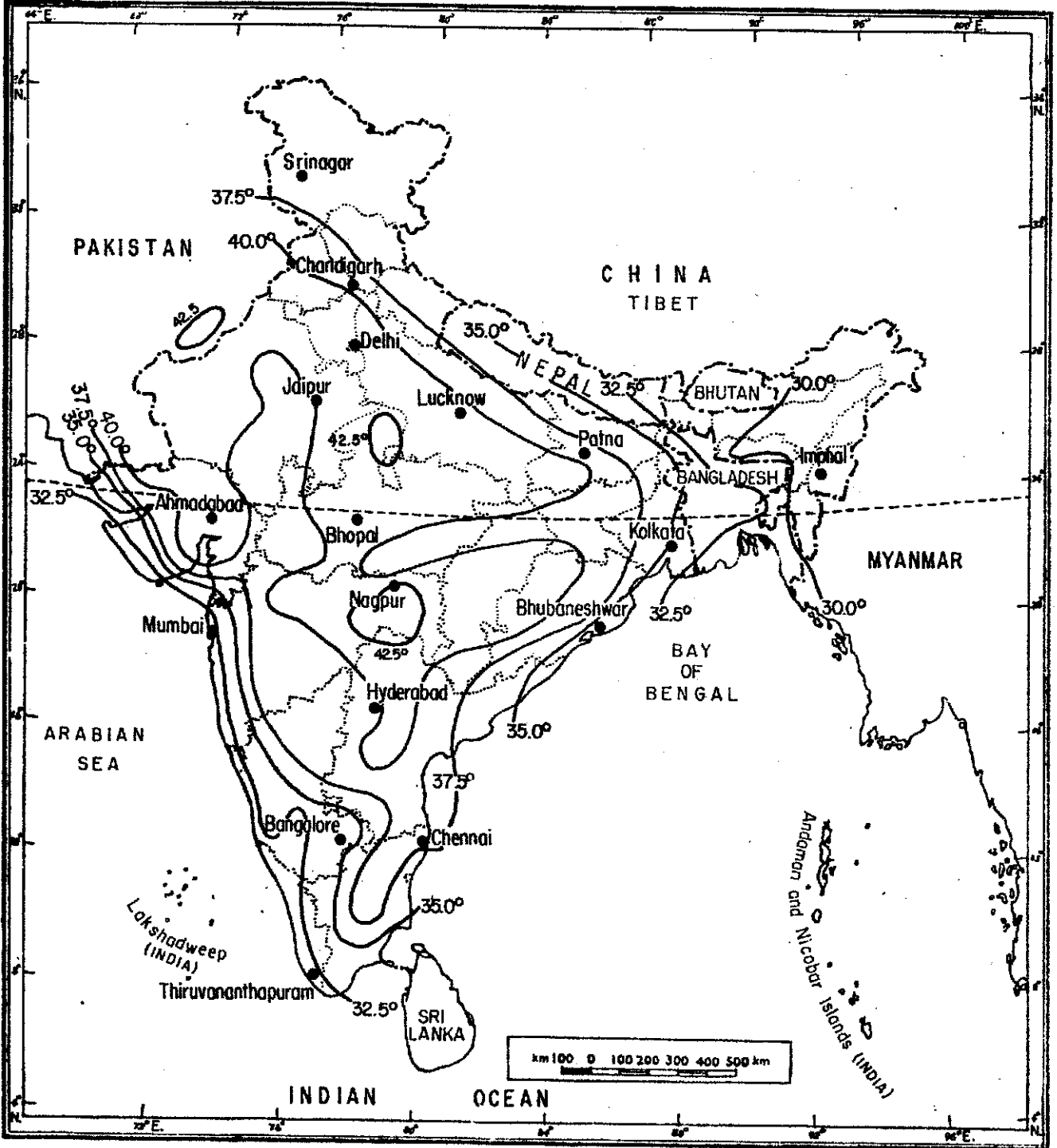
\* The main characteristic features of hot weather season are - hot and dry weather, blowing of Loo - a hot dry wind in northern plains, afternoon dust storms some times causing drizzle and mild showers in Kerala (Mango showers), West Bengal and Assam. (Northwesters / Kali Baisakhi)

### (iii) The Advancing Southwest Monsoon Season

This season is a rainy season for most parts of India. It starts with the inflow of Southwest monsoons which strike the coast of Kerala normally in the first week of June and cover most of India by mid July. This weather continues till September. The arrival of these warm moisture laden winds brings a total change in weather conditions. Their arrival causes sudden rains which bring down the temperatures considerably. The decline in temperature is between 5°C to 10°C. The sudden onset of rain is called break of monsoons or the burst of monsoons. The arrival of these winds may be delayed by a week or two depending upon the pressure conditions over northern plains and over the Indian Ocean (Fig. 18.1). The peninsular shape of India divides these Southwest monsoons into two branches - Arabian Sea Branch and Bay of Bengal Branch.

(a) Arabian Sea Branch of Southwest monsoons strikes the western coast of India and causes heavy rains on the western slopes of the Western Ghats. After crossing the Western Ghats, these winds cause less rainfall on the eastern slopes as they gain in temperature while descending. This area is, therefore, known as rain shadow area. This explains why interior parts of Maharashtra, Karnataka and Telangana get meagre rains from these winds. Southwest monsoons striking along the coast of Saurashtra and Kutch and pass over Rajasthan and beyond to meet the Bay of Bengal Branch. These winds cause widespread rain in these states and western Himalayan region.

(b) The Bay of Bengal Branch is divided into two sub branches after striking eastern Himalayas. One branch moves towards the east northeast direction and causes heavy rains in Brahmaputra valley and northeast hills of India. The other branch moves towards northwest along the Ganga valley and the Himalayan ranges causing heavy and widespread rains over vast areas. In this region, the amount of rainfall decreases from east to west owing to the progressive decrease in humidity of these winds (Fig. 18.8)



