# Chapter 13 Weather

## The Difference Between Weather and Climate

The term weather should not be confused with climate, though they are very closely related to each other in the study of meteorology and climatology. We don't hear people saying that the climate of the day is warm or cold, but we do talk of warm weather, a cold morning, a sunny afternoon, a rainy day or a chilly night. Any casual remarks about the atmospheric conditions of a certain place at a certain time are about weather. It is never static, and thus cannot be generalized. In the same country, even over a small area, the weather can vary tremendously. It may be sunny in one part of the district, but raining heavily a few miles away. Strong gales may be experienced along the coasts while the interior may be relatively calm. It is important to realise that any place can be subjected to haphazard changes in weather at any time.

When we speak of climate we mean the average atmospheric conditions of an area over a considerable time. For climatic averages, a minimum period of 35 years is desirable. This involves the systematic observation, recording and processing of the various elements of climate such as rainfall, temperature, humidity, air pressure, winds, clouds and sunshine before any standardization of the climatic means or averages can be arrived at. The climate of Malaysia is described as *hot, wet, equatorial climate* which is a summing up of the average everyday climate of the country throughout the year.

The degree of variability in the climate or weather of a country also differs. Generally speaking, the climate of temperate latitudes is far more variable than that of the tropics. The climate of the British Isles is so changeable that many people have commented that 'Britain has no climate, only weather'. Conversely, the climate of Egypt is so static that it makes a good deal of sense when people say that 'Egypt has no weather, only climate'.

## The Importance of Climate and Weather

The profound influence of climate and weather over man's activities can be seen from his everyday life. Forces of nature have regulated to a very great extent the sort of food we eat, what we wear, how we live and work. Our mental alertness, our physical characteristics and even our racial differences when closely examined have at least some relationship with climate. The direction of winds once controlled the pattern of trading routes. The safety of modern air communications is closely tied to accurate meteorological reports from the ground stations. Despite the advances made in science and technology, farmers and their crops are still at the mercy of the climate and the weather. Conditions of temperature, precipitation and humidity may promote or discourage the growth of fungus and diseases which may be injurious to both men and crops. Death rates are normally high in tropical countries and low in deserts, because germs are not transmitted readily in regions of high temperature and low humidity. Cool, fresh mountain air is always good for health.

*Weather Bureaux or Meteorological Stations* are scattered all over the globe, including the oceans, using some of the most up-to-date weather instruments to gather a wide range of data as raw materials for the construction of weather maps or synoptic

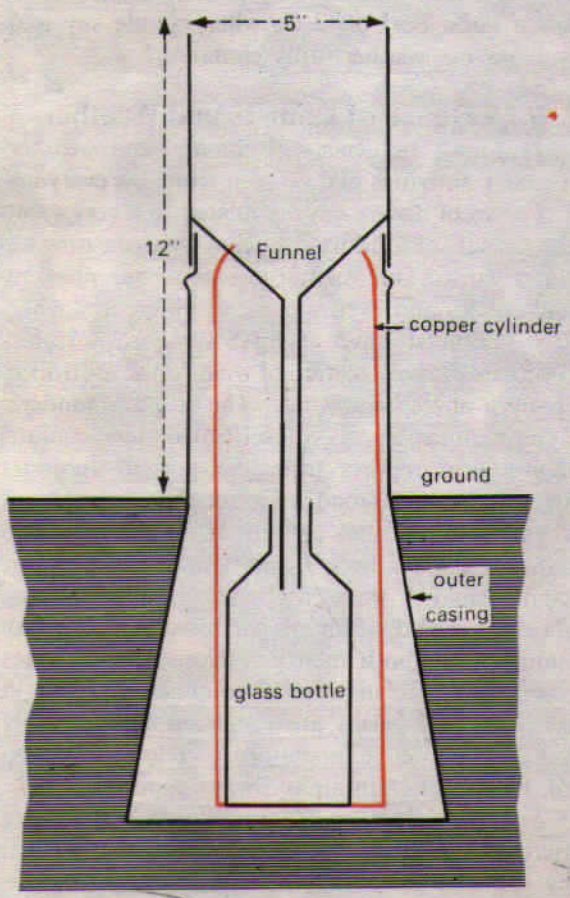
charts. Though men are still unable to tame the forces of nature such as floods, droughts, typhoons or hurricanes, a sound knowledge of the trends or the weather systems can often help to avoid or reduce the seriousness of the calamities. Professional meteorologists are able to forecast the weather fairly accurately from local observations. A fall in the barometer, a change of cloud types, a bright sunset or even a whisper of the wind can be very useful tips to a weather forecaster in detecting what is going to happen next. A casual glance at the sky will be sufficient for a weather expert to sum up the conditions of the atmosphere.

To-day farmers are becoming more and more dependant upon *meteorological services*. A knowledge of the likely weather of a place will be useful for a farmer to plan his work for the season or the year. Frequent *agricultural bulletins* issued by the Meteorogical Office will assist farmers to take due precautions against frosts, hail, heavy snowfall or a period of possible drought. Sailors at sea are warned promptly of any on-coming gale or typhoon. Modern air transport, military operations, geographical expeditions, even important games and outings, often take due consideration of meteorological reports. A fair knowledge of the weather is not only useful but often essential.

## The Elements of Weather and Climate

To collect various climatic data and to prepare maps and charts of them, the following elements of climate are normally observed and measured by weather instruments.

**1. Rainfall.** Rainfall including other forms of precipitation (snow, sleet and hail) is always measured by a metal instrument called a rain gauge (Fig 96). It consists of a copper cylinder with a metal funnel either 5 inches or 8 inches in diameter, which leads into a smaller copper container or a glass bottle. The hole in the funnel that leads down to the container is very small so that evaporation of the collected rain is minimised. The gauge should be at least one foot



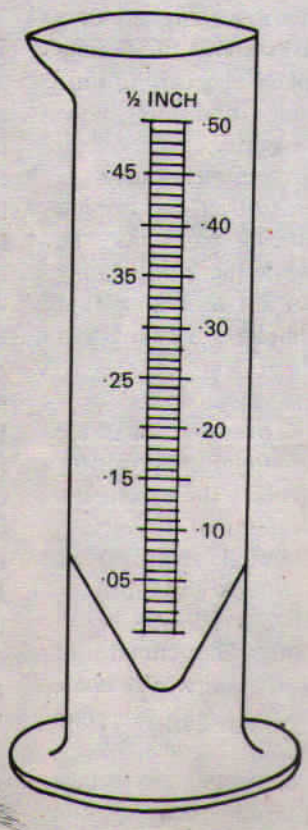





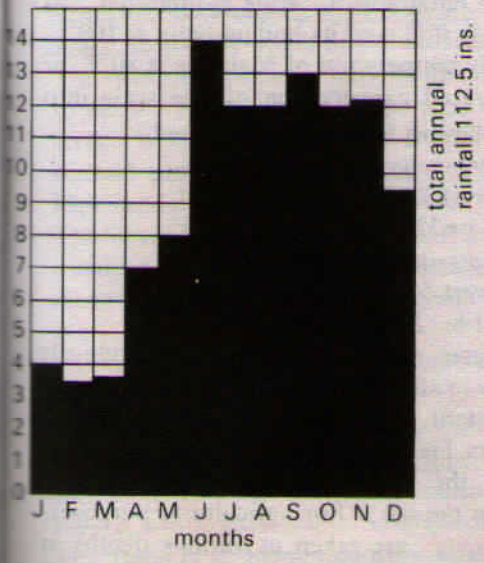
Fig 96 (a) A rain gauge (b) Ordinary measuring cylinder (c) A calibrated taper measure

above the ground and firmly fastened, to avoid splashing. The instrument should be sited well away from tall buildings, high trees and other objects which would shelter it.

The *measurement* of the rainfall is done by removing the funnel, emptying the rain in the container into a graduated cylinder with a $1\frac{1}{2}$ inch diameter. The reading should be done at eye-level and to an accuracy of 0·01 inch. For greater accuracy, a special kind of taper measure as shown in Fig. 96 (b) which tapers at the bottom may be used. It gives an accuracy up to 0·005 inch. An inch of rainfall means the amount of water that would cover the ground to a depth of 1 inch, provided none evaporated, drained off or percolated away. For meteorological recordings, a *rain-day* is reckoned as a period of 24 hours with at least 0·01 inch or more rain being recorded. If the amount exceeds 0·04 inch, it is considered a wet day. For general reckoning, the average rainfall for Malaysia is less than 0·3 inch a day. Only a torrential downpour can account for more than an inch of rainfall in a day. The rain gauge must be examined every day. In temperate regions, snowfall is carefully melted by warming the funnel and then measured. For all practical purposes 10 to 12 inches of snow may be considered as equivalent to 1 inch of rain.

The daily records of rainfall will be added at the end of the month to find the total rainfall for that month. The total for each month is again added at the end of the year to find the *annual rainfall*. The mean annual rainfall is obtained from the averages of annual rainfall taken over a long period of say 35 years. For plotting in rainfall maps, places having the same mean annual rainfall are joined by a line called an isohyet, as shown in many atlases. Rainfall can also be graphically depicted as shaded rainfall columns, one for each month of the year as in Fig. 97 or in dispersal diagrams, one dot for each year for as many years as possible as in Fig. 98. The former illustrates the monthly rainfall regime over a year and the latter shows at a glance the range of dry and wet years for 35 years.

**2. Pressure.** Air is made up of a number of mixed gases and has *weight*. It therefore exerts a pressure on the earth's surface which varies from place to place and from time to time. This force that presses on the surface of any object can be fairly accurately measured. The instrument for measuring pressure is a barometer, as shown in Fig. 99, invented by the scientist Galileo and his assistant Torricelli in 1643. The ordinary mercury barometer consists of a long glass tube, sealed at the upper and open at the lower end. The lower end is inverted in a bowl of mercury, whose surface is exposed to the air. Variations in the atmospheric pressure on the mercury surface are balanced by the column of mercury in the glass tube. This gives the pressure of the air and can




97 A rainfall histogram showing the monthly rainfall of Kota Kinabalu, E. Malaysia

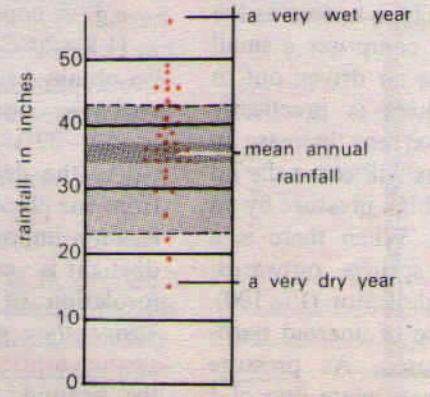



Fig 98 A rainfall dispersal diagram for Gibraltar for 35 years

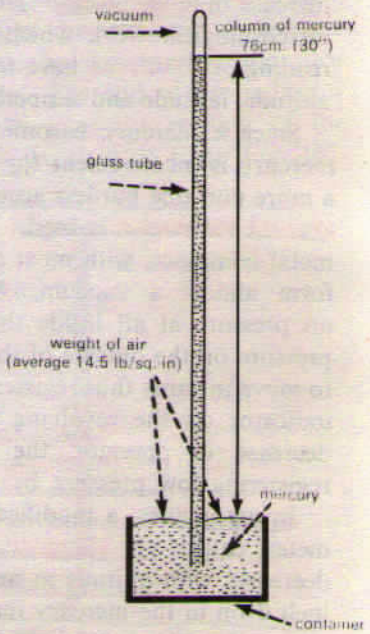



Fig 99 A mercury barometer

be read off quickly from the scale on the glass tube. Any liquid could be used for this purpose, but mercury has been chosen because it is the heaviest liquid known. If ordinary water were used, the corresponding column for normal atmospheric pressure would be 34 feet! At sea level, the mercury column is 29.9 inches, or 760mm. If the pressure increases, the air pressing on the surface will force up the mercury column to about 31 inches (high pressure). When the pressure decreases, as less air presses on the surface, the mercury column will drop about 28 inches (low pressure). As pressure is a force, it is more appropriate to measure it in terms of a unit of force. A new unit known as the millibar (mb) was adopted by meteorological stations in 1914. A normal atmospheric pressure equivalent to 14·7 lb. per square inch in weight or a reading of 29·9 inches of mercury in the column is 1013 millibars. On maps places of equal pressure are joined by lines called isobars. In temperate latitudes, pressure changes are very rapid in the formation of cyclones and anticyclones. In normal circumstances, they vary from 960 mb. to 1,040 mb.

Pressure readings vary with a number of factors. A *sea-level* reading of 30 inches will be halved on *mountainous* regions of 3·5 miles above sea level. This is because as one ascends there is less air above and so the weight, or pressure is less. The barometer is also sensitive to gravitational forces at different latitudes. The mercury itself also expands with an increase in temperature. Therefore for professional meteorological work which requires very accurate readings, corrections have to be made in respect of altitude, latitude and temperature.

Since a mercury barometer that dips in liquid mercury is inconvenient for outdoor measurement, a more portable but less accurate type known as the aneroid barometer is used. This comprises a small metal container, with most of the air driven out to form almost a vacuum. As there is practically no pressure at all inside the box, any increase in pressure on the outside of the box will cause the lid to move inwards thus registering high pressure by an indicator on the revolving dial. When there is a decrease in pressure, the lid springs outwards, registering low pressure by the indicator (Fig.100).

In aeroplanes, a modified type of aneroid barometer called an altimeter is used. As pressure decreases with altitude at an approximate rate of 1 inch drop in the mercury reading for every 900 feet ascent, the altimeter gives the reading in feet for height attained instead of millibars or inches. With this,

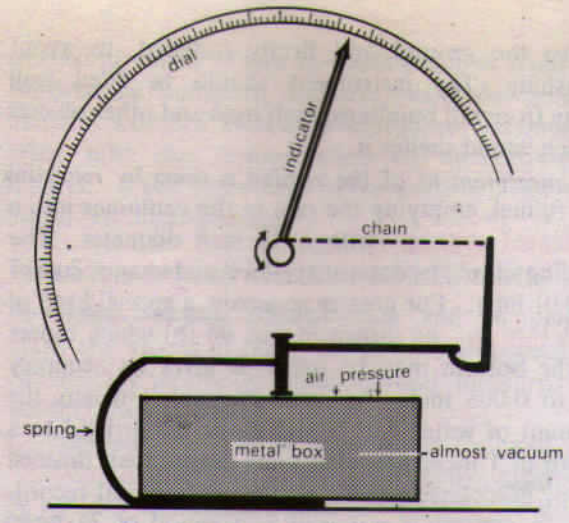


Fig 100 An aneroid barometer

the pilot will be able to tell the altitude of the plane above sea level. For a continous record of pressure changes, as is sometimes required, the self-recording barogram is used.

**3. Temperature.** Temperature is a very important element of climate and weather. The instrument for measuring temperature is the thermometer which is a narrow glass tube filled with mercury or alcohol. It works on the principle that mercury *expands* when heated and *contracts* when cooled. On thermometers, temperatures are marked in one of two ways. In °F. (Fahrenheit) the freezing-point is 32°F. and the boiling-point is 212°F. For most scientific purposes the Centigrade °C. scale is preferred. Its freezing-point is 0°C. and its boiling-point is 100°C. The mean daily temperature of Malaysia is 80°F. or 26.7°C. For rapid conversation of one scale into another, the following formulae may be used.

To obtain *Fahrenheit* = (1·8 × °C.) +32°F.

e.g. to convert 20°C. into Fahrenheit:
(1·8 ×20°C.) +32°F. =36° +32° =68°F.

To obtain *Centigrade* = (°F.−32)÷1·8

e.g. to convert 59°F. into Centigrade:
(59°−32°)÷1·8=27÷1·8=15°C.

As the degree of 'hotness' varies tremendously from one place to another, the siting of the instrument is very important. A temperature taken in open daylight is very high, because it measures the direct insolation of the sun. It is better described as *'temperature in the sun'*. For agricultural purposes, earth temperatures are taken at various depths in the ground. The thermometer is enclosed in a special glass tube and the bulb is embedded in paraffin wax, so that they are less sensitive to abrupt temperature changes. To assess the possible damages

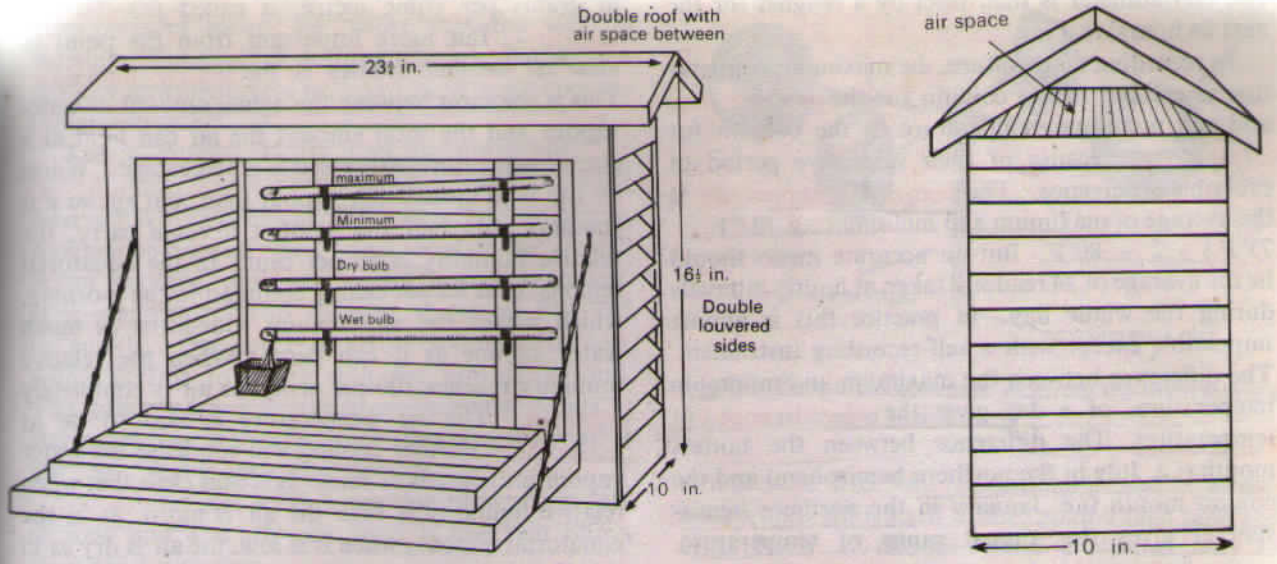



Fig 101 A Stevenson Screen

done by ground frosts to crops in temperate latitudes, grass temperatures are also taken.