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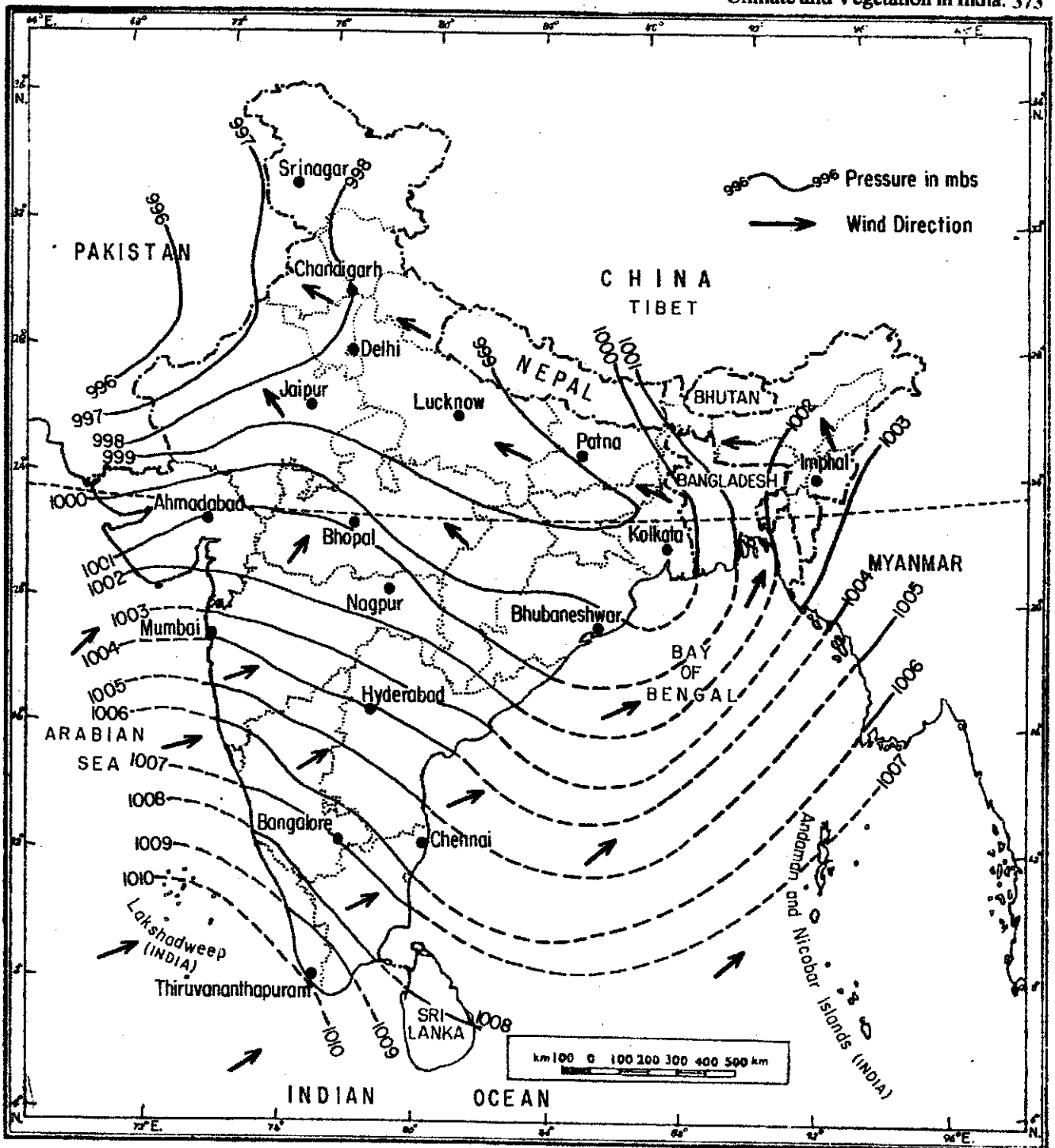
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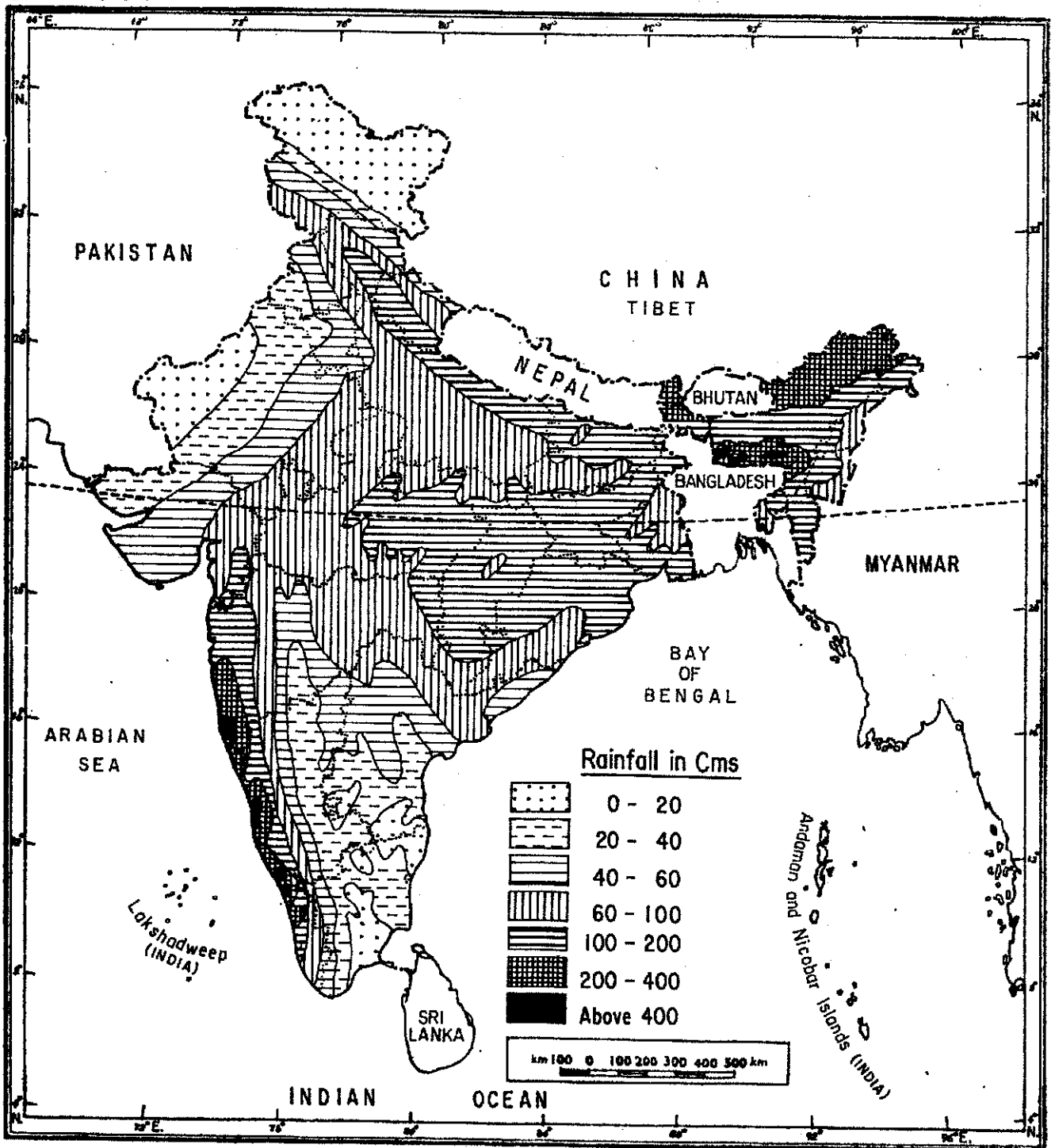
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**(c) The characteristics of Southwest Monsoons**