But the temperatures that we are so accustomed to in climatic graphs are shade temperatures, that is the temperatures of the air. Precautions therefore must be taken to exclude the intensity of the sun's radiant heat. This is done by placing the thermometers in a standard meteorological shelter known as the Stevenson Screen (Fig. 101). It consists of a white wooden box raised 4 feet above the ground on stilts. The roof is double-layered with an intervening air space to exclude much of the direct rays of the sun. The sides of the box are louvred like 'venetian blinds' to allow free circulation of the air. One side of the screen is hinged to serve as a door which can be opened and closed to give access to the instruments kept inside. The floor of the screen is also louvred. The Stevenson Screen normally carries maximum and minimum thermometers, dry and wet bulb thermometers. Larger ones may also contain a self-recording thermogram and hygrogram.

Maximum and minimum temperatures are measured by the maximum and minimum thermometers. They are either in the form of separate thermometers or joined in a U-shaped glass tube as in the *Six's thermometer*. The maximum thermometer records the highest temperature reached during the day. The mercury in the closed glass tube expands when the temperature rises. It pushes a metal indicator up the tube and this stays at the maximum level when the temperature drops. The end of the indicator nearest the mercury, as indicated in Fig. 102, gives the reading of the maximum temperature, which is 87°F. in this case. To reset the mercury for the next day's reading, swing it hard or draw the indicator back by a magnet.

The minimum thermometer records the lowest temperature reached during the day; it probably occurs in the middle of the night or early in the morning. The glass tube is filled with alcohol which allows the indicator to slide freely along the tube. When the temperature drops, the alcohol contracts and drags the indicator towards the bulb by the surface tension of the indicator. When the temperature rises, the alcohol flows past the indicator leaving it where it was. The end of the indicator farthest from the bulb gives the reading of the minimum temperature, which is 73°F. in Fig. 102.

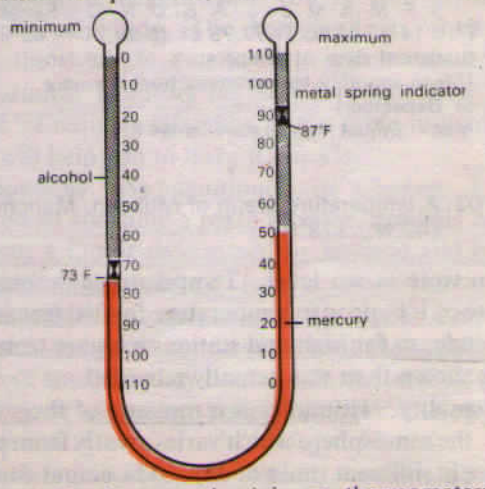
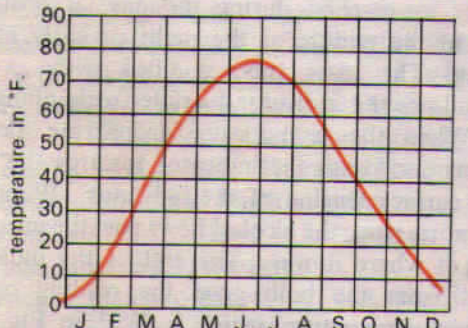



Fig 102 Maximum and minimum thermometers

The thermometer is then reset by a magnet for the next 24 hours' reading.

In recording temperature, the maximum temperature is entered in the column for the previous day and the minimum temperature in the column for current day because of their respective period of probable occurrence. The mean daily temperature is the average of maximum and minimum e.g. (87°F. + 73°F.) ÷ 2 = 80°F. But an accurate mean should be the average of 24 readings taken at hourly intervals during the whole day. In practice this is almost impossible except with a self-recording instrument. The difference between the maximum and minimum temperatures of a day gives the diurnal range of temperature. The difference between the hottest month (i.e. July in the northern hemisphere) and the coldest month (i.e. January in the northern hemisphere) gives the annual range of temperature.

In diagramatic representations, monthly mean temperatures are shown in simple temperature graphs (Fig. 103) or in temperature distribution maps as isotherms. For these maps temperatures are reduced to sea level — that is shown as if the recording




J F M A M J J A S O N D Range
F°. 8 14 30 47 60 71 77 75 61 48 29 14 69°
Statistical data of temperature of Mukden
(Mean monthly temperatures from January to December)
Mean annual temperature is 44°F.

Fig 103 A temperature graph of Mukden, Manchuria (42°N., 123°E.)

station were at sea level. Temperatures decrease at the rate of 1°F. drop in temperature for 300 feet ascent in altitude, so for highland stations a higher temperature is shown than was actually recorded.

**4. Humidity.** Humidity is a measure of the dampness of the atmosphere which varies greatly from place to place at different times of day. The actual amount of water vapour present in the air, which is expressed in grams per cubic metre, is called the absolute humidity. But more important from the point of view of weather studies is the relative humidity. This is the ratio between the actual amount of water vapour and the total amount the air can hold at a given temperature, expressed as a percentage. Warm air can hold more water vapour than cold air, so if it contains only half the amount it *could* carry, the relative humidity is 50 per cent. In the equatorial regions, over 80 per cent is common in the morning, which means the air contains four-fifths as much water vapour as it can carry. When the relative humidity reaches 100 per cent, the air is completely saturated. The air temperature is said to be at dew-point. Further cooling will condense the water vapour into clouds or rain. It is thus clear that when relative humidity is high the air is moist, as in the equatorial regions; when it is low, the air is dry as in the deserts.

The instrument for measuring relative humidity is the hygrometer, which comprises wet-and dry-bulb thermometers placed side by side in the Stevenson Screen (Fig. 104). The dry-bulb is, in fact, the ordinary thermometer that measures the shade temperature mentioned earlier. The wet-bulb is kept wet by a wick that dips into a reservoir of distilled water. When the air is not saturated evaporation, which produces a cooling effect, takes place from the moist wick. The wet bulb therefore always shows a lower reading than the dry bulb. With reference to prepared tables for calculating relative humidity, under the difference column of the dry and wet bulb reading, the relative humidity can be obtained as a percentage. Normally a large difference indicates a low R.H. and a small difference a high R.H. If both have the same reading, R.H. is 100 per cent; the air is saturated.

**5. Winds.** Wind is air in motion and has both direction and speed. Unlike other elements in climate such as rain, snow or sleet, winds are made up of a series of gusts and eddies that can only be

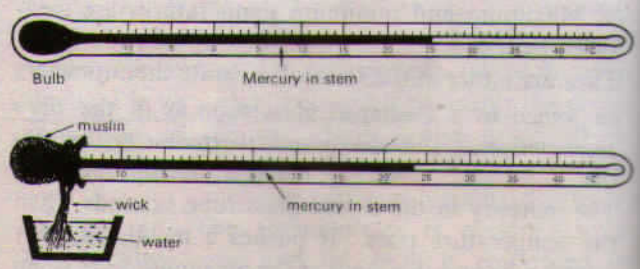



Fig 104 The hygrometer consisting of wet and dry bulb thermometers

felt but not seen. When leaves fall, trees sway and dust particles move, we realise that the wind is blowing. But there is nothing tangible that we can show or measure unless we make use of some conventional instruments.

The instrument widely used for measuring wind direction is a wind vane or weather cock. As wind direction is always blocked by trees and tall buildings, weather cocks and wind vanes need to be erected in an exposed position, to get a true direction. It is made up of two parts as shown in Fig. 105 (a) and (b). One part is an arrow or vane on the top, which is free to move with the prevailing wind. The other part with the four compass points is stationary and shows in which direction the wind is moving. Winds are always named from the direction they blow; an east wind is one that blows from east to west and a south-west wind is one that blows from the south-west.

Most of the weather cocks that we see on church spires and country buildings seldom give a correct indication of wind directions. They are either too low or are blocked by taller structures nearby. The direction of smoke-drift or flag movements in fairly open spaces provides the most reliable indication of wind direction. Sometimes a piece of *woven-cloth* with a tail is fixed to the top of a high pole and drifts freely in mid-air. This is another way of indicating wind direction.

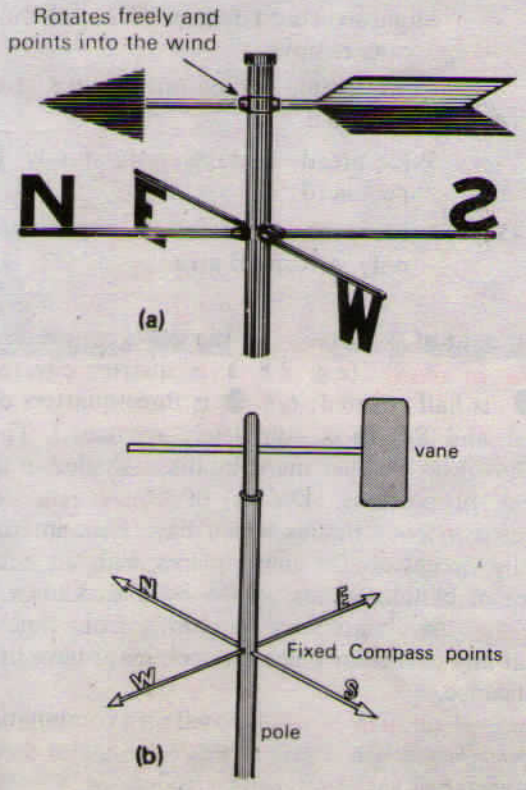



Fig 105 Wind Vanes

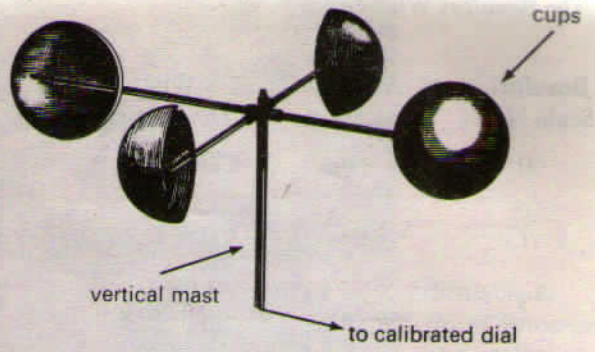



Fig 106 Simplified sketch to illustrate the main features of a wind anemometer

The speed of wind is usually measured by an anemometer (Fig. 106). It consists of three or four semi-circular cups attached to the ends of horizontal spokes mounted on a high vertical spindle. As the concave sides of the cups offer greater resistance to the winds, the horizontal spokes will rotate, moving a central rod which transmits the velocity (speed) of the wind in miles per hour to an electrically operated dial. But the speed recorded is not absolutely accurate because after the winds have abated, the rotation continues due to its own momentum. With some modifications, the anemometer can also record wind directions.

Since an anemometer is not easily available, a little practice of local wind observations will help us to assess the speed of winds. By seeing the way some objects move, a great deal can be said about the strength of winds. The best guide is obtainable from the Beaufort Wind Scale which was devised by Admiral Beaufort in 1805 for estimating wind speed. Frequent reference to the table in your free time will help you to learn it quickly.

**6. Sunshine.** As mentioned in Chapter 1, the amount of sunshine a place receives, depends on the seasons, a factor determined by latitude and by the position of the earth in its revolution around the sun. Tourist resorts, particularly in the higher temperate latitudes, are most concerned about the numbers of hours of sunshine they receive. In the tropics, where sunshine is abundant people are less interested in the amount.

In the meteorological station, sunshine duration is recorded by a sun-dial, 4 inches in diameter,

**The Beaufort Wind Scale**

| Beaufort Scale No. | Arrow Indication | Wind Description | Speed (m.p.h.) | Effects (a guide to observation) |
|---|---|---|---|---|
| 0 | | Calm | Less than 1 | Smoke rises vertically |
| 1 | | Light air | 1–3 | Wind direction shown by smoke-drift but not by wind-vanes |
| 2 | | Slight Breeze | 4–7 | Wind felt on face; leaves rustle; vanes moved by wind |
| 3 | | Gentle Breeze | 8–12 | Leaves and twigs in constant motion; winds extend light flags |
| 4 | | Moderate Breeze | 13–18 | Raises dust and loose paper; small branches moved |
| 5 | | Fresh Breeze | 19–24 | Small trees in leaf begin to sway; crested wavelets form on inland water |
| 6 | | Strong Breeze | 25–31 | Large branches in motion; whistling heard in telegraph wires . |
| 7 | | Moderate Gale | 32–38 | Whole tree in motion; walking inconvenienced |
| 8 | | Fresh Gale | 39–46 | Twigs broken off trees; progress generally impeded |
| 9 | | Strong Gale | 47–54 | Slight structural damage occurs, chimney pots removed |
| 10 | | Whole Gale | 55–63 | Considerable structural damage, trees uprooted |
| 11 | | Storm | 64–75 | Widespread damage, very rarely experienced |
| 12 | | Hurricane | More than 75 | Widespread devastation, experienced only in tropical areas |

through which the sun's rays are focussed upon a sensitized card, graduated in hours. A line is made on the card when it is sufficiently heated, but not when the rays are faint. On maps places with equal sunshine duration are joined by isohels.

**7. Clouds.** When air rises, it is cooled by expansion. After dew-point has been reached cooling leads to condensation of water vapour in the atmosphere. Tiny droplets of water vapour which are too small to fall as rain or snow (less than 0·001 cm., approximately 0·0005 inches in radius) will be suspended in the air and float as clouds. Their *form, shape, height and movements* tell us a great deal about the sky conditions and the weather we are likely to experience. It is fascinating and very rewarding to know something about the clouds which we see everyday. For meteorological purposes, the amount of cloud-cover in the sky is expressed in eighths or oktas (e.g. 2/8 ◑ is quarter covered; 4/8 ◑ is half covered; 6/8 ◕ is three-quarters obscured and 8/8 ● is completely overcast.) They are shown on weather maps by discs, shaded in the correct proportions. Details of cloud type are indicated in code figures which have been internationally accepted. On maps places with an equal degree of cloudiness are joined by lines known as isonephs. As clouds vary so quickly from time to time at any particular place, isoneph maps have little significance.

The classification of clouds is based on a combination of *form, height and appearance.* Four major cloud types and their variations can be recognised.

**(a) High Clouds:** mainly cirrus (Ci) of feathery form at 20—40,000 feet above ground.

Cirrus cloud
*Royal Netherlands Meteorological Institute*

Cirrocumulus cloud
*Meteorologie National Paris*

Cirrostratus with scattered cumulus
*Meteorologie National Paris*

i. **Cirrus (Ci)** This looks fibrous and appears like wisps in the blue sky; it is often called 'mares' tails'. It indicates fair weather, and often gives a brilliant sunset.

ii. **Cirrocumulus (Cc)** This appears as white globular masses, forming ripples in a 'mackerel sky'.

iii. **Cirrostratus (Cs)** This resembles a thin white sheet or veil; the sky looks milky and the sun or moon shines through it with a characteristic 'halo'

**(b) Medium Clouds:** mainly alto (Alt) or middle-height clouds at 7—20,000 feet.

iv. **Altocumulus (Alt-Cu)** These are woolly, bumpy clouds arranged in layers and appearing like waves in the blue sky. They normally indicate fine weather.

v. **Altostratus (Alt-St)** These are denser, greyish clouds with a 'watery' look. They have a fibrous or striated structure through which the sun's rays shine faintly.

**(c) Low Clouds** mainly stratus or sheet clouds below 7,000 feet.

vi. **Stratocumulus (St-Cu)** This is a rough, bumpy cloud with the waves more pronounced than in altocumulus. There is great contrast between the bright and shaded parts.

vii. **Stratus (St)** This is a very low cloud, uniformly grey and thick, which appears like a low ceiling or highland fog. It brings dull weather with light drizzle. It reduces the visibility of aircraft and is thus a danger.

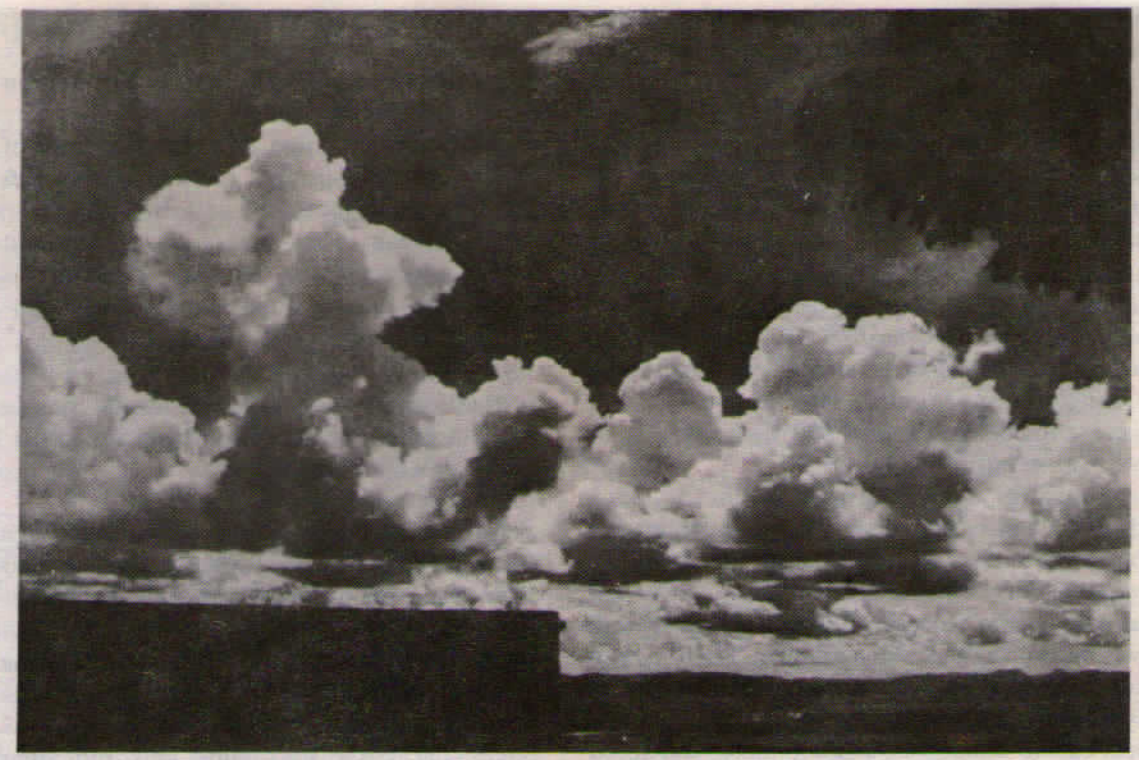
viii. **Nimbostratus (Ni-St)** This is a dark, dull cloud, clearly layered, and is also known as a *'rain cloud'*. It brings continuous rain, snow or sleet.