- (i) These winds generally strike the Indian coast in the first week of June. But their arrival and departure may be before time or even it may be delayed.
- (ii) There may be dry spells in between rainy periods. Such long dry spells may even lead to failure of crops.
- (iii) At times, these winds skip over certain regions without causing rainfall.
- (iv) The amount and timing of rainfall and intervening duration of wet and dry spells varies from year to year. This is known as the vagaries of the monsoons.
- (v) The spatial distribution of rainfall is uneven - some regions may receive heavy rains while the others will have to be contented with meagre or scanty rains.
- (vi) Generally, these winds start retreating by the end of September. But, sometimes, their departure may be delayed till October or they may retreat even much earlier.

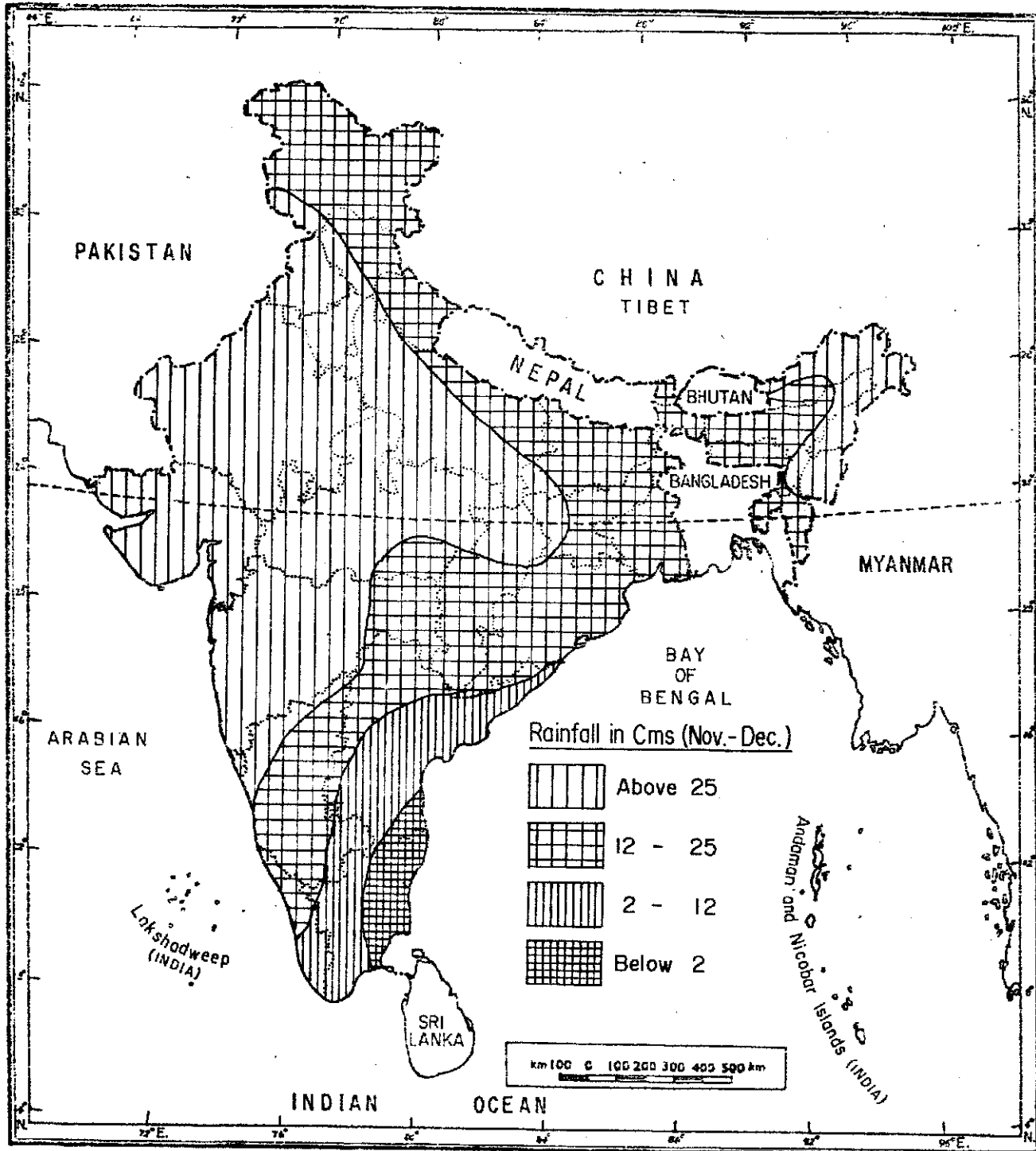
The main features of advancing South West monsoon season are :

- \* Low pressure conditions over Northwestern parts of India and high pressure conditions over surrounding seas.
- \* The general wind direction particularly on the Arabian Sea and the Bay of Bengal is southwest to northeast. The cause wide spread rains interspersed with dry spells.
- \* The onset of monsoons is in the first week of June and with drawal by the end of September.
- \* The weather is generally hot and humid during this season.

**(iv) The Retreating Southwest Monsoon Season**

The Southwest monsoons start retreating in the first week of September from Pakistan border in Northwest India. Thus, these winds withdraw earlier from the regions where they reach the last. The retreat of these winds takes place due to weakening of low pressure area over the northwestern parts of India. This happens due to low temperatures caused by apparent shift of the sun towards the equator and also owing to the widespread rains bringing down temperatures perceptibly. Consequently, the air pressure starts decreasing. Such changes in the patterns of atmospheric pressure causes Southwest monsoons to withdraw. Hence, this period is known as the season of retreating of Southwest monsoons. By the end of October, these winds retreat from most of northern India. As a result, fair weather conditions prevail over this region. The moist air and high temperatures around 24°C make weather very oppressive and unbearable in the month of October. This is called 'Kwar Ki Umas' or "October heat." The continuous decrease in temperature after mid-October help winter to set in by November or early December.

The low pressure area lying over Northwest India is transferred to the middle of the Bay of Bengal by the end of October. As a result of these unstable conditions, severe cyclonic storms originate in the Bay of Bengal. These cyclonic storms strike along the eastern coast of India causing wide spread rain in the coastal regions. Some times very sever storms cause damage to the standing crops, cattle, property, the lines of transport, communication and even electricity. Tamil Nadu coast receives maximum of its rainfall during October and November - the period of retreating monsoons.