**(d) Clouds with great vertical extent:** mainly cumulus or heap clouds with no definite height (2-30,000 feet).

ix. **Cumulus (Cu)** This is a vertical cloud with a rounded top and horizontal base, typical of humid tropical regions, associated with up-rising convectional currents. Its great white globular masses may look grey against the sun but it is a 'fair weather cloud'.

x. **Cumulonimbus (Cu-Ni)** This is, in fact, an overgrown cumulus cloud, extending for a tremendous vertical height from a base of 2,000 feet to over 30,000 feet. Its black and white globular masses take a fantastic range of shapes. Its cauliflower top often spreads out like *an anvil*. This is frequently seen in tropical afternoons. It is also referred to as a *'thunder-cloud'* and brings convectional rain, accompanied by lightning and thunder

Altocumulus cloud *Royal Netherlands Meteorological Institute*



Cumulus cloud *J. Mondaine*

Cumulonimbus cloud *Royal Netherlands Meteorological Institute*

**8. Other Elements pertaining to visibility.** Other elements affecting visibility include haze, mist and fog.

**(a) Haze** This is caused by smoke and dust particles in industrial areas or may be due to unequal refraction of light in air of different densities in the lower atmosphere. The term is usually used in connection with the reduction of visibility in regions of low humidity, less than 75 per cent. When visibility is less than $1\frac{1}{4}$ miles, haze is present.

**(b) Mist** The condensation of water vapour in the air causes small droplets of water to float about forming clouds at ground level called mist. It reduces visibility to about 1,000 metres or 1,100 yards. Unlike haze, mist occurs in wet air, when the relative humidity is over 75 per cent.

**(c) Fog** Ordinary fog is due to water condensing on dust and other particles like smoke from houses and factories. It only occurs in the lower strata of the atmosphere as a sort of dense '*ground cloud*'. The visibility in fog is even less than 1,000 metres. In industrial areas, like those of the Black Country and northern England, very thick smoky fog is formed, called smog. The visibility may be reduced to 220 yards or even less.

Fogs that occur on hills are called hill fogs. They are most common in the morning, even in the tropics, and disperse when the sun rises. In temperate lands, when days are hot and nights are clear and still, fogs may also result from cooling of the land surface by radiation. The lower layers of the air are chilled and water vapour in the atmosphere condenses to form radiation fog or land fog. When the cooling surface is over the sea or when a damp air stream is brought into contact with a cold current as off Newfoundland, sea fog is formed. It varies in depth and thickness. Some sea fogs are so shallow and light that the masts of ships can be seen protruding above them.

Generally speaking fogs are more common over seas than lands, and are most prevalent over coastal areas. The dry interiors experience haze or mist. Dense fogs are more likely to occur in the high and middle latitudes rather than the tropics.

## QUESTIONS AND EXERCISES

1. (a) What instruments are normally kept in the school weather station?
   (b) Why is it important that the times of observation and the method of recording should be uniform?
   (c) Explain what precautions you would take to ensure that your observations and records from the various instruments are accurate.

2. Name the instruments you would use to measure the following elements of climate.
   (a) relative humidity
   (b) atmospheric pressure
   (c) wind velocity

For any *two* of the above, and with annotated diagrams, explain how the instruments work.

3. What weather elements are measured by the following apparatus?
   (a) a rain gauge
   (b) the Six's maximum and minimum thermometers
   (c) a wind vane

Describe how the above apparatus function and state what special precautions must be taken when taking readings from them.

4. *Either:* Explain the following
   (a) Wind speed at 2,500 feet is greater than that at the surface.
   (b) Britain has no climate, only weather
   (c) Fog is, in fact, cloud at ground level
   *Or:* Distinguish between
   i. mist and fog
   ii. cirrus and stratus clouds
   iii. climate and weather

5. Define any *three* of the following terms or phrases, in their relation to weather studies.
   (a) mean annual rainfall
   (b) diurnal range of temperature
   (c) Beaufort Scale
   (d) synoptic charts
   (e) lapse rate

# Chapter 14 Climate

## The Atmosphere

The atmosphere is made up of gases and vapour, and receives incoming *solar energy* from the sun giving rise to what we call climate. We actually live at the bottom of this indefinite layer of atmosphere where the air is densest. Higher up, the air thins out and it is still a matter of conjecture where the atmosphere ends. One estimate puts this limit at about 600 miles above sea level. The lowest layer, in which the weather is confined, is known as the troposphere. It extends from the earth's surface for a height of 6 miles, and within it temperature normally falls with increasing altitude. The climatic elements such as temperature, precipitation, clouds, pressure and humidity within the troposphere account for the great variations in local climate and weather that play such a great part in our daily lives. From analyses taken in different parts of the globe, it is found that the lower part of the atmosphere contains a consistent proportion of certain gases: 78 per cent of nitrogen, 21 per cent of oxygen, 0.03 per cent of carbon dioxide and minute traces of argon, helium and other rare gases. In addition, it has an unpredictable proportion of water, existing either as a gas like water vapour, a liquid like rain, clouds and sleet or a solid like snow and hailstones, as well as other solid particles like smoke and dust. It is because of the *variable water content* of the atmosphere that we have such great contrasts in weather and climate over different parts of the world. If we were to live in a dry atmosphere, absolutely without water, there would be no weather and not even much climate.

Above the troposphere lies the stratosphere or the upper layer of the atmosphere. It extends upwards for another 50 miles or even more. It is not only very cold, but cloudless, with extremely thin air and without dust, smoke or water vapour but there are marked seasonal temperature changes. Beyond the stratosphere is the ionosphere which goes several hundred miles up. It has electrically conducting layers which make short-wave radio transmission possible over long distances. Modern artificial satellites, launched in the upper strata of the atmosphere, as well as balloons are used to transmit back to earth valuable information regarding the conditions of the atmosphere.

## Insolation

The only source of energy for the earth's atmosphere comes from the sun which has a surface temperature of more than 10,800°F. This energy travels through space for a distance of 93 million miles and reaches us as solar energy or radiant energy in the process called insolation. This radiation from the sun is made up of three parts, the visible 'white' light that we see when the sun shines and the less visible ultra-violet and infra-red rays. The visible 'white' light is the most intense and has the greatest influence on our climate. The ultra-violet rays affect our skin and cause sun-burn when our bare body is exposed to them for too long a period. The infra-red rays can penetrate even dust and fog and are widely used in photography. Only that part of the sun's radiation which reaches the earth is called insolation.

What matters most is the effect of the atmosphere upon the incoming solar radiation. It is estimated that of the total radiation coming to us, 35 per cent reaches the atmosphere and is directly reflected back to space by dust, clouds and air molecules. It plays practically no part in heating the earth and its atmosphere. Another 14 per cent is absorbed by the water vapour, carbon dioxide and other gases. Its interception by the air causes it to be 'scattered' and 'diffused' so that the visible rays of the spectrum between the ultra-violet and infra-red give rise to the characteristic blue sky that we see above us. The remaining 51 per cent reaches the earth and warms the surface. In turn the earth warms the layers of air above it by direct contact or conduction, and through the transmission of heat by upward movement of air currents or convection. This radiation of heat by the earth continues during the night, when insolation from the sun cannot replace it. The earth-surface therefore cools at night.

The rate of heating differs between land and water surfaces. Land gets heated up much more quickly than the water. Because water is transparent heat is absorbed more slowly and because it is always in motion, its absorbed heat is distributed over a greater depth and area. Thus any appreciable rise in temperature takes a much longer time. On the other hand the opaque nature of land allows greater absorption but all the radiant heat is concentrated at the surface, and temperature rises rapidly. Because

of these differences between land and water surfaces land also cools more quickly than water.

## Elements of Climate and Factors Affecting them

Of the various climatic elements, temperature, precipitation, pressure and winds are the most important because of their far reaching global influences. These elements and their distribution, whether horizontal from equatorial to polar regions, or vertical from ground to atmosphere, are in one way or another affected by some or all of the climatic factors: latitude, altitude, continentality, ocean currents, insolation, prevailing winds, slope and aspect, natural vegetation and soil.

## Temperature

### The Importance of Temperature

1. Temperature influences the actual amount of water vapour present in the air and thus decides the moisture-carrying capacity of the air.
2. It decides the rate of evaporation and condensation, and therefore governs the degree of stability of the atmosphere.
3. As relative humidity is directly related to the temperature of the air, it affects the nature and types of cloud formation and precipitation.

## Factors Influencing Temperature

1. **Latitude.** As explained in Chapter 1, due to the earth's inclination, the mid-day sun is almost overhead within the tropics but the sun's rays reach the earth at an angle outside the tropics. Temperature thus diminishes from equatorial regions to the poles. This is illustrated in Fig. 107. It shows two bands of rays coming from the sun to two different latitudes on the earth's surface. Band RI falls vertically over the equatorial latitudes on surface E. Band R2 falls obliquely over the temperate latitudes on surface T. RI travels through a *shorter distance* and its concentrated solar insolation heats up a smaller surface area; temperature is thus high. On the other hand, R2 travels through a *longer distance* and much of its heat is absorbed by clouds, water vapour and dust particles. Its oblique ray has to heat up a large area; temperature is therefore low.

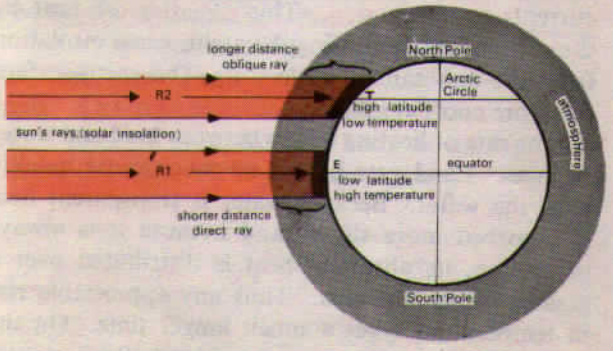



Fig. 107 The effect of latitude on solar insolation. This shows why temperatures are lower in higher latitudes than in the tropics

2. **Altitude.** Since the atmosphere is mainly heated by conduction from the earth, it can be expected that places nearer to the earth's surface are warmer than those higher up. Thus temperature decreases with increasing height above sea level. This rate of decrease with altitude (lapse rate) is never constant, varying from place to place and from season to season. But for all practical purposes, it may be reckoned that a fall of 1°F. occurs with an ascent of 300 feet or 0.6°C. per 100 metres. It is usually more in summer than in winter. For example in temperate latitudes, in summer, an ascent of only 280 feet will cause the temperature to drop by 1°F., whereas in winter it requires 400 feet. Similarly, the lapse rate is greater by day than at night, greater on elevated highlands than on level plains. In tropical countries where the sea level temperature is 80°F., a town that is located at a height of 4,500 feet (shown as X in Fig. 108) will record a mean temperature of 65°F.
3. **Continentality.** Land surfaces are heated more quickly than water surfaces, because of the higher specific heat of water. In other words, it requires only one-third as much energy to raise the temperature of a given volume of land by 1°F. as it does for an equal volume of water. This accounts for the warmer

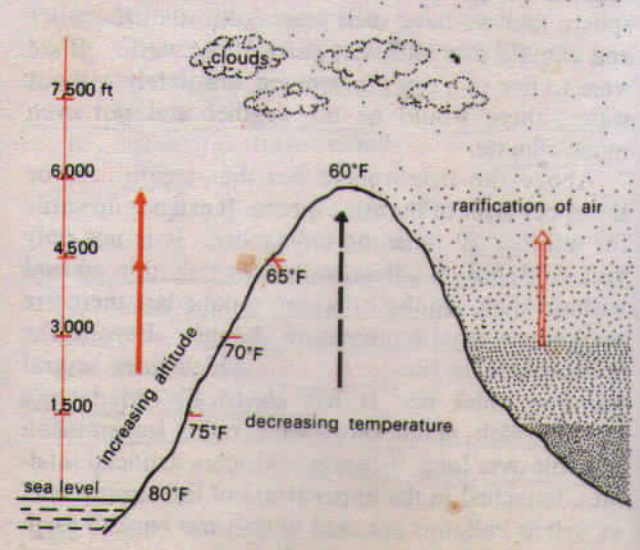



Fig. 108 The lapse rate. The effect of altitude on mean annual temperature in a tropical area

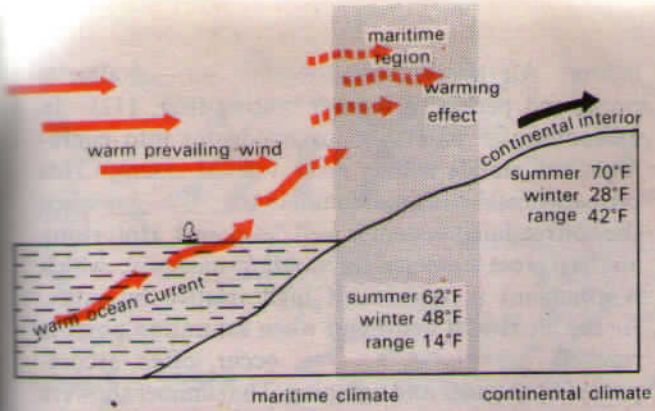



Fig. 109 The warming effect of warm ocean currents and prevailing winds on coastal regions with a Maritime climate in temperate latitudes

summers, colder winters and greater range of temperature of continental interiors as compared with maritime districts.

**4. Ocean currents and winds.** Both ocean currents and winds affect temperature by transporting their heat or coldness into adjacent regions (Fig. 109). Ocean currents like the Gulf Stream or the North Atlantic Drift warm the coastal districts of western Europe keeping their ports ice-free. Ports located in the same latitude but washed by cold currents, such as the cold Labrador Current off north-east Canada, are frozen for several months.

Cold currents also lower the summer temperature, particularly when they are carried landwards by on-shore winds. On the other hand on-shore Westerlies, convey much tropical warm air to temperate coasts, especially in winter. The Westerlies that come to Britain and Norway tend to be cool winds in summer and warm winds in winter and are most valuable in moderating the climate.

Local winds, e.g. Fohn, Chinook, Sirocco, Mistral, also produce marked changes in temperature.

**5. Slope, shelter and aspect.** A steep slope experiences a more rapid change in temperature than a gentle one. Mountain ranges that have an east-west alignment like the Alps show a higher temperature on the *south-facing 'sunny slope'* than the north-facing 'sheltered slope'. The greater insolation of the southern slope is better suited for vine cultivation and has a more flourishing vegetative cover. Consequently, there are more settlements and it is better utilised than the 'shady slope' (Fig.110). In hilly areas a hot day followed by a calm, cloudless night during which the air cools more rapidly over the higher ground may induce cold, heavy air to flow down the slope and accumulate at the valley bottom pushing the warmer air upwards. The temperature

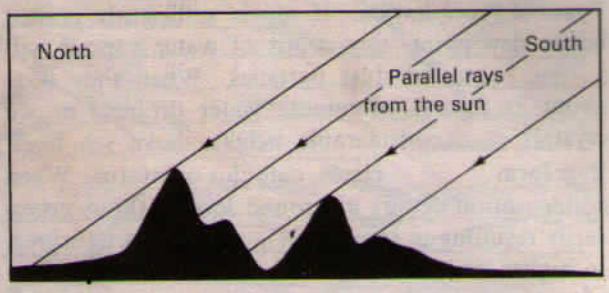



Fig. 110 South-facing slopes are more sunny

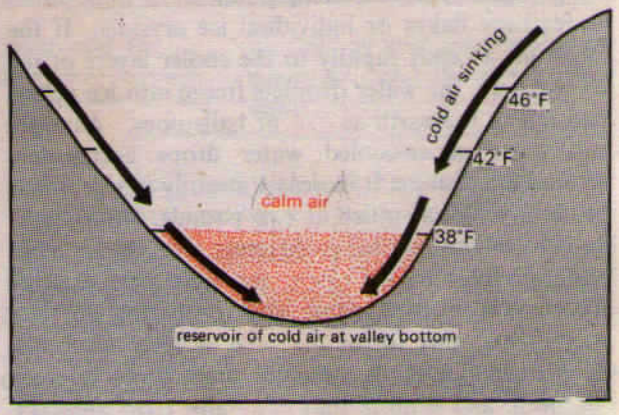



Fig. 111 Temperature inversion at valley bottom on a calm, still night e.g. an Alpine valley in spring

may then be lower in the valley than higher up as the slopes as show in Fig. 111. A reversal of the lapse rate has taken place. This is called a temperature inversion.

**6. Natural vegetation and soil.** There is a definite difference in temperature between forested regions and open ground. The thick foliage of the Amazon jungle cuts off much of the in-coming insolation and in many places sunlight never reaches the ground. It is, in fact, cool in the jungle and its shade temperature is a few degrees lower than that of open spaces in corresponding latitudes. During the day trees lose water by evapo-transpiration so that the air above is cooled. Relative humidity increases and mist and fog may form.

Light soils reflect more heat than darker soils which are better absorbers. Such soil differences may give rise to slight variations in the temperature of the region.

As a whole, dry soils like sands are very sensitive to temperature changes, whereas wet soils, like clay, retain much moisture and warm up or cool down more slowly.

## Precipitation

**Types of Precipitation.** If air is sufficiently cooled below dew-point, tiny drops of water vapour will condense around dust particles. When they float about as masses of minute water droplets or ice crystals at a considerable height above sea level, they form clouds — cirrus, cumulus or stratus. When condensation occurs at ground level without necessarily resulting in rain, haze, mist or fog are formed. In higher latitudes or altitudes, where condensation of water vapour may take place in the atmosphere at temperatures below freezing-point, snow falls, either as feathery flakes or individual ice crystals. If the moist air ascends rapidly to the cooler layers of the atmosphere, the water droplets freeze into ice pellets and fall to the earth as hail or hailstones. As more and more super-cooled water drops accumulate around a hailstone, it increases steadily in size; some of them weigh as much as two pounds. In a severe hail-storm the hailstones do great damage to crops and buildings. Very often, the ice-pellets exist as frozen rain-drops, melting and re-freezing on their way down; this forms sleet. It is only when the droplets in clouds coalesce into larger drops between 0.2 mm. and 6 mm, that rain falls.

## Rainfall

**Types of Rainfall.** There are three major types of rainfall.

1. **Convectional rainfall.** This type of rainfall is most common in regions that are intensely heated, either during the day, as in the tropics, or in the summer, as in temperate interiors. When the earth's surface is heated by conduction, moisture-laden vapour rises because heated air always expands, and becomes lighter. Air rises in a convection current after a prolonged period of intense heating (Fig. 112). In ascending, its water vapour condenses into cumulonimbus clouds with a great vertical extent. This probably reaches its maximum in the afternoon when the convectional system is well developed. Hot, rising air has great capacity for holding moisture, which is abundant in regions of high relative humidity. As the air rises it cools and when saturation point is reached torrential downpours occur, often accompanied by thunder and lightning. The summer showers in temperate regions are equally heavy with occasional thunderstorms. These downpours may not be entirely useful for agriculture because the rain is so intense that it does not sink into the soil but is drained off almost immediately.

2. **Orographic or relief rain.** Unlike convectional rain which is caused by convection currents, orographic rain is formed wherever moist air is forced to ascend a mountain barrier. It is best developed on the windward slopes of mountains where the prevailing moisture-laden winds come from the sea. The air is compelled to rise as shown in Fig.113, and is thereby cooled by expansion in the higher altitudes and the subsequent decrease in atmospheric pressure. Further ascent cools the air until the air is completely saturated (relative humidity is 100 per cent). Condensation takes place forming clouds and eventually rain. Since it is caused by the relief of the land, it is also known as relief rain. Much of the precipitation experienced on the windward slopes of the north-east of West Malaysia, western New Zealand, western Scotland and Wales and the Assam hills of the Indian sub-continent, is relief rain.