Based upon Survey of India outline map printed in 1979.

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The main characteristic features of retreating Southwest monsoon season are :

- \* weakening of low pressure area over Northwest India;
- \* fall in temperatures throughout India;
- \* shifting of low pressure area to the south; and
- \* origin of cyclonic storms in the Bay of Bengal causing heavy rains and damage to crops and property along the eastern coast of India.

### INTEXT QUESTIONS 18.4

1. List four important features of each seasons given below -

(a) Cold Weather Season

- (i) \_\_\_\_\_ (ii) \_\_\_\_\_  
 (iii) \_\_\_\_\_ (iv) \_\_\_\_\_

(b) Hot Weather Season

- (i) \_\_\_\_\_ (ii) \_\_\_\_\_  
 (iii) \_\_\_\_\_ (iv) \_\_\_\_\_

(c) The Advancing Southwest Monsoon Season

- (i) \_\_\_\_\_ (ii) \_\_\_\_\_  
 (iii) \_\_\_\_\_ (iv) \_\_\_\_\_

(d) The Retreating Southwest Monsoon Season

- (i) \_\_\_\_\_ (ii) \_\_\_\_\_  
 (iii) \_\_\_\_\_ (iv) \_\_\_\_\_

2. Which of the following statements are correct?

- (i) Northeast Monsoon is cold and dry and do not cause rain over most parts of India.
- (ii) Western disturbances move towards India because of the Easterly jet streams.
- (iii) Region lying to the west of Aravallis is not visited by rain bearing winds and hence receive no rainfall.
- (iv) Severe cyclonic storms develop over the Bay of Bengal during October and November causing wide spread rain and considerable damage to life and property along the eastern coast.
- (v) The sudden arrival of monsoon is called the burst of monsoon.
- (vi) Tamil Nadu receives maximum of its rainfall during winter.

### 18.7 DISTRIBUTION OF ANNUAL RAINFALL

Study the map (Fig. 18.10) carefully, you will find that the regional variations in average

annual rainfall are well pronounced. The map on distribution of rainfall shows that northeastern parts of Jammu and Kashmir and extreme western Rajasthan receive a rainfall of less than 20 cm. On the other hand, the west coastal plains, Sub-Himalayan areas of northeast India including the Shillong plateau receive more than 200 cm. of annual rainfall. Southern slopes of Khasi and Jaintia Hills, particularly in the Cherrapunji Valley receive the highest rainfall exceeding 1000 cm., while the Brahmaputra valley and Purvachal hills towards east and north east receive rainfall of 200 cm. or less. Starting from the southern coast of Gujrat, the isohyte of 100 cm. runs somewhat parallel to the coast of Western Ghats upto Kanyakumari. To the east of Western Ghats, the rainfall drops abruptly below 60 cm. over interior Maharashtra and Karnataka. Most large parts of Punjab, Haryana, central and eastern Rajasthan and western Gujarat also receive rainfall below 60 cm. Starting from the southwestern parts of Jammu and Kashmir, the isohyte of 100 cm. moves eastwards upto east of Allahbad from where it bends to the west and south west, running over western Madhya Pradesh, eastern Maharashtra and northern Andhra Pradesh, it joins eastern coast near Visakhapatnam. To the west and south west of this isohyte, the areas receive less rainfall. Some parts of Coromandel coast receive a rainfall of more than 100 cm. The areas receiving less than 100 cm. of rainfall depend on means of irrigation for agricultural activities

In India, distribution of rainfall particularly of the southwest monsoon has a close relationship with the relief. Hence is it even desribed as "relief" or "orographic" rainfall. By and large places with higher altitude have greater chance to catch more rainfall than the places with less altitude. The direction of moist winds also matters.

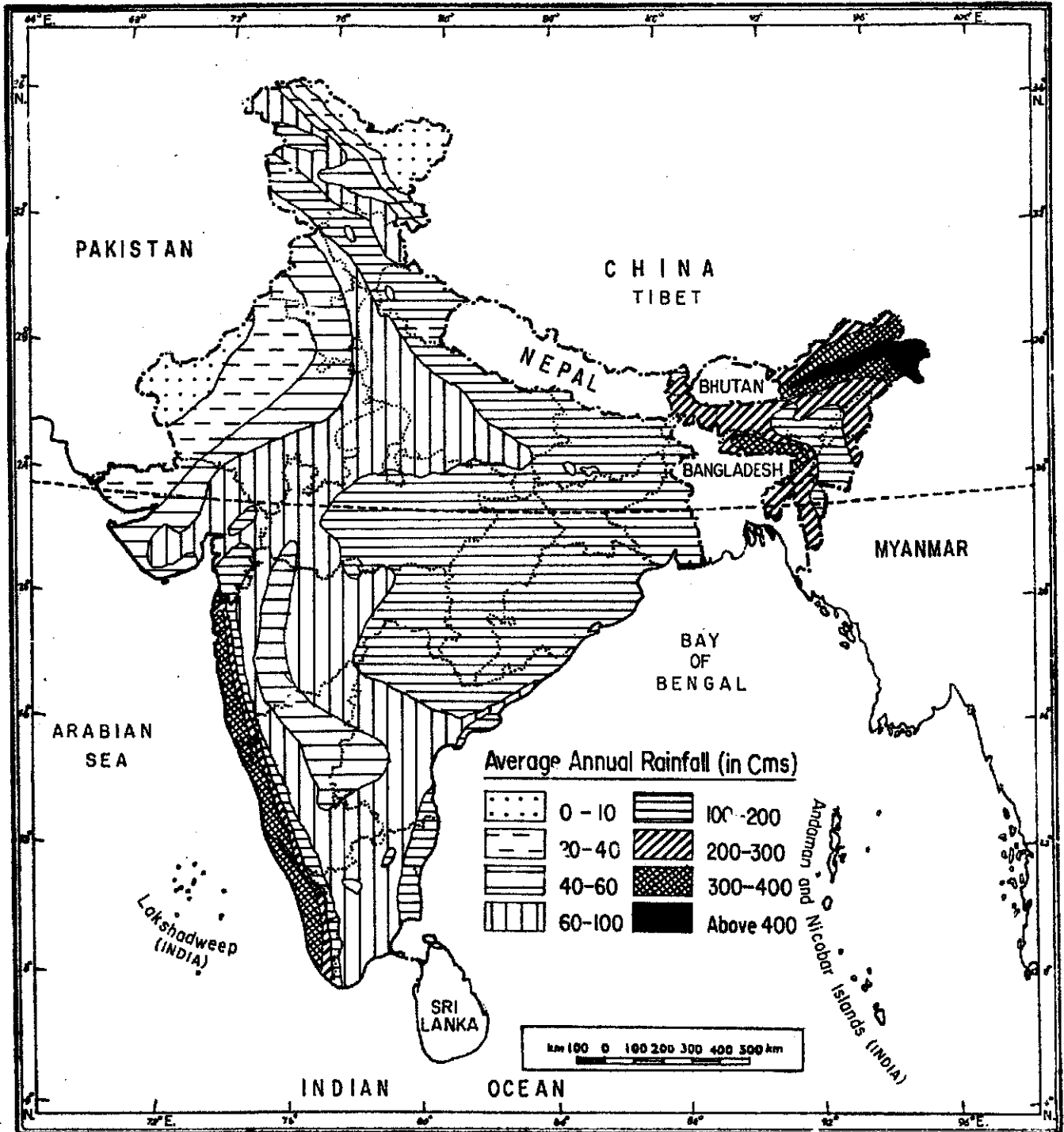
The distribution of annual rainfall in different parts of India shows the following trends :

- \* The rainfall decreases as one moves from Calcutta to Amritsar.
- \* It shows declining trend towards interior from the coastal areas on Deccan Plateau.
- \* North eastern parts receive more rainfall than north western parts of India.
- \* Areas lying on the windward side receive more rains than the areas lying on the leeward side.

### 18.8 The Monsoonal Unity of India

Despite the regional diversities in climatic conditions it is obvious from the above description that there exists a climatic unity in India. The 'Climatic Unity' means that weather conditions over different parts of India are more or less the same during different seasons round the year leaving minor variation as exceptions to the rule. Indian climate is called 'monsoon climate'. It explains how much influence the monsoon winds have in bringing climatic unity. This unity in climatic conditions results from the combined influence of regular movements of monsoons (seasonal winds) and the bounding role of the Himalayan mountain system.

The monsoonal unity of India caused by these twin factors referred to earlier is discernible in the following facts which reflect upon the life styles and activities of the common masses in India.



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**(i) Rhythm of seasons :** The sequence of hot, wet and cold seasons affect the life styles and economic activities of the people throughout India in the following ways :

Firstly, the farmers all over India start their agricultural activities i.e. ploughing of fields, sowing of seeds, transplantation etc. with or just before the onset of monsoons. The pattern, Kharif crops - rice and millets, cotton and sugar cane in different areas is an expression of amount of rainfall they receive. During winter, wheat is the major rabi crop in cool and irrigated areas; whereas barley, gram and oil seeds are common crops of unirrigated areas in northern and central India.

Secondly, the clothes are also affected by seasons. During Summer, the people of India wear cotton clothes whereas the woollen clothes are used in winter season especially in north and central India.

Thirdly, most parts of India have to put up with a long dry season; contrary to it the season of life giving rains is limited to only a few months. This has a far reaching effect on the life style of the Indian people. When the rain-drops of the monsoon clouds fall on the thirsty parched land, their music and fragrance coming out of the land generate similar emotional responses all over India. This is reflected in the Kajari of Bhojpuri and Malhar of Brij and their counter parts in other regions of India. Most of the Indian festivals are closely linked with seasons. In North India, Baisakhi is celebrated when rabi crop is ready for harvesting. During winter, when the sun shines vertically over the Tropic of Capricorn and extreme cold weather conditions prevail over northern plains Lohri and Makar Sakranti are celebrated in the north and west while Pongal distinctly is its southern counterpart. Holi is celebrated in spring after bidding good bye to the prolonged cold winter especially in the north.

Fourthly, the rainfed subsistence farming has been the oldest response of the village community . Its entire year long economy is based on it, country of monsoons, howsoever meagre it may be.

Lastly, the seasonal and regional variations in weather conditions have made different regions capable of producing different crops in varying quantities making all regions completely interdependent. This is no mean a contribution of the monsoons in promoting underlying unity despite all pervasive diversity.

**(ii) Thirst for Water :** You know that rain occurs over most parts of India only during four or five months of the year. Thus, India remains dry for seven to eight months in a year. Even during rainy season, spells of dry period are common. Being an agricultural society, the need for water is all pervasive in most parts of India. Even the rainiest parts around Cherrapunji and in Konkan and Kerala have no drinking water during the long and dry summer months. All eyes are focussed on black monsoon clouds in every part of the country.

**(iii) The Waiting for Monsoon Rains :** The farmers as well as citizens all over India eagerly wait for monsoon rains after a long dry season not only to get rid of summer heat but to start agricultural activities which sustain rural as well as urban economy. So, bursting of monsoon is welcomed with equal joy everywhere in India.

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(iv) **Incidence of Droughts and Floods :** The paradox of Indian monsoons is that no part in India is spared from occasional or even frequent floods or droughts, if not famines. The drought are common even in the areas of heavy rainfall like Kerala and Assam; likewise, dry areas of Northwest India are not free from floods, be it Punjab or Rajasthan desert. Consequently, there is need to conserve, control and store water for irrigation, drinking and power generation.

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### INTEXT QUESTIONS 18.5

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1. Write T/rue or F/false against each of the following statements
    - (a) The amount of rainfall decreases from east to west in northern plains.
    - (b) Gujarat and Rajasthan receive low rainfall as monsoon winds become dry on reaching these states.
    - (c) The date of arrival of monsoon winds is always definite in different parts of India.
    - (d) Coromandel coast receives bulk of its rainfall in October-November from north east monsoon winds.
    - (e) Only certain parts of India experience the occurrence of droughts and floods.
  
  2. Name two areas of India which receive less than 20 cm. of annual rainfall.
    - (i) \_\_\_\_\_
    - (ii) \_\_\_\_\_
- 

### 18.8 NATURAL VEGETATION IN INDIA

The assemblage of plant species e.g. trees, shrubs, grasses, creepers and climbers and the like living in association with one another in a given environment is known as natural vegetation. Contrary to this, a forest denotes a large tract covered by trees and shrubs which has an economic significance for us. Thus, a forest has a different connotation than what the Natural Vegetation has.

The variations in climatic conditions in India have resulted in having various types of natural vegetation in different parts of the country. It is so because each plant needs a definite range of temperature and precipitation for its growth. This justifies the growth of tropical evergreen vegetation confined mainly to the Western Ghats, on account of hot and wet climatic conditions obtained there. The same is true for temperate evergreen vegetation of northeast India and thorny or arid or semi-arid vegetation of Rajasthan desert and adjoining areas. Deciduous vegetation grows in central parts of India owing to moderate climatic conditions prevailing over there.