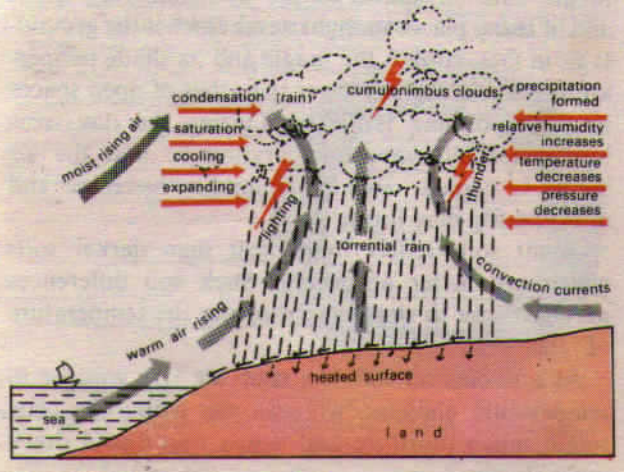



Fig. 112 Convection rainfall

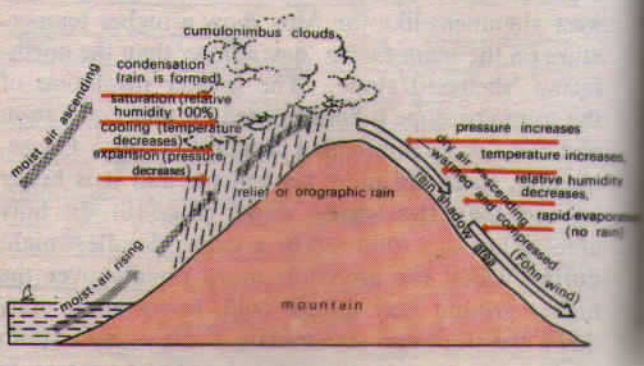



Fig. 113 Orographic or relief rain

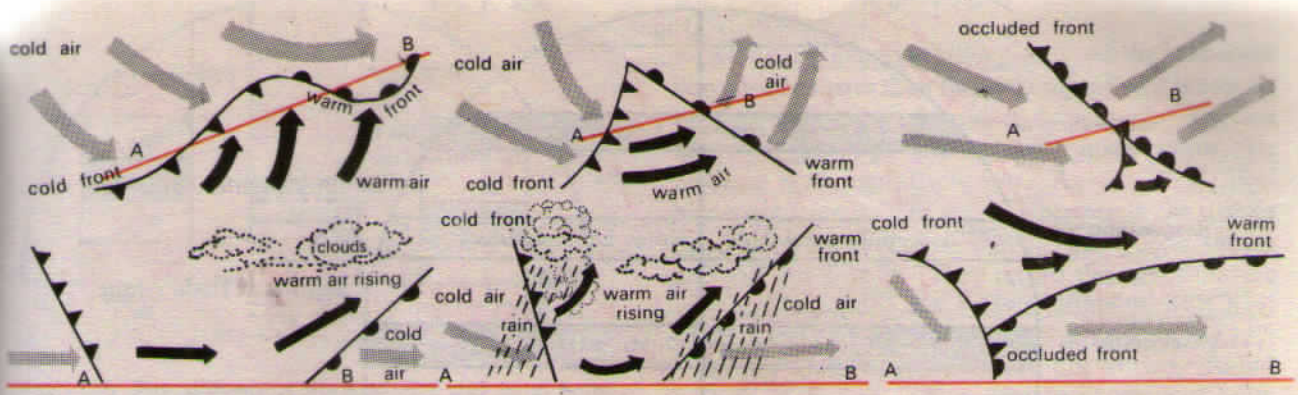



Fig. 114 Cyclonic or frontal rain (depression)
(a) The convergence of warm and cold air
(b) Warm air rises over cold air, cyclonic rain occurs
(c) Cold air eventually pushes up warm air and the sky is clear again

On descending the leeward slope, a decrease in altitude increases both the pressure and the temperature, the air is compressed and warmed. Consequently, the relative humidity will drop. There is evaporation and little or no precipitation. The area in the lee of the hills is termed the rain shadow area. The effects of rain shadow are felt on the Canterbury Plain of South Island, New Zealand and the western slopes of the Northern and Central Andes and in many other areas.

**3. Cyclonic or frontal rain.** This type of rainfall is independent of relief or convection. It is purely associated with cyclonic activity whether in the temperate regions (depressions) or tropical regions (cyclones). Basically it is due to the convergence (meeting) of two different air masses with different temperatures and other physical properties. As cold air is denser, it tends to remain close to the ground. The warm air is lighter and tends to rise over the cold air as shown in Fig. 114. In ascent, pressure decreases, the air expands and cools, condensation takes place and light showers called cyclonic or frontal rain occur. The heavier and colder air masses eventually pushes up the warmer and lighter air and the sky is clear again.

## Pressure and Planetary Winds

**World pressure belts.** We studied in Chapter 11 the circulation of waters in the oceans and noted that they follow a regular pattern, flowing from the poles equatorwards and from the equator polewards. In the same way, there is also a circulation of air over the surface of the earth caused by the differences in pressure.

Along the equator and within 5 degrees north and south, is the Equatorial Low Pressure Belt, where there is intense heating, with expanding air and ascending convection currents. This equatorial belt is often termed the Doldrums, because sailors in the olden days often found themselves becalmed here. It is a zone of wind convergence.

About 30°N. and S. occur the Sub-Tropical High Pressure Belts where the air is comparatively dry and the winds are calm and light. It is a region of descending air currents or wind divergence and anticyclones. It is frequently referred to as the Horse Latitudes.

Around the latitudes 60°N. and S. are two Temperate Low Pressure Belts which are also zones of convergence with cyclonic activity. The sub-polar low pressure areas are best developed over the oceans, where temperature differences between summer and winter are negligible.

At the North and South Poles 90°N. and S. where temperatures are permanently low, are the Polar High Pressure Belts. Unlike the water masses of the high latitudes in the southern hemisphere, high pressures of the corresponding latitudes in the northern hemisphere are a little complicated by the presence of much land. Some pressure differences between summer and winter can be expected.

**The planetary winds.** Within this pattern of permanent pressure belts on the globe, winds tend to blow from the high pressure belts to the low pressure belts as the planetary winds. Instead of blowing directly from one pressure belt to another, however, the effect of the rotation of the earth (Coriolis Force) tends to deflect the direction of the winds. In the northern hemisphere, winds are deflected to their right, and in the southern hemisphere to their left as shown in Fig. 115. This is know as Ferrel's

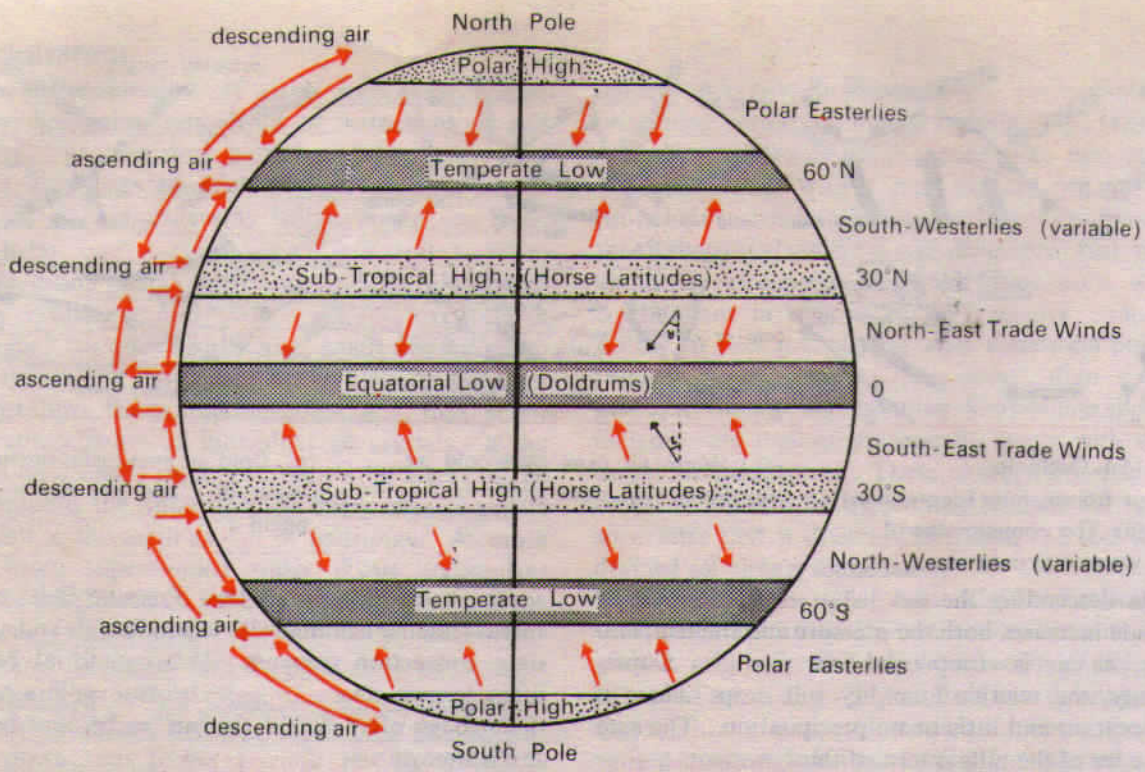



Fig. 115 The distribution of world pressure belts and planetary winds

Law of Deflection. The Coriolis Force is absent along the equator but increases progressively towards the poles.

For this reason, winds blowing out from the Sub-Tropical High Pressure Belt in the northern hemisphere towards the Equatorial Low become North-East Trade Winds and those in the southern hemisphere become the South-East Trade winds. These trade winds are the most regular of all the planetary winds. They blow with great force and in a constant direction. They were thus helpful to early traders who depended on the wind when sailing the high seas; hence the name 'trade winds'. Since they blow from the cooler sub-tropical latitudes to the warmer tropics, they have great capacity for holding moisture. In their passage across the open oceans, they gather more moisture and bring heavy rainfall to the east coasts of continents within the tropics. As they are off-shore on the west coast, these regions suffer from great aridity and form the Trade Wind Hot Deserts of the world, e.g. the Sahara, Kalahari, Atacama and the Great Australian Deserts.

From the Sub-Tropical High Pressure Belts, winds blow towards the Temperate Low Pressure Belts as the variable Westerlies. Under the effect of the Coriolis Force, they become the South-Westerlies in the northern hemisphere and the North-Westerlies in the southern hemisphere. They are more variable in the northern hemisphere, but they play a valuable role in carrying warm equatorial waters and winds to western coasts of temperate lands. This warming effect and other local pressure differences have resulted in a very variable climate in the temperate zones, dominated by the movements of cyclones and anticyclones. In the southern hemisphere where there is a large expanse of ocean, from 40°S. to 60°S., Westerlies blow with much greater force and regularity throughout the year. They bring much precipitation to the western coasts of continents. The weather is damp and cloudy and the seas are violent and stormy. It is thus usual for seafarers to refer to the Westerlies as the *Roaring Forties, Furious Fifties and Shrieking or Stormy Sixties,* according to the varying degree of storminess in the latitudes in which they blow.

It must be pointed out that not all the western coasts of the temperate zone receive Westerlies throughout the year. Some of them like California, Iberia,, central Chile, southern Africa and south-western Australia receive Westerlies only in *winter.* This is caused by the *'shifting of the wind belts'* of such regions which lie approximately between the latitudes 30° and 40°N. and S. Due to the earth's inclination, as explained in Chapter 1, the sun is

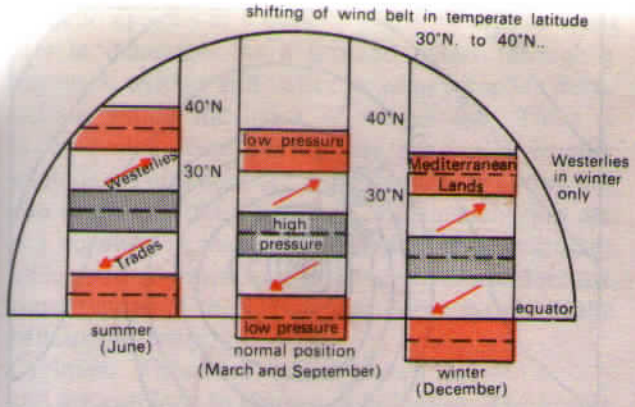



Fig. 116 The shifting of the pressure and wind belts in the northern hemisphere—showing their positions in summer and winter and at the equinoxes

overhead at midday in different parts of the earth at different seasons. The entire system of pressure and wind belts follows the movement of the midday sun. In June when the overhead sun is over the Tropic of Cancer, all the belts move about 5°-10° north of their average position. The 'Mediterranean' parts of the southern continents then come under the influence of the Westerlies and receive rain in June (winter in the southern hemisphere). In the same manner, when the sun is overhead at the Tropic of Capricorn in December, all the belts swing 5°–10° south of their average position. The 'Mediterranean' parts of Europe and California then come under the influence of the Westerlies and receive rain in December (winter in the northern hemisphere). This is illustrated in Fig.116.

Lastly, mention must be made of the Polar Easterlies which blow out from the Polar High Pressure Belts towards the Temperate Low Pressure Belts. These are extremely cold winds as they come from the tundra and ice-cap regions. They are more regular in the south than in the north.

## Land and Sea Breezes and Monsoons

Land and sea breezes are, in fact, monsoons on a smaller scale. Both are basically caused by **differential heating** of land and sea, the former in a **diurnal** rhythm and the latter in a *seasonal* rhythm.

During the day, the land gets heated up much faster than the sea. Warm air rises forming a region of local **low pressure**. The sea remains comparatively cool with a higher pressure so a **sea breeze** blows in from sea to land. Its speed or strength is between 5–20 m.p.h. and it is generally stronger in tropical than temperate regions. Its influence does not normally exceed 15 miles from the coast. It is most deeply felt when one stands facing the sea in a coastal resort.

At night the reverse takes place. As the land cools down much faster than the sea, the cold and heavy air produces a region of local **high pressure**. The sea conserves its heat and remains quite warm. Its pressure is comparatively low. A **land breeze** thus blows out from land to sea. Fishermen in the tropics often take advantage of the out-going land breeze and sail out with it. They return the next morning with the in-coming sea breeze, complete with their catch. Land and sea breezes are illustrated in Fig.117.

In the same way, **monsoons** are caused. Rapid heating in the hot **summer** over most parts of India for example induces heated air to rise. The *South-West Monsoon* from the surrounding ocean is attracted by the low pressure over the land and blows in, bringing torrential rain to the sub-continent.

Similarly, in **winter** when the land is cold, the surrounding seas remain comparatively warm. High pressure is created over Indo-Pakistan and the *North-East Monsoon* blows out from the continent into the Indian Ocean and the Bay of Bengal.

## Fohn Wind or Chinook Wind

Both the Fohn and Chinook winds are **dry winds** experienced on the leeward side of mountains when descending air becomes compressed with increased pressure. The Fohn wind is experienced in the valleys of the northern Alps, particularly in Switzerland in spring. Chinook winds are experienced on the eastern slopes of the Rockies in U.S.A. and Canada in winter.

As illustrated in Fig. 113 air ascending the southern slopes of the Alps **expands and cools**. Condensation takes place when the air is saturated. Rain and even snow fall on the higher slopes.

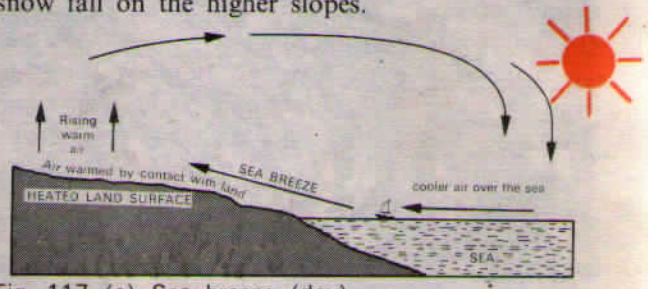
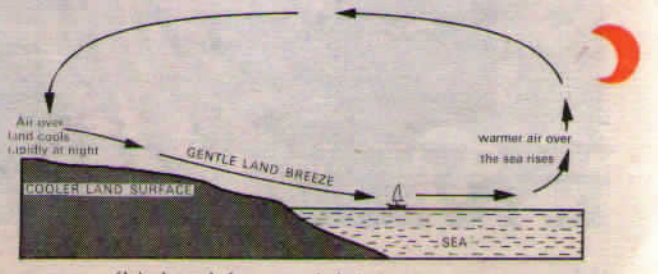



Fig. 117 (a) Sea breeze (day)




(b) Land breeze (night)

In descending the northern slope, the wind experiences an increase in pressure and temperature. The air is compressed and warmed. Most of its moisture is lost and the wind reaches the valley bottom as a dry, hot wind—the Fohn. It may raise the temperature by 15° to 30°F., within an hour! It melts snow and causes *avalanches*. In North America it is called Chinook, meaning *'the snow-eater'*. But it has its blessings too, it hastens the growth of crops and fruits and thaws the snow-covered pastures. In the Rockies, the Chinook has been known to raise temperature by 35°F. within 15 minutes! The occurrence of frequent Chinooks means winter is mild.

## Cyclonic Activity

**Tropical cyclones, typhoons, hurricanes and tornadoes**

All these are different kinds of tropical cyclones. They are well developed low pressure systems into which violent winds blow. Typhoons occur in the China Sea; tropical cyclones in the Indian Ocean; hurricanes in the West Indian islands in the Caribbean; tornadoes in the Guinea lands of West Africa, and the southern U.S.A. in which the local name of *Whirl-wind* is often applied, and *willy-willies* occur in north-western Australia.

Typhoons occur mainly in regions between 6° and 20° north and south of the equator and are most frequent from July to October. In extent, they are smaller than temperate cyclones and have a diameter of only 50 to 200 miles, but they have a much steeper pressure gradient. Violent winds with a velocity of over 100 m.p.h. are common. The sky is overcast and the torrential downpour is accompanied by thunder and lightning. In the wake of the typhoon, damage is widespread, e.g. in 1922, a typhoon that hurled huge waves on to the Swatow coast drowned 50,000 people.