#### MAJOR VEGETATION TYPE

Natural vegetation cover in India is generally divided under the following heads :

- i) Moist Tropical Evergreen and Semievergreen Vegetation
  - ii) Moist Tropical Deciduous Vegetation
  - iii) Dry Tropical Vegetation
-

- iv) Tidal Vegetation and
- v) Mountain Vegetation.

Let us deal with them one by one :

### 1. Moist Tropical Evergreen Vegetation

These are the tropical rain forests which are further divided into two sub-types on the basis of their characteristics as under-

**(a) The Wet Tropical Evergreen Vegetation** is found in regions of very high annual rainfall exceeding 300 cm. with a very brief dry season. Southern Western Ghats of Kerala and Karnataka and very wet Northeastern Hills are known for this type of vegetation. It resembles the equatorial vegetation. This type of vegetal cover has been badly depleted due to over cutting. The major characteristics of this type of vegetation are given below.

- (i) These forests are dense and have lofty evergreen trees, often as high as 60 metres and above.
- (ii) The number of vegetal species per unit area is too large to exploit them commercially.
- (iii) Mahogany, Cinchona, Bamboos and Palms are typical species of plants found in these forests. Undergrowth is very dense and thick. Grass is almost absent.
- (iv) The wood of these trees is very hard and heavy to work with.

**(b) Moist Tropical Semi-evergreen Vegetation** is found between wet evergreen vegetation and moist temperate deciduous vegetation. This type of vegetation is found on the Meghalaya plateau, Sahyadris and Andaman and Nicobar Islands. This vegetation is confined to areas receiving an annual rainfall of about 250 to 300 cm. Given below are its important characteristics.

- (i) The vegetation cover is less dense than the wet evergreen forests.
- (ii) Timber of these forests is fine grained and of good quality.
- (iii) Rosewood, Aini and Telsur are important trees in Sahyadris, Champa, Joon and Gurjan in Assam and Meghalaya and Ironwood, Ebony and Laurel grow in other regions.
- (iv) Shifting agriculture and over exploitation of forests has depleted this vegetal cover to a great extent.

### 2. Moist Tropical Deciduous Vegetation :

This is the most wide spread vegetal cover of India. This type of vegetation is found in areas receiving annual rainfall of 100 to 200 cm. These include the Sahyadris, the north eastern plateau of the peninsula, the Himalayan foot hills in the Sivaliks, the bhabars and terai. The important characteristics of this vegetation are :

- (i) The trees shed their leaves once in a year in dry season.
- (ii) This is a typical monsoon vegetation consisting of larger number of commercially important species than the evergreen forests.
- (iii) Teak, sal, sandalwood, shisham, cane and bamboo are important trees of these forests.
- (iv) Large scale cutting of trees for timber has depleted these forests hopelessly.

### 3. Dry Tropical Vegetation :

This type of vegetation is divided into two groups as under :

---

(a) Dry Tropical Deciduous Vegetation is found in regions receiving annual rainfall between 70 to 100 cm. These regions include parts of Uttar Pradesh, northern and western Madhya Pradesh, parts of Gujarat, Maharashtra, Andhra Pradesh, Karnataka and Tamil Nadu. These areas experience a long dry season and a moderate rainfall limited at best to four months. The important characteristics of this vegetation are stated as under.

- (i) Stretches of open grass are most common between group of trees. Teak is the dominant tree of this type of vegetation.
- (ii) The trees shed their leaves during the long dry season.

(b) Dry Tropical Thorny Vegetation is found in areas receiving annual rainfall less than 70 cm. These areas include north and north western parts of India and leeward side of the Sahyadris. The important characteristics of this type of vegetation are as underneath.

- (i) Vast, poor and coarse grass lands are interspersed with widely spaced trees and bushes.
- (ii) Acacia, euphorbias, cactus etc. are true representatives of this type of vegetation. Wild palm and spiny and thorny varieties are also found here and there.

#### 4. Tidal Vegetation

This type of vegetation grows mainly in the deltaic regions of the Ganga, Mahanadi, Godavari and Krishna which are flooded by tides and high sea waves. Mangrove is

the representative of this type of vegetation. Sundari is the typical tree of tidal forests. It is found in abundance in the lower Ganga delta of West Bengal. This is the reason why it is popularly known as Sunderban. It is known for its hard and durable timber.