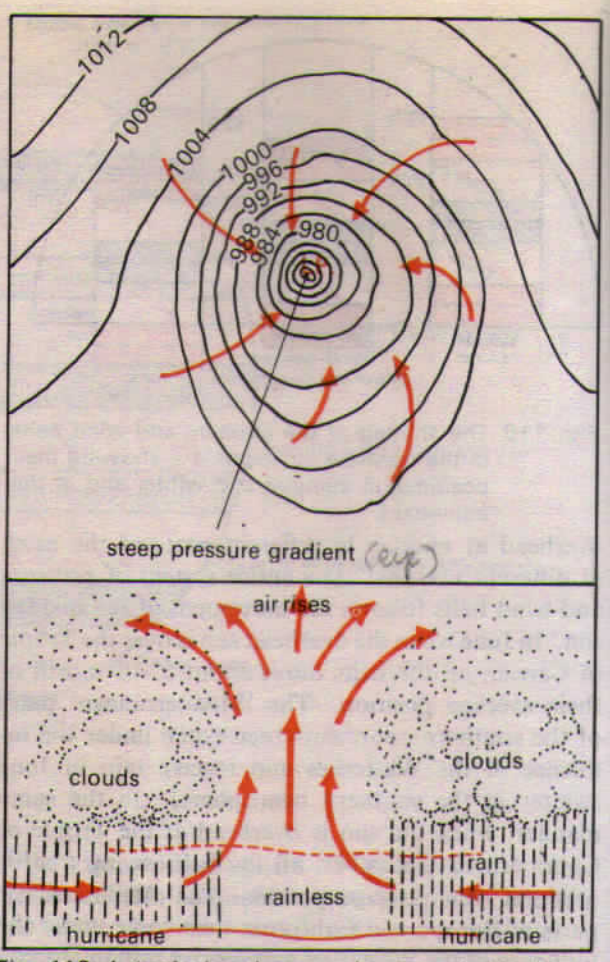



Fig. 118 A tropical cyclone—a hurricane in the West Indies

Tropical storm Judy off South East Asia *Royal Observatory Hong Kong*

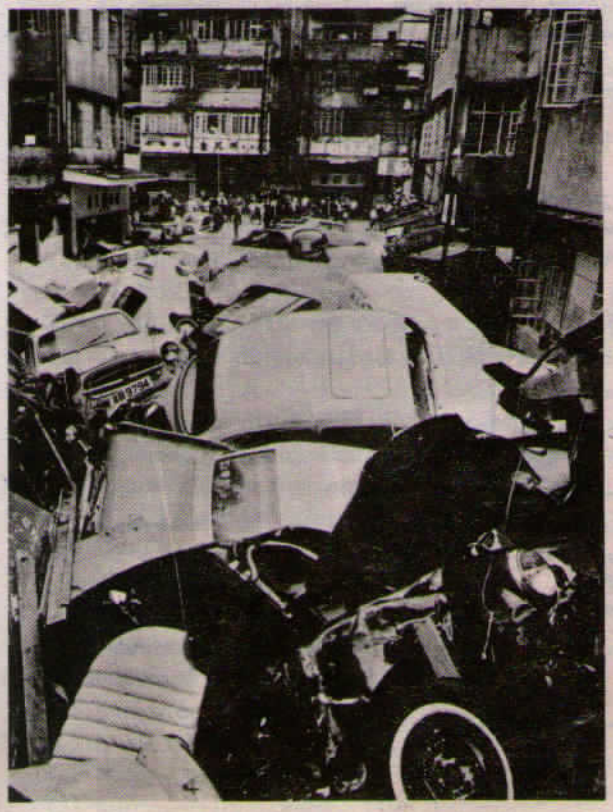
The other tropical cyclones have similar characteristics and differ, perhaps, only in intensity, duration and locality. Hurricanes have calm, rainless centres where the pressure is lowest (about 965 mb.) but around this 'eye', the wind strength exceeds force 12 of the Beaufort Scale (75 m.p.h.) (Fig.118). Dense dark clouds gather and violent stormy weather lasts for several hours. A terrible hurricane struck Barbados in the West Indies in 1780, which nearly destroyed the whole island, tearing down buildings and uprooting trees. About 6,000 inhabitants were reported dead.

Tornadoes are small but very violent tropical and sub-tropical cyclones in which the air is spiraling at a tremendous speed of as much as 500 m.p.h.! A

tornado appears as a dark funnel cloud 250 to 1,400 feet in diameter. As a tornado passes through a region, it writhes and twists, causing complete devastation within the limits of its passage. There is such a great difference in pressure that houses virtually explode. Tornadoes are most frequent in spring but can occur at almost any time. Fortunately they are not common in many countries and their destructive effects are confined to a small area. Tornadoes are most typical of the U.S.A. and occur mainly in the Mississippi basin.

**Cyclones.** These are better known as depressions and are confined to temperate latitudes. The lowest pressure is in the centre and the isobars, as shown in climatic charts, are close together. Depressions vary from 150 to 2,000 miles in extent. They remain quite stationary or move several hundred miles in a day. The approach of a cyclone is characterised by a fall in barometric reading, dull sky, oppressive air and strong winds. Rain or snow falls and the weather is generally bad. Winds blow inwards into regions of low pressure in the centre, circulating in anticlockwise direction in the northern hemisphere and clockwise in the southern hemisphere (Fig.119a)

Chaos caused by a typhoon in Hong Kong *Government Information Services Hong Kong*



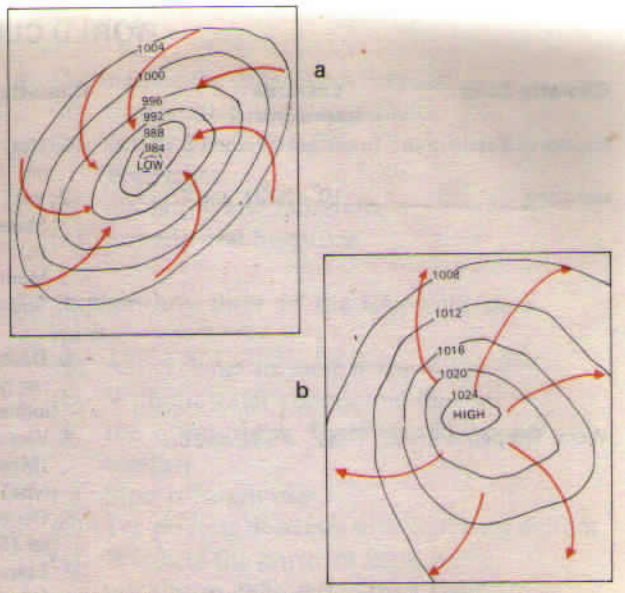



Fig. 119 (a) A cyclone in the northern hemisphere (close isobars, anti-clockwise winds)
(b) An anticyclone in the northern hemisphere (well-spaced isobars, winds blow in clock-wise direction)

Precipitation resulting from cyclonic activities is due to the convergence of warm tropical air and cold polar air. Fronts are developed and condensation takes place, forming either rain, snow or sleet.

**Anticyclones.** These are the opposite of cyclones, with high pressure in the centre and the isobars far apart. The pressure gradient is gentle and winds are light. Anticyclones normally herald fine weather. Skies are clear, the air is calm and temperatures are high in summer but cold in winter. In winter intense cooling of the lower atmosphere may result in thick fogs. Anticyclonic conditions may last for days or weeks and then fade out quietly. Winds in anticyclones blow outwards and are also subject to deflection, but they blow clockwise in the northern hemisphere and anticlockwise in the southern hemisphere (Fig. 119b).

## Climatic Types and Natural Vegetation

It is necessary to divide the world into several climatic zones, each with its own climatic characteristics, natural vegetation (forests, grasslands or deserts), crops, animals and human activities. Though the geographical characteristics may not be absolutely uniform in each climatic type, they have many things in common. Fig. 120 gives the scheme of the world's climatic types with their seasonal rainfall and natural vegetation.

## WORLD CLIMATIC TYPES

| Climatic Zone | Latitude (approximate) | Climatic Type | Rainfall Regime (with approx. total) | Natural Vegetation |
|---|---|---|---|---|
| Equatorial Zone | 0° – 10°N. and S. | 1. Hot, wet equatorial | Rainfall all year round: 80 inches | Equatorial rain forests |
| Hot Zone | 10°–30°N. and S. | 2. (a) Tropical Monsoon | Heavy summer rain: 60 inches | Monsoon forests |
| | | (b) Tropical Marine | Much summer rain: 70 inches | |
| | | 3. Sudan Type | Rain mainly in summer: 30 inches | Savanna (tropical grassland) |
| | | 4. Desert: (a) Saharan type (b) Mid-latitude type | Little rain : 5 inches | Desert vegetation and scrub |
| Warm Temperate Zone | 30°–45°N. and S. | 5. Western Margin (Mediterranean type) | Winter rain: 35 inches | Mediterranean forests and shrub |
| | | 6. Central Continental (Steppe type) | Light summer rain: 20 inches | Steppe or temperate grassland |
| | | 7. Eastern Margin: (a) China type (b) Gulf type (c) Natal type | Heavier summer rain: 45 inches | Warm, wet forests and bamboo |
| Cool Temperate Zone | 45°–65°N. and S. | 8. Western Margin (British type) | More rain in autumn and winter: 30 inches | Deciduous forests |
| | | 9. Central Continental (Siberian type) | Light summer rain: 25 inches | Evergreen coniferous forests |
| | | 10. Eastern Margin (Laurentian type) | Moderate summer rain: 40 inches | Mixed forests (coniferous and deciduous) |
| Cold Zone | 65°–90°N. and S. | 11. Arctic or Polar | Very light summer rain: 10 inches | Tundra, mosses, lichens |
| Alpine Zone | | 12. Mountain climate | Heavy rainfall (variable) | Alpine pastures, conifers, fern, snow. |

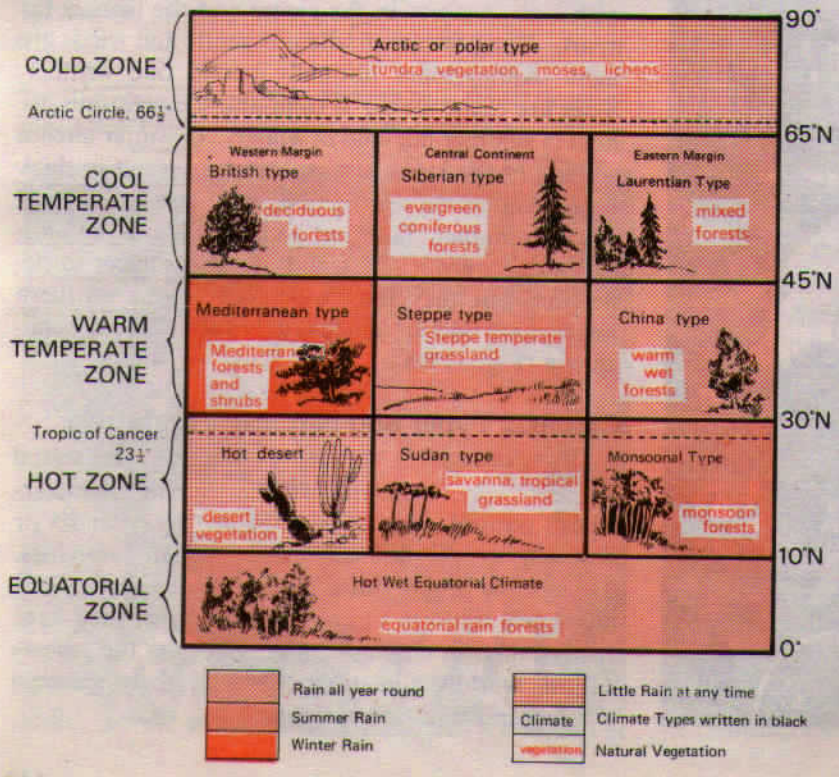



Fig. 120 Scheme of the world's climatic types (with seasonal rainfall and natural vegetation also indicated)

## QUESTIONS AND EXERCISES

1. There are many ways in which rain may be caused. Name any three of them and with the aid of annotated diagrams, describe how each of them occurs.

2. Attempt to explain the role played by temperature in climate. What are the various factors that affect the distribution of temperature in the world?

3. Account for the occurrence of any three of the following. Make use of any relevant sketches.
   (a) the planetary winds
   (b) land and sea breezes
   (c) frontal rain
   (d) extremes of temperature in continental interiors
   (e) Horse Latitudes

4. Distinguish the differences between
   (a) troposphere and stratosphere
   (b) steady Trade Winds and variable Westerlies
   (c) insolation and radiation
   (d) tornado and hurricane

5. Explain any three of the following statements.
   (a) Anticyclones are more frequent in summer.
   (b) Without water vapour and dust in the atmosphere, there would be no weather.
   (c) Sleet is frozen rain.
   (d) Temperature decreases with increasing altitude.
   (e) Winds in the northern hemisphere are always deflected to their right.

## SELECTED QUESTIONS FROM CAMBRIDGE OVERSEAS SCHOOL CERTIFICATE PAPERS

1. (a) Explain how you would:
   i. read and record maximum and minimum temperatures at a school weather station.
   ii. calculate the mean temperature for a particular month.
   (b) Describe and account for the temperature conditions experienced in:
   i. cool temperate western margin (N.W. European) and;
   ii. tropical interior (Sudan) types of climate, as illustrated by the figures given below:

| | | Mean monthly temperature | |
|---|---|---|---|
| i. **Valentia** | **Altitude** | **Lowest** | **Highest** |
| (52°N. 10°W.) | 30 ft. | February: 44°F. (6.7°C.) | July: 59°F. (15°C.) |
| ii. **Kayes** | | | |
| (14°N. 12°W.) | 197 ft. | January: 77°F. (25°C.) | May: 96°F. (35.6°C.) (1968) |

2. Temperature, humidity and wind direction are facts which are recorded at school weather stations.
   (a) For any *two* of these, describe with the aid of annotated diagrams the instruments used and show how to read them correctly.
   (b) Explain clearly the ways in which the school can make use of such records. (1963)

3. (a) Name *three* different types of rainfall and, with the aid of diagrams, show clearly how the rainfall is caused in each case.
   (b) Describe the instrument used to measure the rainfall of a place, and the way in which the information so obtained is used to calculate the mean annual rainfall. (1962)

4. Give reasons for the following:
   (a) Fog at sea often experienced near the Californian coast.
   (b) Many of the hot deserts of the world lie on the west side of a continent either between 20°N. and 30°N. or between 20°S. and 30°S.
   (c) The surface waters in the north-west Atlantic are cooler than surface waters in the north-east Atlantic. (1968)

5. With the aid of diagrams, and by reference to actual examples, describe *three* of the following and state clearly how *each* of the three has been caused:
   (a) land and sea breezes.
   (b) a rain shadow area.
   (c) Fohn (Chinook) winds.
   (d) hurricanes (typhoons). (1967)

# Chapter 15 The Hot, Wet Equatorial Climate

## Distribution

The equatorial, hot, wet climate is found between 5° and 10° north and south of the equator. Its greatest extent is found in the lowlands of the Amazon, the Congo, Malaysia and the East Indies. Further away from the equator, the influence of the on-shore Trade Winds, gives rise to a modified type of equatorial climate with *monsoonal influences*. Within the tropics, the equatorial highlands have a distinctively cooler climate, modified by altitude, such as the Cameron Highlands in Malaysia, the Northern Andes, and the Kenyan Highlands in East Africa. Fig. 121 shows the regions of the world which experience the hot, wet equatorial climate.

## Climate

**Temperature.** The most outstanding feature of the equatorial climate is its great uniformity of temperature throughout the year. The mean monthly temperatures are always around 80°F. with very little variation. There is no winter. Cloudiness and heavy precipitation help to moderate the daily temperature, so that even at the equator itself, the climate is not unbearable. In addition, regular land and sea breezes assist in maintaining a truly equable climate. The diurnal range of temperature is small, and so is the annual range.

Fig. 122 (a) and 122 (b) show the ryhthm of climate experienced in two different equatorial regions, one on a lowland (Kuala Lumpur) and the other on a highland (Bogota). The uniformity in temperature is apparent at once. Kuala Lumpur has its hottest month with 80°F, and its coolest month with 78°F. The annual range is not more than 2°F. The mean monthly temperatures for Bogota are comparatively low because of its altitudinal differences. It is located in the Andes, 8,730 feet above sea level. Its annual range is equally small, also 2°F. (59°F.–57°F.). The dotted line in the temperature graph shows its temperature reduced to sea level. Statistics taken from the various equatorial stations indicate that the annual range of temperature is small: Singapore, 2.3°F., Djakarta 1·8°F., Quito 0·7°F., Colombo 3·2°F. Over the oceans, the range is even smaller, e.g. Jaluit in the Marshall Islands in the Pacific Ocean records a range in temperature of only 0·8°F.

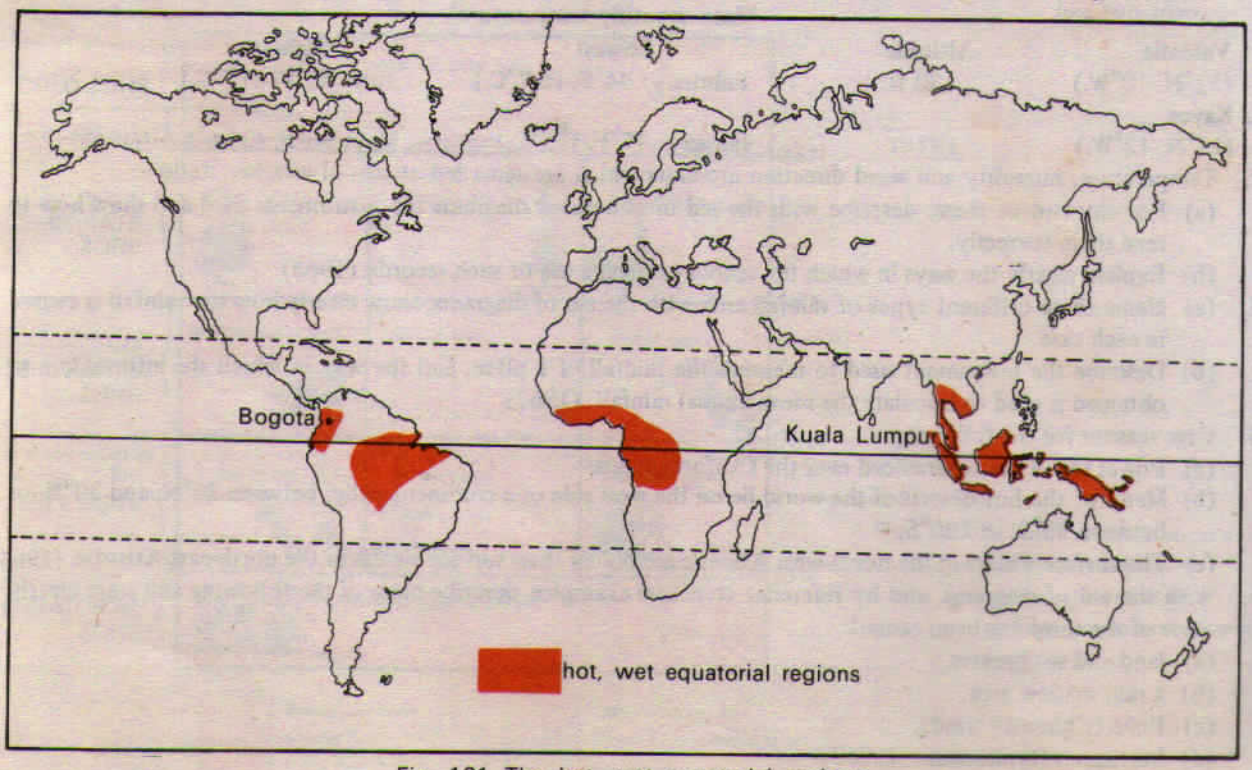
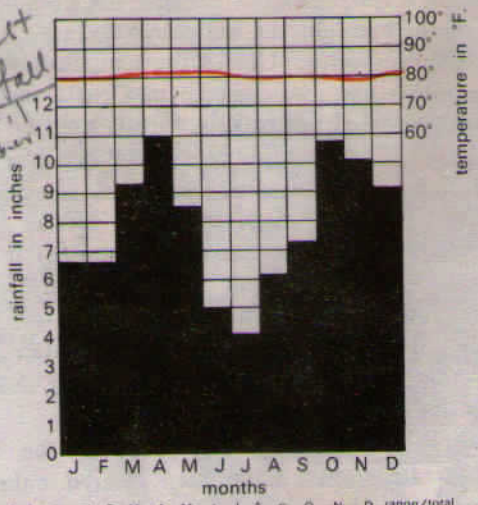


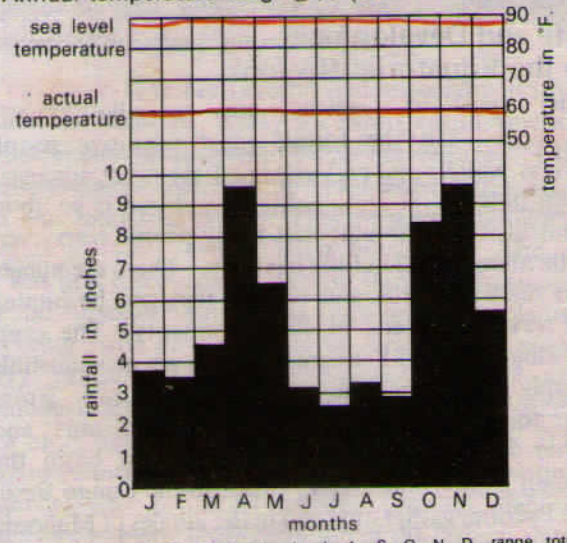

Fig. 121 The hot, wet equatorial regions

Fig. 122 (a) Equatorial Climate—a lowland station
Place: Kuala Lumpur (3°N., 102°E.)
Altitude: 54 feet
Annual precipitation: 95 inches
Annual temperature range: 2°F. (80°–78°F.)




| Kuala Lumpur | J | F | M | A | M | J | J | A | S | O | N | D | range/total |
|---|---|---|---|---|---|---|---|---|---|---|---|---|---|
| Temperature | 79 | 79 | 80 | 80 | 80 | 80 | 79 | 79 | 79 | 79 | 78 | 80 | 2 F |
| Rainfall | 6.7 | 6.7 | 9.3 | 11.0 | 8.5 | 5.0 | 4.1 | 6.2 | 7.3 | 10.8 | 10.1 | 9.1 | 95 ins |

Fig. 122 (b) Equatorial Climate—a highland station
Place: Bogota (4°, 38'S., 74° 15'W.)
Altitude: 8,730 feet
Annual precipitation: 63.4 inches
Annual temperature range: 2°F. (59°–57°F.)




| Bogota | J | F | M | A | M | J | J | A | S | O | N | D | range | total |
|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|
| Temp. | 58 | 58 | 59 | 59 | 59 | 58 | 57 | 57 | 57 | 58 | 58 | 58 | 2°F. | |
| Precip. | 3.7 | 3.5 | 4.5 | 9.6 | 6.5 | 3.2 | 2.6 | 3.3 | 2.9 | 8.4 | 9.6 | 5.6 | | 63.4" |

**Precipitation.** Precipitation is heavy, between 60 inches and 100 inches, and well distributed throughout the year. There is no month without rain, and a distinct dry season like those of the Savanna or the Tropical Monsoon Climates, is absent. Instead, there are two periods of maximum rainfall, in April and October as shown in Fig. 122 (a) and 122 (b), which occur shortly after the equinoxes. Least rain falls at the June and December solstices. The double rainfall peaks coinciding with the equinoxes are a characteristic feature of equatorial climates not found in any other type of climate. But this simple pattern may be upset by local conditions, e.g. Kota Bharu, Kelantan receives most of its rainfall from the North-East Monsoon at the end of the year and Rangoon, Burma, from the South-West Monsoon between June and September. As one goes further north and south of the equator, particularly in coastal districts open to the influences of the trades, the tendency is towards a monsoonal pattern with the heaviest rainfall coming in the summer months, i.e. June, July and August in the northern hemisphere and December, January and February in the southern hemisphere.

Due to the great heat in the equatorial belt, mornings are bright and sunny. There is much evaporation and convectional air currents are set up, followed by heavy downpours of convectional rain in the afternoons from the towering cumulonimbus clouds (see Chapter 13). Thunder and lightning often accompany the *torrential showers* and the amount of rainfall recorded in one single afternoon may be as much as the deserts receive for the entire year! Besides the convectional rainfall, mountainous regions also experience much orographic or relief rain. In addition, there are some intermittent showers from cyclonic atmospheric disturbances caused by the convergence of air currents in the Doldrums.

The relative humidity is constantly high (over 80

Forested slopes of Mt. Kinabalu. The lower slopes have been cleared in places for cultivation. The vegetation on the higher slopes gradually changes in response to lower temperatures *Paul Popper*

per cent) making one feel 'sticky' and uncomfortable. The monotonous climate, oppressive and enervating, taxes one's mental alertness and physical capability, though along the coasts refreshing sea breezes do bring some relief. As a result, most of the white settlers, whose bodies are attuned to cooler and more varied conditions take to the cooler highlands whenever they can.

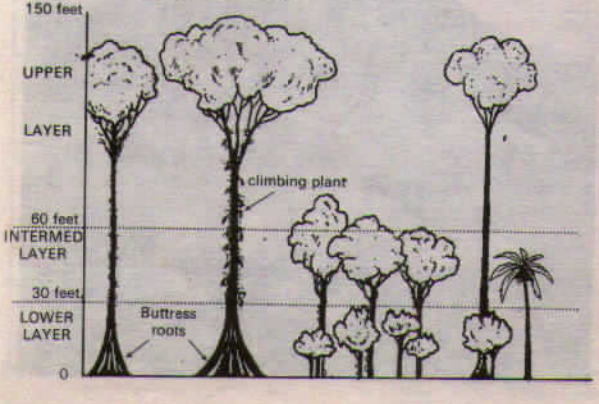
## Equatorial Vegetation

High temperature and abundant rainfall in the equatorial regions support a luxuriant type of vegetation – the tropical rain forest. In the Amazon lowlands, the forest is so dense and so complete in its vegetational extravagance that a special term 'selvas' is used. Unlike the temperate regions, the growing season here is all the year round – seeding, flowering, fruiting and decaying do not take place in a seasonal pattern, so some trees may be in flower while others only a few yards away may be bearing fruit. There is neither drought nor cold to check growth in any part of the year. The characteristic features of the equatorial vegetation may be summarized as follows.

**1. A great variety of vegetation.** The equatorial vegetation comprises a multitude of evergreen trees that yield tropical hardwood, e.g. mahogany, ebony, greenheart, cabinet woods and dyewoods. There are smaller palm trees, climbing plants like the lianas or rattan which may be hundreds of feet long and epiphytic and parasitic plants that live on other plants. Under the trees grow a wide variety of ferns, orchids and lalang.

**2. A distinct layer arrangement.** From the air, the tropical rain forest appears like a thick canopy of foliage, broken only where it is crossed by large rivers or cleared for cultivation. All plants struggle upwards for sunlight resulting in a peculiar layer arrangement. The tallest trees attain a height of over 150 feet (Fig. 123). Their slender trunks pierce skywards with wide-spread branches at the top. The smaller trees beneath form the next layer, and the ground is rooted with ferns and *herbaceous* plants which can tolerate shade. Because the trees cut out most of the sunlight the undergrowth is not dense.

Fig. 123 Sketch to show the three distinct layers of an equatorial forest




**3. Multiple species.** Unlike the temperate forests, where only a few species occur in a particular area, the trees of the tropical rain forests are not *found in* pure stands of a single species. It has been estimated that in the Malaysian jungle as many as 200 species of trees may be found in an acre of forest. This has made commercial exploitation of tropical timber a most difficult task. Many of the tropical hardwoods do not float readily on water and this makes haulage an expensive matter. It is therefore not surprising that many tropical countries are net timber importers!

**4. Forest Clearings.** Many parts of the virgin tropical rain forests have been cleared either for *lumbering or shifting cultivation*. When these clearings are abandoned, less luxuriant secondary forests, called belukar in Malaysia, spring up. These are characterized by short trees and very dense undergrowth. In the coastal areas and brackish swamps, mangrove forests thrive.

## Life and Development in the Equatorial Regions

The equatorial regions are generally sparsely populated. In the forests most primitive people live as *hunters and collectors* and the more advanced ones practise shifting cultivation. Food is so abundant in such a habitat that many people worry very little about the life of the next day. There are numerous animals, birds and reptiles that can be hunted to serve the needs of the community. The ever-flowing rivers and streams provide an inexhaustible supply of fish that the people spear or trap. From the forest, they gather leaves, fruits, nuts and other forest products. In the Amazon basin the Indian tribes collect wild rubber, in the Congo Basin the Pygmies gather nuts and in the jungles of Malaysia the Orang Asli make all sorts of cane products and sell them to people in villages and towns. In the clearings for shifting cultivation, crops like manioc (tapioca), yams, maize, bananas and groundnuts are grown. When the fertility is exhausted, the clearing is abandoned and they move on to a new plot. Such farming practices are becoming more and more widespread even among backward tribes.

With the coming of the Europeans, many large

Harvesting oil palm fruits in Malaysia

plantations have been established, especially in Java, Sumatra, Malaysia, West Africa and Central America. The climate has proved to be very favourable for the cultivation of certain crops that are highly valued in the industrial West. The most outstanding is natural rubber, called *hevea brasiliensis*. Though it was first discovered in its wild state as *Para rubber* in the Amazon basin, it has since been transplanted to other parts of the equatorial lands and is grown very profitably on large estates. Malaysia and Indonesia are the leading producers, each accounting for more than a third of the world production. The home country, Brazil exports practically no natural rubber. The problems of tree diseases and the lack of commercial organization of the Indians in the Amazon lowlands have brought about this unexpected 'shift' of rubber cultivation.

Another tropical crop that has achieved an amazing success is cocoa. It is most extensively cultivated in West Africa, bordering the Gulf of Guinea. The two most important producers are Ghana and Nigeria. There is a keen demand for the crop and acreages are rapidly on the increase. Most of the crop leaves West Africa for Europe or North America for the cocoa and chocolate industry. From the same area another crop, oil palm, has done equally well and many countries outside Africa have now taken to its cultivation. Other crops that have been found suitable for the hot, wet equatorial climate and are extensively cultivated are coconuts, sugar, coffee, tea, tobacco, spices, cinchona, bananas, pineapples and sago.

## Factors Affecting the Development of Equatorial Regions

**1. Equatorial climate and health.** Under conditions of excessive heat and high humidity, Man is subject to serious physical and mental handicaps. He perspires profusely and loses vigour and energy in such an enervating environment. He exposes himself to such dangers as sun-stroke and to such diseases as malaria and yellow-fever. Consequently, his capacity for active work is greatly reduced and his resistance to diseases is much weakened. Unless there is adequate provision for satisfactory sanitation, physical and mental health are bound to be affected. Nowadays malaria eradication schemes are in progress in most tropical areas and vaccines

Market gardening in Singapore. In many parts of the equatorial zone intensive farming, to supply city-dwellers with vegetables, is profitable *Primary Production Department Singapore*

have been developed to counteract other diseases.

**2. Prevalence of bacteria and insect pests.** The hot, wet climate which stimulates rapid plant growth, also encourages the spread of insects and pests. As germs and bacteria are more easily transmitted through moist air, equatorial conditions are ideal for the survival of such organisms. Insects and pests not only spread diseases but are injurious to crops. They plague both men and animals.

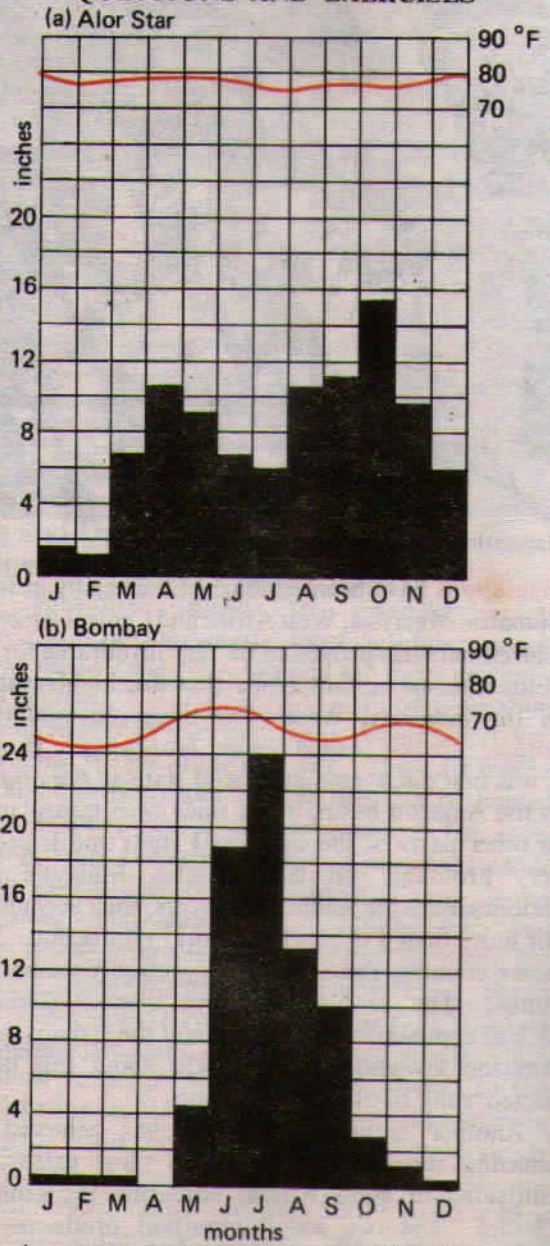
**3. Jungle hinders development and maintenance.** The jungle is so luxuriant that it is quite a problem to clear a small patch of it and even more difficult to maintain it. Lalang (tall grass) and thick undergrowth spring up as soon as the shade trees are cut and unless they are weeded at regular intervals, they may *choke crops* and overwhelm estates. In the same way, roads and railways constructed through the equatorial lands have to cut through forests, dense thickets and swamps and those who build and maintain them encounter wild animals, poisonous snakes and insects. Once completed, they have to be maintained at a *high cost*. Many remote parts of the Amazon basin, the Congo and Borneo are without modern communication lines. The rivers form the only natural highways.

**4. Rapid deterioration of tropical soil.** It is a misconception that tropical soils are rich. In its virgin, untouched state, due to heavy leaf-fall and the decomposition of leaves by bacteria, a thick mantle of humus makes the soil fairly fertile. This is clear from the shifting cultivators' heavy croppings in their newly cleared ladangs. But once the humus is used and the natural vegetative cover is removed, the torrential downpours soon wash out most of the soil nutrients. The soil deteriorates rapidly with subsequent soil erosion and soil impoverishment One may quote the Indonesian island of Java as an exception, because of its rich volcanic ashes and the energetic local people. In Malaysia, Singapore and eastern Brazil much progress has also been made in the development of the tropical lands through systematic planning and the will of the people to succeed.

**Difficulties in lumbering and livestock farming.** As mentioned earlier, though the tropics have great potential in timber resources, commercial extraction is difficult. The trees do not occur in homogenous stands, there are no frozen surfaces to facilitate logging and the tropical hardwoods are sometimes too heavy to float in the rivers, even if these flow in the desired directions.

Livestock farming is greatly handicapped by an absence of meadow grass, even on the highlands. The few animals like bullocks or buffaloes are kept mainly as beasts of burden. Their yield in milk or beef is well below those of the cattle in the temperate grasslands. The grass is so tall and coarse that it is not nutritious. In Africa, domesticated animals are attacked by tsetse flies that cause *ngana*, a deadly disease.

## QUESTIONS AND EXERCISES




1. The above two graphs taken from two different stations, Alor Star in West Malaysia and Bombay in India, show two different types of climate.

(a) Name the type of climate experienced in each of the stations.

(b) Describe the major differences in temperature and precipitation between the two stations.

(c) In what ways are the rainfall of the the two stations similar.

2. What type of climate is characterized by two periods of maximum rainfall? Explain why this is so. What local conditions may upset this normal pattern?

3. Outline the characteristics of the equatorial climate and vegetation and for any *one* equatorial region describe how the inhabitants overcome some of the difficulties posed by the environment.

4. Write brief notes on any *three* of the following statements about the equatorial regions.

(a) Cloudiness and heavy precipitation moderate the temperature of the equatorial regions.

(b) The most prominent feature of the tropical rain forest is its layer arrangement.

(c) Large-scale livestock farming is unknown in the hot, wet equatorial areas.

(d) The greatest single drawback to commercial lumbering in equatorial regions is inaccessibility.

(e) The equatorial environment is best suited to plantation agriculture.

5. On the map of the world, locate the hot, wet equatorial forests. Relate their vegetational characteristics to the climate of the regions.

# Chapter 16 The Tropical Monsoon and Tropical Marine Climates

## Distribution

We have learnt in Chapter 13 that some parts of the world experience seasonal winds like land and sea breezes but on a much larger scale. These are the tropical monsoon lands with on-shore wet monsoons in the summer and off-shore dry monsoons in the winter. They are best developed in the Indian sub-continent, Burma, Thailand, Laos, Cambodia, parts of Vietnam and south China and northern Australia. Outside this zone, the climate is modified by the influence of the on-shore Trade Winds all the year round, and has a more evenly distributed rainfall. Such a climate, better termed the Tropical Marine Climate, is experienced in Central America, West Indies, north-eastern Australia, the Philippines, parts of East Africa, Madagascar, the Guinea Coast and eastern Brazil (Fig.124).

## Climatic Conditions in Tropical Monsoon Lands

The basic cause of monsoon climates is the difference in the rate of heating and cooling of land and sea. In the summer, when the sun is overhead at the Tropic of Cancer, the great land masses of the northern hemisphere are heated. Central Asia, backed by the lofty Himalayan ranges, is more than 15°F. hotter than its normal temperature and a region of intense low pressure is set up. The seas, which warm up much slower, remain comparatively cool. At the same time, the southern hemisphere experiences winter, and a region of high pressure is set up in the continental interior of Australia. Winds blow outwards as the South-East Monsoon, to Java, and after crossing the equator are drawn towards the continental low pressure area reaching the Indian sub-continent as the South-West Monsoon, as shown in Fig. 125(a).