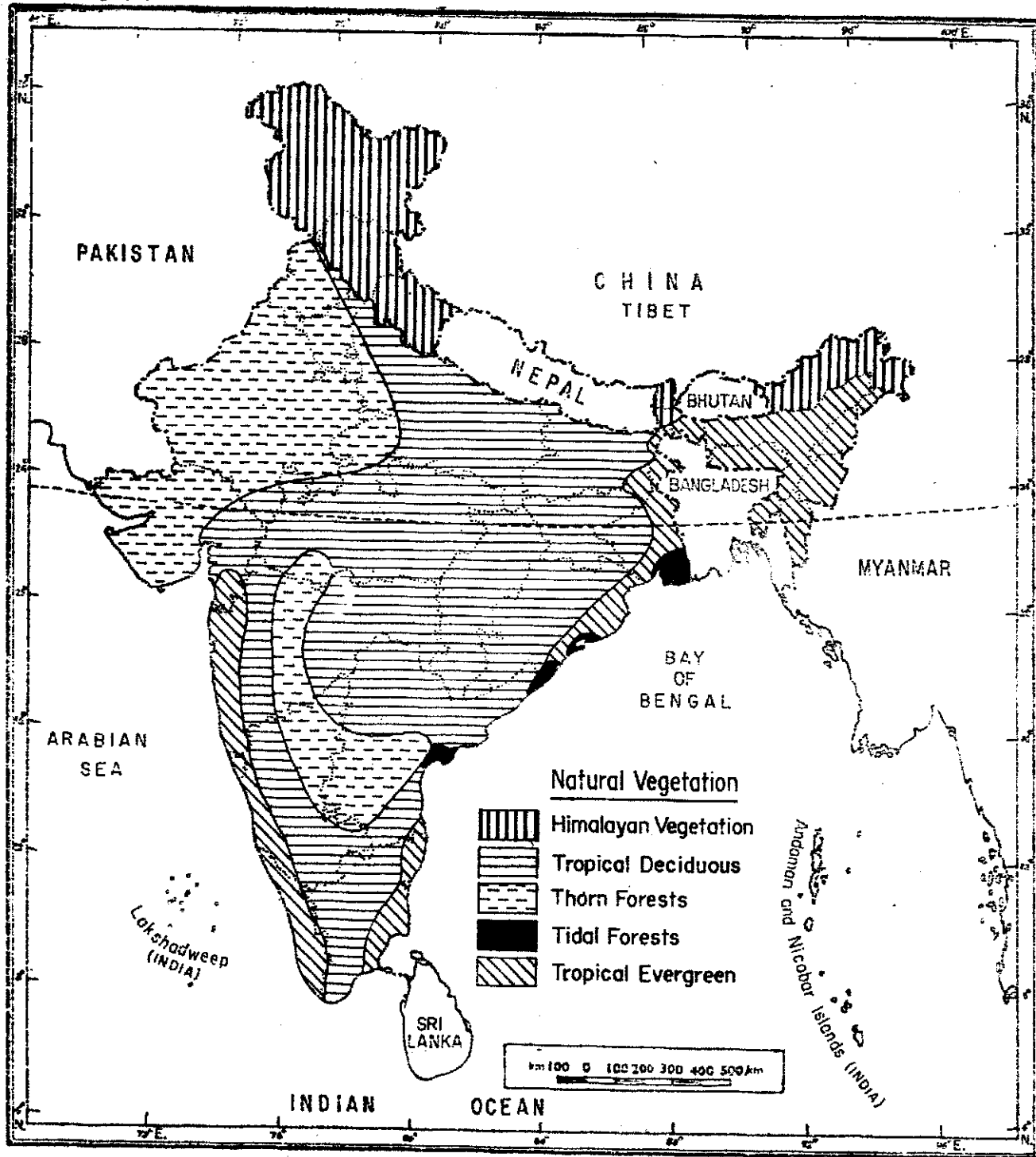
#### 5. The Mountain Vegetation

Due to the difference in temperature and other weather conditions of northern and peninsular mountain ranges, there exists difference in the vegetal cover of these two groups of mountain ranges. Hence, the mountain vegetation can be classified as the mountain vegetation of Peninsular plateau and the mountain vegetation of the Himalayan ranges.

##### (a) The Mountain Vegetation of Peninsular Plateau

The high altitude area of the plateau region include Nilgiri, Annamalai and Palni hills, Mahabaleshwar in Western Ghats, Satpura and Maikal hills. The important characteristics of vegetation of this region are :

- (i) Stretches of open rolling grass plains with undeveloped forests or bushes.
- (ii) The wet temperate forests below 1500 metres are less dense than those found above this height.
- (iii) The forests have thick undergrowth, epiphytes, mosses and ferns.
- (iv) Magnolia, laurel, elm are common trees.
- (v) Cinchona and eucalyptus have been introduced from outside the country.



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**(b) The Mountain Vegetation of the Himalayan Ranges**

In the Himalayan mountain region, the vegetation is different at increasing altitudes. This can be divided into following types :

- (1) Moist Tropical Deciduous forests are found along the foot hills in the Siwaliks, upto the height of 1000 metres. We have already learnt about these forests.
- (2) The Wet Temperate Evergreen forests are found in the areas lying between 1000 to 3000 metres. The important characteristics of these forests are stated as under.
  - (i) These are very thick forests of lofty trees.
  - (ii) Oak and chestnut are the predominant trees of the eastern Himalayan region while Chil or Chir Pine is in the western part.
  - (iii) Sal is the important tree in lower altitudes.
  - (iv) Deodar, silver fir and spruce are predominant trees between the height of 2000 and 3000 metres. These forests are less dense as compared to the forests at lesser elevations.
  - (v) These forests are of great economic importance to the local population.

3. Dry Temperate Vegetation is found on the higher hilly slopes of this mountain region which has moderate temperatures and rainfall between 70 cm. and 100 cm. Important characteristics of this type of vegetation are :

- (i) This vegetation resembles the Mediterranean vegetation.
- (ii) Wild olives, acacia are important trees along with hard, coarse and thick savanna grass.
- (iii) Oak and deodar are found here and there.

4. Alpine vegetation is found between the altitude of 3000 and 4000 metres. The important characteristics of these forests are described below.

- (i) These are far less dense,
- (ii) Silver fir, juniper, birch, pine and rhododendron are important trees of these forests. However, all of them have only a stunted growth.
- (iii) Alpine pastures are found at still higher altitudes.
- (iv) The trees get progressively stunted as they approach the snow line.

- \* Natural vegetation is the assemblage of plant species living in association with one another in a given environment.
- \* Variations in temperature and rainfall conditions have a clear impact on vegetation of different regions.
- \* The major vegetation belts include the moist tropical evergreen, the moist tropical deciduous, dry deciduous, the tidal and the mountain vegetation - which telescope altitudinally the natural vegetation almost from the tropical to Alpinetypes.

---

**INTEXT QUESTIONS 18.6**


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1. Give suitable technical terms for the following statements :
    - (a) The assemblage of plant species living in association with one another in a given environment. \_\_\_\_\_
    - (b) A large area densely covered by trees and shrubs generally with a common crown or canopy \_\_\_\_\_.
  2. Choose correct alternative for each of the following statements :
    - (a) Climatic conditions comprise mainly
      - (i) temperature (ii) precipitation (iii) temperature and precipitation (iv) pressure
    - (b) The natural vegetation of north western parts of India is of
      - (i) moist tropical evergreen (ii) moist tropical deciduous (iii) dry tropical thorny type (iv) alpine type
    - (c) Alpine pastures are found in the Himalayan mountain ranges at the height between :
      - (i) 2000 to 2500 mts. (ii) 1300 to 1500 mts. (iii) 1500 to 2000 mts. (iv) 3000 to 4000 mts.
  3. Classify the following species of trees into the types of vegetation given below :- Mahogany, Ebony, Shisham, Cinchona, Sal, Palm, Rosewood
    - (i) Moist Tropical Evergreen \_\_\_\_\_
    - (ii) Moist Tropical Deciduous \_\_\_\_\_
    - (iii) Moist Tropical Semievergreen \_\_\_\_\_
  4. Name the type of vegetation found in the regions of annual rainfall
    - (i) exceeding 300 cm. \_\_\_\_\_
    - (ii) between 200 and 300 cm. \_\_\_\_\_
    - (iii) between 100 and 200 cm. \_\_\_\_\_
  5. Give two most important characteristics of the moist tropical deciduous vegetation.
    - (a) \_\_\_\_\_
    - (b) \_\_\_\_\_
- 

**WHAT YOU HAVE LEARNT**

- India is a country of climatic diversities which are expressed in the variations in the distribution of temperature, pressure, winds and amount of precipitation.
  - The factors which are responsible for determining the climate of different regions of India include her location and latitudinal extent, physiography, the role of Himalayan ranges as a climatic divide, the monsoon winds, upper air circulation, western disturbances and cyclonic storms.
  - Derived from Arabic word 'mousim' monsoon implies the rhythm of season and seasonal reversal of winds.
  - Meteorologically, the year in India is divided into four seasons namely the cold weather season, the hot weather season, the advancing southwest monsoon season and the retreating Southwest monsoon season. These seasons have different characteristics of weather conditions.
-

- Despite climatic diversities, there exists monsoonal rhythm and climatic unity in India. The monsoons and the Himalayan ranges as a climatic divide play an important role in unifying climatic conditions in India.
- Natural vegetation implies the assemblage of plant species living in association with one another in a give environment. Diversity in climatic conditions has resulted into a marked diversity in natural vegetation. The important vegetation types in India include the moist tropical evergreen, the moist tropical deciduous, the dry deciduous, the tidal forests and the mountain vegetation.