In the winter, conditions are reversed. The sun is overhead at the Tropic of Capricorn, central Asia is extremely cold, resulting in rapid cooling of the land. A region of high pressure is created with outblowing winds—the North-East Monsoon. On crossing the equator, the winds are attracted to the low pressure centre in Australia and arrive in northern Australia as the North-West Monsoon

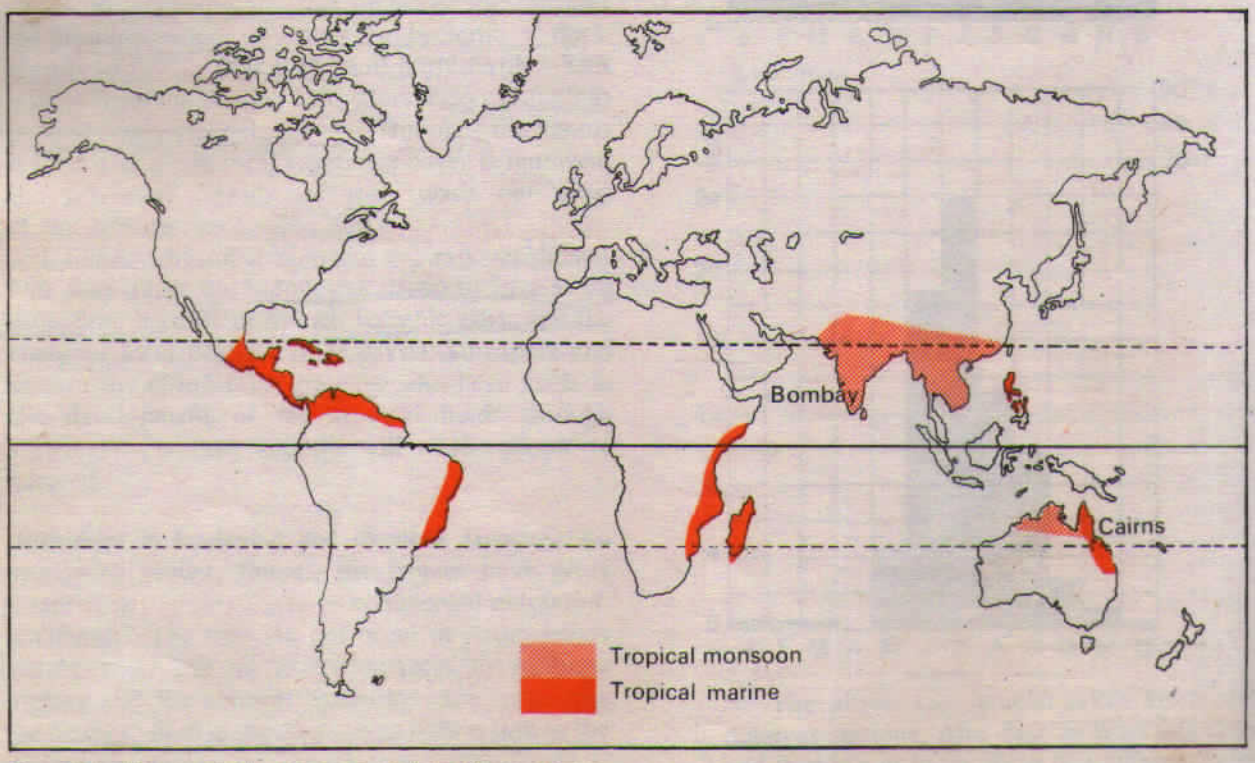



Fig. 124 The tropical monsoon and marine regions

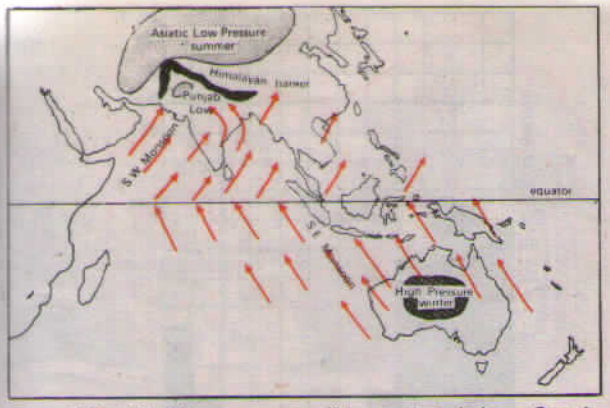
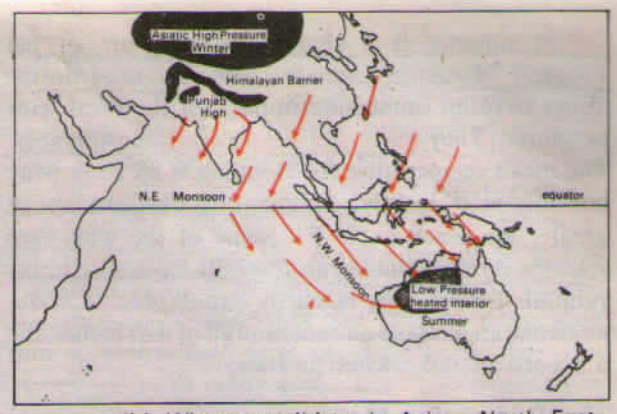



Fig. 125 (a) Summer conditions in Asia—South West Monsoon in Indo-Pakistan is on-shore in the rainy season (July)




(b) Winter conditions in Asia—North-East Monsoon in Indo-Pakistan is off-shore in the cool, dry season (January)

(Fig. 125 (b)). In other parts of the world which experience a tropical monsoon climate a similar seasonal reversal of wind directions occurs.

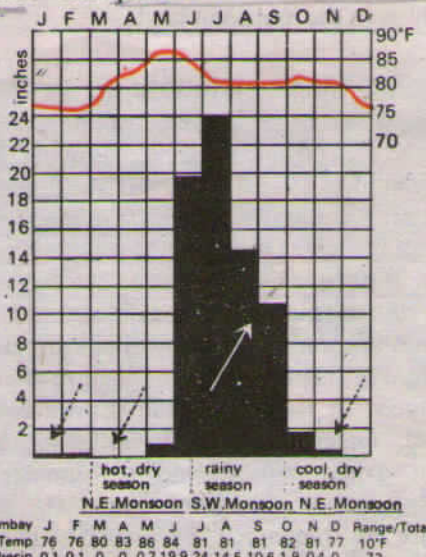
## The Seasons of Tropical Monsoon Climate

In regions like the Indian sub-continent which have a true Tropical Monsoon Climate, *three* distinct seasons are distinguishable, as illustrated in Fig. 126 (a).

**1. The cool, dry season (October to February).** Temperatures are low 76°F. in Bombay and only 50°F. in Punjab, with heavy sinking air. Frosts may occur at night in the colder north. The centre of high pressure is over the Punjab. Outblowing dry winds, the North-East Monsoon, bring little or no rain to the Indian sub-continent. However, a small amount of rain falls in Punjab from cyclonic sources and this is vital for the survival of winter cereals. Where the North-East Monsoon blows over the Bay of Bengal it acquires moisture and thus brings rain to the south-eastern tip of the peninsula at this time of the year. For instance, in Madras 50 inches of rain falls during October and November, accounting for half its annual rainfall.

**2. The hot dry season (March to mid-June).** As can be seen from Fig. 126(a), the temperature rises sharply with the sun's northward shift to the Tropic of Cancer. Bombay has a mean May temperature of 86°F. which is considered moderate, for many parts of India are even hotter. The heat is so great that schools and colleges are closed. The stifling heat and the low relative humidity make outdoor life almost unbearable. Day temperatures of 95°F. are usual in central India and the mean temperature in Sind may be as high as 110°F. Coastal districts are a little relieved by sea breezes. There is practically no rain anywhere. By May, the temperature is so high that an intense low pressure zone is set up in north-west India. *Duststorms* are frequent, followed by long awaited rainstorms that 'break' by the middle of June. The transitional period between 'no rain' and 'plenty of rain' is over.

**3. The rainy season (mid-June to September).** With the 'burst' of the South-West Monsoon in mid-June, *torrential downpours* sweep across the country to the delight of everybody. Almost all the rain for the year falls within this rainy season. For example in Bombay 19·9 inches are recorded in June, 24 inches in July, 14·5 inches in August and a further 10·6 inches in September. As much as 95 per cent of the annual rainfall is concentrated within four months. This pattern of concentrated heavy rain-




| Bombay | J | F | M | A | M | J | J | A | S | O | N | D | Range/Total |
|---|---|---|---|---|---|---|---|---|---|---|---|---|---|
| Temp | 76 | 76 | 80 | 83 | 86 | 84 | 81 | 81 | 81 | 82 | 81 | 77 | 10°F |
| Precip | 0·1 | 0·1 | 0 | 0 | 0·7 | 19·9 | 24 | 14·5 | 10·6 | 1·9 | 0·4 | 0 | 22 |

Fig. 126 (a) Tropical Monsoon Climate
Place: Bombay, India (18° 55'N., 73°E.)
Altitude: 37 feet
Annual precipitation: 72 inches
Annual temperature range: 10°F. (86°–76°F.)

fall in summer is a characteristic feature of the Tropical Monsoon Climate. The torrential downpours have an immediate impact on the local temperature. They lower the temperature considerably. The mean temperature for Bombay is 86°F. in May but only 81°F. in July. In the north the drop is even greater, as much as 13°F. Some of the windward stations on the Himalayan foothills have very heavy rainfall, though this is partly orographic. *Cherrapunji* has an average annual rainfall of 425 inches and a record of 905 inches in 1861.

## The Retreating Monsoon

The amount and frequency of rain decreases towards the end of the rainy season. It retreats gradually southwards after mid-September until it leaves the continent altogether. The Punjab plains which receive the south-west monsoon earliest are the first to see the withdrawal of the monsoon. The skies are clear again and the cool, dry season returns in October, with the outblowing North-East Monsoon.

The role of monsoons in India is vital in its economy. A late monsoon or one that ends far too early will condemn large stretches of agricultural land to drought. There will be widespread famine from crop failure and thousands will perish. When there is too much water from the rainy monsoons, severe floods occur, destroying both crops and lives and disrupting communications. In no part of the world has the climate affected Man's way of life so profoundly as in the monsoon lands.

## The Tropical Marine Climate

This type of climate is experienced along the eastern coasts of tropical lands, receiving steady rainfall from the Trade Winds all the time. The rainfall is both orographic where the moist trades meet upland masses as in eastern Brazil, and convectional due to intense heating during the day and in summer. Its tendency is towards a summer maximum as in monsoon lands, but without any distinct dry period. Fig. 126 (b) shows the rhythm of climate as experienced in Cairns, on the eastern coast of Queensland, under the constant influence of the South-East Trade Winds, and in summer also affected by the tropical monsoons. Its wettest months are in January (15·8 inches), February (16·4), March (17·7) and April (12·1), which is summer in the southern hemisphere. Approximately 70 per cent of the annual rainfall is concentrated in the four summer months. There is no month

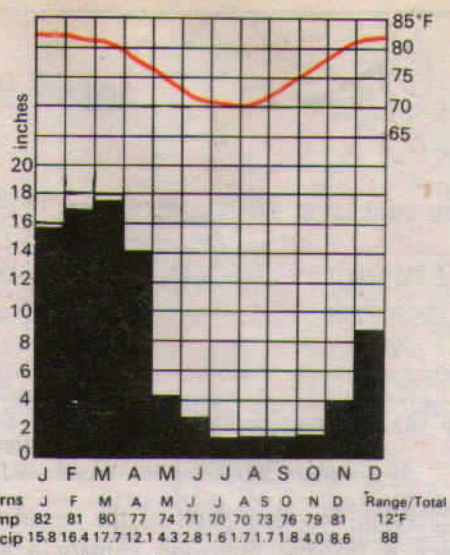



Fig. 126 (b) Tropical marine Climate
Place: Cairns, Australia (17°S., 145°, 42'E.)
Altitude: coastal lowland
Annual precipitation: 88 inches
Annual temperature range: 12°F. (82°–70°F.)

without any rainfall. The range of temperature is typical of the tropical latitudes with a maximum of 82°F. in January and a minimum of 70°F. in July—a range of 12°F. for the year. Due to the steady influence of the trades, the Tropical Marine Climate is more favourable for habitation, but it is prone to severe tropical cyclones, hurricanes or typhoons, as mentioned in Chapter 13.

## Tropical Monsoon Forests

The natural vegetation of tropical monsoon lands depends on the *amount of the summer rainfall.* Trees are normally deciduous, because of the marked dry period, during which they shed their leaves to withstand the drought. Where the rainfall is heavy, e.g. in southern Burma, peninsular India, northern Australia and coastal regions with a tropical marine climate, the resultant vegetation is forest. The forests are more open and less luxuriant than the equatorial jungle and there are far fewer species. Most of the forests yield valuable timber, and are prized for their durable hardwood. Amongst these teak is the best known. Burma alone accounts for as much as three-quarters of the world's production. It is such a durable timber that it is extensively used for ship building, furniture and other constructional purposes. Other kinds of timber include sal, acacia and some varieties of eucalyptus in northern Australia. Together with the forests are bamboo thickets, which often grow to great heights (Fig. 127).

With a decrease in rainfall in summer, the forests thin out into thorny scrubland or savanna with

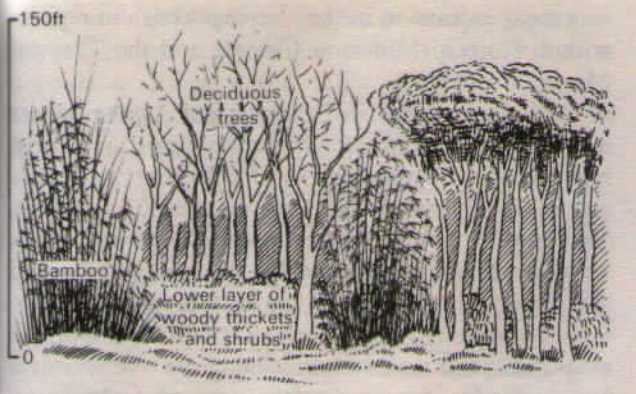



Fig. 127 Main features of a monsoon forest

scattered trees and tall grass. In parts of the Indian sub-continent, rainfall is so deficient that semi-desert conditions are found. Monsoonal vegetation is thus most varied, ranging from forests to thickets, and from savanna to scrubland.

## Agricultural Development in the Monsoon Lands

Much of the monsoon forest has been cleared for agriculture to support the very dense population. The cultural landscape throughout the length and breadth of the monsoon lands deeply reflects the intensity of Man's quest for subsistence. Wherever possible, crops are grown. The plains are ploughed, and the hills are terraced to provide farmland. Farms are small and the people are forever 'land hungry'. In their quest for land, they have removed the natural vegetation, sometimes wantonly, resulting in acute soil erosion. This is particularly serious in the Indian sub-continent which has a very high density of population with a rapid rate of growth. But in the plains the same piece of land may have been tilled for generations with little or no replenishment, and yet able to yield fairly reasonable returns.

Tropical agriculture dependent on natural rainfall and a large labour force, reaches its greatest magnitude in the monsoon lands. The soil provides the basis for the livelihood of millions. Farming is not only the dominant occupation of the greater part of the people, but also forms the mainstay of the economy of the Indian sub-continent, China, South-East Asia, eastern Brazil and the West Indies. The following types of agriculture are recognisable.

1. **Wet padi cultivation.** Rice is the most important staple crop and is grown in tropical lowlands wherever the rain exceeds 70 inches. It is perhaps the most characteristic crop of the monsoon lands and its total acreage far exceeds that of any other crop. In fact, very few areas outside the influence of the monsoons ever take to the cultivation of padi. There are two main varieties, the wet padi, which is mainly grown on lowlands in flooded fields or in terraced uplands, and the dry padi grown in regions of lower rainfall. A minimum of 50 inches of rainfall is required during the growing season. Droughts and floods that are almost inseparable from a monsoonal type of climate can be very detrimental to its cultivation. Irrigation water from rivers, canals, dams or wells is extensively used in the major rice producing countries. Other food crops like maize, millet, sorghum, wheat, gram and beans are of subsidiary importance. They are cultivated in the drier or cooler areas where rice cannot be grown.

2. **Lowland cash crops.** A wide range of lowland tropical cash crops are cultivated for the export market, after local needs have been met. The most important crop in this category is cane sugar. As much as two-thirds of world's sugar production comes from tropical countries. Sugar is either grown on plantations or on small holdings wherever rainfall and sunshine are abundant. Some of the major producers include India, Java, Formosa, Cuba, Jamaica, Trinidad and Barbados. Jute is confined

Harvesting sugar-cane in Queensland, Australia *Australian News and Information Bureau*

almost entirely to the Ganges - Brahmaputra delta, in India and Bangladesh. It has long been a leading hard fibre for the manufacture of sacks (gunny). Manila hemp (abaca) is a product of the Philippines, particularly of Mindanao. It is used to make high quality rope. Other crops include indigo, still cultivated in India and Java; cotton, a major export of the Indian sub-continent and bananas, coconuts and spices.

**3. Highland plantation crops.** The colonization of tropical lands by Europeans gave rise to a new form of cultivated landscape in the cooler monsoonal highlands. This is the cultivation of certain tree crops in tropical plantations. Thousands of acres of tropical upland forests were cleared to make way for *plantation agriculture* in which tea and coffee are the most important crops. These were luxuries in Europe in the eighteenth century and the products of the plantations were originally meant only for export to the mother countries where there was a great craze for the beverages. Later, the local people also got into the habit of drinking them and they fast became necessities. Both the beverages became so popular in and out of the tropics that there was great expansion in their acreages both in regions with a Tropical Monsoon Climate and the Tropical Marine Climate.

Coffee originated in Ethiopia and Arabia, where it is still grown, but *Brazil* now accounts for almost half the world's production of coffee. It is mainly grown on the eastern slopes of the Brazilian plateau. The crop is also cultivated on the highland slopes between 2,000 feet and 4,500 feet in the Central American states, India and eastern Java.

Tea originated in China and is still an important crop there, but as it requires moderate temperatures (about 60°F.), heavy rainfall (over 60 inches) and well drained highland slopes it thrives well in the tropical monsoon zone, but preferably at a higher altitude. The best regions are thus the Himalayan foothills of India and Bangladesh, the central highlands of Sri Lanka and western Java, from all of which it is exported. In China tea is grown mostly for local consumption.