## TERMINAL QUESTIONS

1. Answer the following questions in brief :-
  - (i) How do western disturbances influence the weather conditions of north west India?
  - (ii) Define natural vegetation. How is a forest different from it?
  - (iii) Which place in India receives the maximum rainfall and why?
2. Distinguish between :
  - (i) The equable and extreme climate;
  - (ii) The cold weather season and hot weather season;
  - (iii) The southwest and northeast monsoons.
  - (iv) Wet and moist tropical evergreen; and moist tropical deciduous vegetation.
3. Give reasons :-
  - (i) Dras in Kargil is always colder than Thiruvananthapuram.
  - (ii) Rainfall decreases from Calcutta to Delhi.
  - (iii) Winter is dry and cold over greater part of India.
  - (iv) Heat becomes unbearable in October despite the temperatures being around 24°C.
  - (v) Southwest monsoons start retreating from northern India after September.
  - (vi) The western coastal plains receive more rainfall compared to the interior plateau region lying east of the Western Ghats.
  - (vii) The Himalayan vegetation belts are defined altitudinally and not horizontally.
4. Describe five major factors which influence the climate of India. Illustrate your answer with examples.
5. Explain with suitable examples the uneven distribution of rainfall in India.
6. Identify the characteristics of monsoons in India.
7. Explain with examples how climatic conditions affect natural vegetation in different parts of India.
8. Locate and label the following on the outline maps of India-
  - (i) Dras and Cherrapunji;
  - (ii) Areas receiving rainfall from 'western disturbances';
  - (iii) Areas receiving rainfall from northeast monsoons.
  - (iv) Areas receiving annual rainfall less than 20 cm.
  - (v) Tidal forests and tropical thorn forests.

## CHECK YOUR ANSWERS

### INTEXT QUESTIONS

#### 18.1

1. (a) Jaisalmer in Rajasthan desert (b) Dras in Jammu & Kashmir
2. (i) Thiruvananthapuram (ii) Delhi  
(iii) (a) Thiruvananthapuram (b) Nagpur (c) Delhi (d) Chennai  
(iv) June, July, August, September  
(v) Leh.

#### 18.2

1. The Himalayas
2. Mumbai lies along the western coast while Delhi is too far away to have any oceanic influence.
3. Western jet stream.
4. Because they are cold and dry land bearing winds.
5. Owing to the reversal of pressure conditions at the peak of the summer season between land and sea.

#### 18.3

1. Monsoons refers to a system of winds in the tropical regions under which the direction of winds is reversed completely between summer and winter.
2. The shifting of planetary pressure and wind belts.
3. (i) Differential heating and cooling of land and sea.  
(ii) Shifting of planetary pressure and wind belts.  
(iii) System of jet streams.

#### 18.4

- 1.(a) (i) Cold and dry in most of India.  
(ii) direction of winds is generally northeasterly.  
(iii) light rain, hails in northwestern plains and snowfall in Western Himalayan region.  
(iv) rainfall along coromondal coast from N.E. monsoons.
- (b) (i) generally hot and dry throughout India.  
(ii) Variable wind direction.  
(iii) blowing of hot and dry wind called "LOO" in northern plains causing heat strokes.  
(iv) light rain in Kerala, W. Bengal and Assam.(premonsoon showers)
- (c) (i) generally rainy throughout India.  
(ii) general direction of winds is southwesterly.  
(iii) onset and withdrawal of these winds is somewhat uncertain.  
(iv) amount of rainfall varies from place to place and time to time.
- (d) (i) Weakening of low pressure are over northern parts of India.  
(ii) fall in temperatures throughout India.  
(iii) shifting of low pressure area to the seas around India .  
(iv) origin of cyclonic storms in the Bay of Bengal causing heavy rains.
2. 1. (i) True; (ii) False; (iii) False\*; (iv) True; (v) True; (vi) False"

#### 18.5

1. (a) True; (b) False; (c) False; (d) True; (e) False
2. (a) Ladakh (b) Rajasthan desert

**18.6**

1. (a) Natural Vegetation (b) Forest
2. (iii) temperature and precipitation  
(b) (iii) dry tropical thorny type  
(e) (iv) 3000 to 4000 mts.
3. (i) Moist Tropical Evergreen - Mahogany, Cinchona and Palm  
(ii) Moist Tropical Deciduous - Sal, Shisham  
(iii) Moist Tropical Semi Evergreen - Ebony and Rose Wood
4. (i) Moist Tropical Evergreen  
(ii) Moist Tropical Semi Evergreen  
(iii) Moist Tropical Deciduous
5. (a) The trees shed their leaves once in a year in dry season.  
(b) This belt consists of a number of commercially important species of trees such as Teak, Sal, Shisham bamboos and Sandalwood.

**TERMINAL QUESTIONS**

1. (i) See page 32 second para graph  
(ii) See para first of 18.8 part of lesson on page 46.  
(iii) Cherrapunji in Meghalaya 1080 cms : lying in a valley surrounded by hills from three side, monsoons are forced to give heavy rains.
2. (i) Refer page 24 and 27  
(ii) Refer page 31, 32 and 35 for cold weather season and hot weather season.  
(iii) Refer page 32 for N.E. Monsoons and page 36 and 40 for S.W. Monsoons.  
(iv) Refer page 47 for moist tropical evergreen and for moist tropical deciduous vegetation.
3. (i) Because Dras is located in high altitude and latitude in interior parts of Jammu and Kashmir while Thiruvananthapuram has coastal location and is nearer to equator.  
(Refer page 24)  
(ii) Refer page 34  
(iii) Refer page 36  
(iv) Refer page 40  
(v) Refer page 40  
(vi) Refer page 40  
(v) Refer page 50. Owing to the difference in temperature and precipitation in the increase in altitude in the Himalayas.
4. Refer page 27 to 29
5. Refer to sections 18.6 & 18.7
6. Refer section 18.8
7. Refer section 18.8
8. (i) Refer your atlas for locating Dras and Cherrapunji  
(ii) Refer figure 18.4  
(iii) Refer figure 18.4  
(iv) Refer figure 18.10  
(v) Refer figure 18.12