**4. Lumbering.** Wherever there are tropical forests which still have not been felled to make way for the plough, *lumbering* is undertaken in the more accessible areas. This is particularly important in conti-

Tea picking in a plantation in Sri Lanka *Camera Press*

nental South-East Asia. Of the tropical deciduous trees, teak, of which Burma is the leading producer, is perhaps the most sought after. It is valuable on account of its great durability, strength, immunity to shrinkage, fungus attack and insects. It is grown in hilly districts up to 3,000 feet in altitude with a moderate rainfall. Under government supervision, teak trees which are cut have to be replaced. This is the only way to ensure the steady supply of the timber which is the second greatest money-earner for Burma after rice. In northern Burma, in the region of the Chindwin River, there are large teak plantations. It takes as long as 100 years for a teak tree to mature into commercial timber. Green teak logs are so heavy that they will not float readily on water. It is therefore necessary to 'poison' the tree several years before actual felling, so that it is dry and light enough to be floated down the Chindwin and the Irrawaddy to reach the saw mills at Rangoon. The individual logs are tied in rafts and guided downstream by crews of men and tugboats. It takes something like 18 months for a log of teak to reach Rangoon to be sawn into planks for export.

**5. Shifting Cultivation.** This most primitive form of farming is widely practised. Instead of rotating the crops in the same field to preserve fertility, the tribesmen move to a new clearing when their first field is exhausted. The clearing, or field, in the midst of the jungle is usually made by fire, which destroys practically everything in its way. After planting, little attention is paid to the field either in weeding or manuring. The crops are left entirely to the care of nature. The farmers use simple hoes and sticks for ploughing and seeding. Draught animals are unknown and labour is exclusively manual. Their needs are so basic that every farmer produces much the same range of crops as his neighbours. Maize or corn, dry padi, yams, tapioca, sweet potatoes and some beans are the most common crops. Farming is entirely for subsistence, i.e. everything is consumed by the farmer's family, it is not traded or sold.

As tropical soils are mainly latosolic, rapidly leached and easily exhausted, the first crop may be bountiful but the subsequent harvests deteriorate. A few years later, the field has to be abandoned and a new patch cleared elsewhere. This system of a short period of cultivation alternating with long periods of fallowing is probably the best way of using land in many parts of the tropics where manuring is unknown.

Shifting cultivation is so widely practised amongst indigenous peoples that different local names are used in different countries. For example, *ladang* in Malaysia, *taungya* in Burma, *tamrai* in Thailand, *caingin* in the Philippines, *humah* in Java, *chena* in Sri Lanka and *milpa* in Africa and Central America.

## QUESTIONS AND EXERCISES

1. The climate of India is characterized by three distinct seasons. Explain why this is so.

2. With the aid of diagrams or sketch maps, explain any *three* of the following statements.
   (a) The east coasts of continents within the tropics have much heavier rainfall than the interiors or the west coasts.
   (b) The Tropical Monsoon Climate is, in fact, land and sea breezes on a continental scale.
   (c) Near the equatorial latitudes, the period of maximum rainfall is closely related to the movements of the overhead sun.
   (d) There is a marked difference in temperature between the east and west coasts of countries in latitudes 20° to 35°N.

3. In which parts of the monsoon lands has the natural vegetation been removed by men? Describe and explain the uses made of the cleared lands.

4. Name the types of climate which have
   (a) rain mainly in winter
   (b) rain only in summer
   (c) rain throughout the year
      i. Describe the characteristic climatic features of any *two* of the types you have named.
      ii. For any *one* of them account for its rainfall distribution.

5. Contrast the essential characteristics of plantation agriculture and shifting cultivation.

# Chapter 17 The Savanna or Sudan Climate

## Distribution

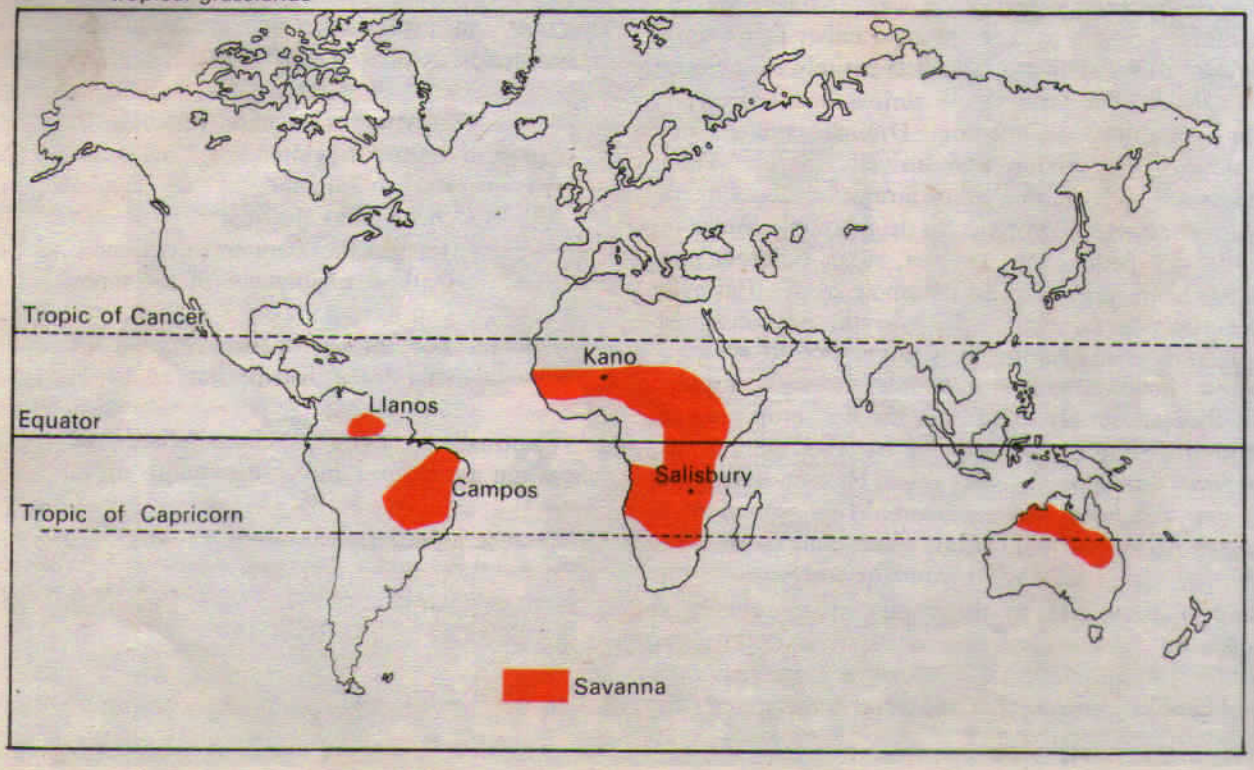
The Savanna or Sudan Climate is a transitional type of climate found between the equatorial forests and the trade wind hot deserts. It is confined within the tropics and is best developed in the Sudan where the dry and wet seasons are most distinct, hence its name the Sudan Climate. The belt includes West African Sudan, and then curves southwards into East Africa and southern Africa north of the Tropic of Capricorn as shown in Fig. 128. In South America, there are two distinct regions of savanna north and south of the equator, namely the *llanos* of the Orinoco basin and the *campos* of the Brazilian Highlands. The Australian savanna is located south of the monsoon strip running from west to east north of the Tropic of Capricorn.

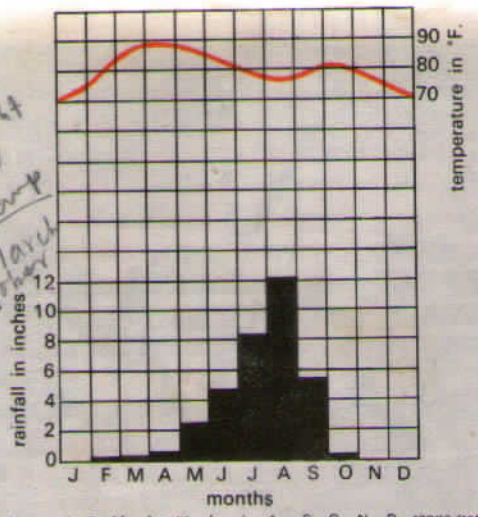
## Climate of the Sudan Type

**Rainfall.** The Sudan type of climate is characterized by an alternate hot, rainy season and cool, dry season, as illustrated in Fig. 129 (a). In the northern hemisphere, the hot, rainy season normally begins in May and lasts until September, as in Kano, Nigeria. The rest of the year is cool and dry. The annual rainfall for Kano, which is located at a height of 1,539 feet above sea level, is 34 inches and is almost entirely concentrated in the summer. But the amount varies from 48 inches at Bathurst, in Gambia on the coast to only 5 inches at Khartoum, in Sudan in the interior. Both the length of the rainy season and the annual total rainfall decrease appreciably from the equatorial region polewards towards the desert fringes. On the whole, the annual precipitation is less than that of the Tropical Monsoon Climate and the length of the wet and dry seasons differs with the locality. In the southern hemisphere, the rainy season is from October to March (the southern summer) as shown in Fig. 129(b) of Salisbury, in Rhodesia. Its annual precipitation of 32 inches also varies much from year to year.

**Temperature.** The monthly temperature hovers between 70°F. and 90°F. for lowland stations. An annual temperature range of 20°F. is typical, but the range increases as one moves further away from the equator. It is, however, interesting to note that the

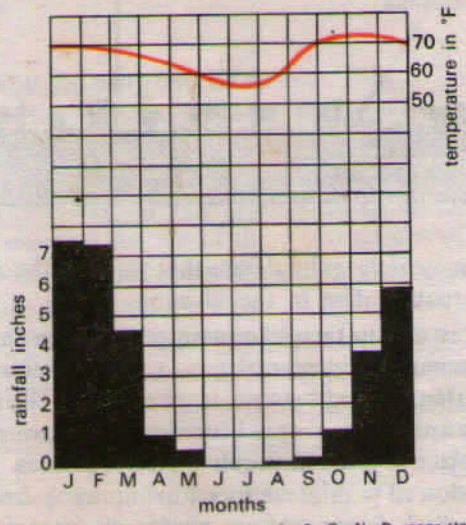
Fig. 128 Regions of Sudan Climate with savanna or tropical grasslands






| Kano | J | F | M | A | M | J | J | A | S | O | N | D | range/total |
|---|---|---|---|---|---|---|---|---|---|---|---|---|---|
| Temp. | 72 | 77 | 85 | 89 | 88 | 83 | 80 | 78 | 80 | 81 | 78 | 73 | 17°F. |
| Precip. | 0 | 0.1 | 0.1 | 0.5 | 2.5 | 4.8 | 8.2 | 12.1 | 5.5 | 0.5 | 0 | 0 | 34" |

Fig. 129 (a) The Savanna or Sudan Climate in the northern hemisphere
Place: Kano, Nigeria (11° 58'N., 8° 20' E.)
Altitude: 1,539 feet
Annual precipitation: 34 inches
Annual temperature range: 17°F. (89–72°F.)




| Salisbury | J | F | M | A | M | J | J | A | S | O | N | D | range/total |
|---|---|---|---|---|---|---|---|---|---|---|---|---|---|
| Temperature | 70 | 69 | 68 | 66 | 61 | 57 | 56 | 60 | 66 | 71 | 71 | 70 | 15° |
| Precipitation | 7.5 | 7.4 | 4.5 | 1.0 | 0.5 | 0 | 0 | 0.1 | 0.3 | 1.1 | 3.7 | 5.8 | 32" |

(b) The Savanna or Sudan Climate in the southern hemisphere
Place: Salisbury, Rhodesia (17°45'S., 31°E.)
Altitude: 4,435 feet
Annual precipitation: 32 inches
Annual temperature range: 15°F (71 – 56°)

highest temperatures do not coincide with the period of the highest sun (e.g. June in the northern hemisphere) but occur just before the onset of the rainy season, i.e. April in Kano and October in Salisbury. There is also a distinct drop in temperature in the rainy period, due to the overcast sky and the cooler atmosphere.

Days are hot, and during the hot season, noon temperatures of over 100°F. are quite frequent. When night falls the clear sky which promotes intense heating during the day also causes rapid radiation in the night. Temperatures drop to well below 50°F. and night frosts are not uncommon at this time of the year. This extreme diurnal range of temperature is another characteristic feature of the Sudan type of climate.

**Winds.** The prevailing winds of the region are the Trade Winds, which bring rain to the coastal districts. They are strongest in the summer but are relatively dry by the time they reach the continental interiors or the western coasts of the continents, so that grass and scattered short trees predominate. In West Africa, the North-East Trades, in fact, blow off-shore from the Sahara Desert and reach the Guinea coast as a dry, dust-laden wind, called locally the Harmattan, meaning 'the doctor'. It is so dry that its relative humidity seldom exceeds 30 per cent. 'The doctor' provides a welcome relief from the damp air of the Guinea lands by increasing the rate of evaporation with resultant cooling effects, but it is such a dry dusty wind that, besides ruining the crops, it also stirs up a thick dusty haze and impedes inland river navigation.

## Natural Vegetation

The savanna landscape is typified by tall grass and short trees. It is rather misleading to call the savanna 'tropical grassland', because trees are always present with the luxuriant tall grass. The terms *'parkland'* or *'bush-veld'* perhaps describe the landscape better. Trees grow best towards the equatorial humid latitudes or along river banks but decrease in height and density away from the equator (Fig. 130). They occur in clumps or as scattered individuals. The trees are deciduous, shedding their leaves in the cool, dry season to prevent excessive loss of water through transpiration, e.g. *acacias*. Others have broad trunks, with water-storing devices to survive through the prolonged drought such as *baobabs and bottle trees*. Trees are mostly hard, gnarled and thorny and may exude gum like *gum arabic*. Many trees are umbrella shaped, exposing only a narrow edge to the strong winds. Palms which cannot withstand the drought are confined to the wettest areas or along rivers. Vegetative luxuriance reaches its peak in the rainy season, when trees renew their foilage and flower.

In true savanna lands, the grass is tall and coarse, growing 6 to 12 feet high. The elephant grass may attain a height of even 15 feet! The grass tends to

Giraffes in the savanna. The vegetation is of grass and scattered trees *J. Allen Cash*

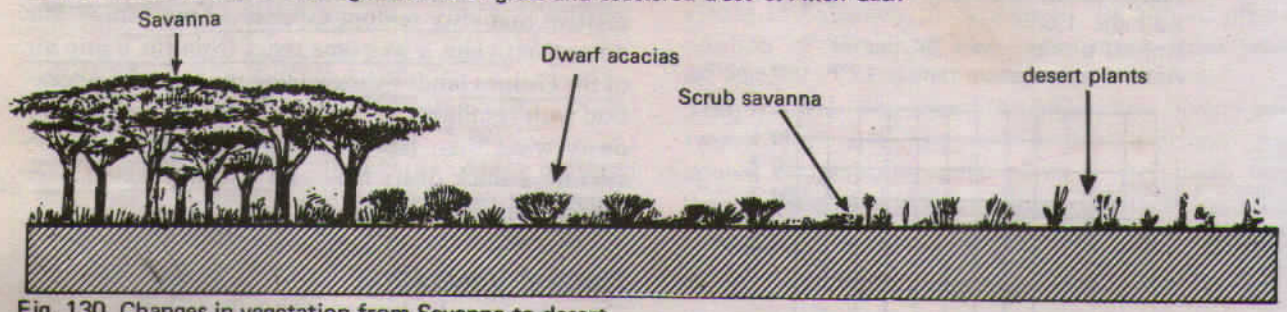



Fig. 130 Changes in vegetation from Savanna to desert

grow in compact *tufts* and has long roots which reach down in search of water. It appears greenish and well nourished in the rainy season but turns yellow and dies down in the dry season that follows. The grass lies dormant throughout the long, rainless period and springs up again in the next rainy season. In between the tall grass are scattered short trees and low bushes. As the rainfall diminishes towards the deserts the savanna merges into thorny scrub. In Australia, this scrubland is particularly well represented by a number of species: *mallee, mulga, spinifex grass* and other bushes.

## Animal Life of the Savanna

The savanna, particularly in Africa, is the home of wild animals. It is known as the 'big game country' and thousands of animals are trapped or killed each year by people from all over the world. Some of the animals are tracked down for their skins, horns, tusks, bones or hair, others are captured alive and sent out of Africa as zoo animals, laboratory specimens or pets. There is such a wealth of animal life in Africa that many of the animal films that we see at the cinema are actually taken in the savanna.

There are, in fact, two main groups of animals in the savanna, the grass-eating herbivorous animals and the fleshing-eating carnivorous animals. The herbivorous animals are often very alert and move swiftly from place to place in search of green pastures. They are endowed with great speed to run away from the savage flesh-eaters that are always after them. The leaf and grass-eating animals include the zebra, antelope, giraffe, deer, gazelle, elephant and okapi. Many are well camouflaged species and their presence amongst the tall greenish-brown grass cannot be easily detected. The giraffe with such a long neck can locate its enemies a great distance away, while the elephant is so huge and strong that few animals will venture to come near it. It is well equipped with tusks and trunk for defence.

The carnivorous animals like the lion, tiger, leopard, hyaena, panther, jaguar, jackal, lynx and puma have powerful jaws and teeth for attacking other animals. Their natural colourings of light

yellowish-brown, often with stripes like the tiger or spots like the leopard, match perfectly with the tawny background of the savanna. They often hide themselves in shady spots up in the branches or amidst the tall bushes, and many wild animals, as well as hunters themselves, are caught unawares in this manner. Along rivers and in marshy lakes are numerous species of reptiles and mammals including crocodiles, alligators, monitors and giant lizards together with the larger rhinoceros and hippopotamus. In such an *animal paradise* there are many diverse species of birds, snakes, butterflies, moths and insects.

In many parts of East and South Africa, national parks have been set up which control the killing of animals. This is a necessity, if many of the rare species of animals are to be preserved and protected from wanton shooting. In Kenya there are large hotels and viewing-towers, built in the heart of the savanna, with special transport arrangements to bring tourists in to see the animals in their natural settings. This is a progressive step made in conserving animal life of the savanna and should be encouraged.

## Human Life in the Savanna

Within the savanna lands of the tropics live many different tribes who are either cattle pastoralists like the Masai of the East African plateau or settled cultivators like the Hausa of northern Nigeria. We shall examine the life of these two groups of people more closely, and see how they adapt themselves to the savanna environment

**The Masai, cattle pastoralists.** The Masai are a nomadic tribe who once wandered with their herds of cattle in the central highlands of East Africa – in Kenya, Tanzania and Uganda. At the height of their power, in the mid-nineteenth century they numbered about 50,000. But today after a century's tribal clashes, epidemics and natural deaths, their numbers have been greatly reduced. They are now mainly confined to the 15,000 square miles of Masai reserves in Kenya and Tanzania. Their old grazing grounds in the Kenyan Highlands were taken over first by the immigrant white settlers for plantation agriculture (coffee, tea, cotton) and dairy farming and later, after independence, by African farmers. They now occupy the less favoured areas of savanna in which are grazed something like a million cattle and perhaps twice as many sheep and goats. On the lower slopes of the East African plateau, where rainfall is as low as 20 inches and there are long periods of drought, the grass seldom reaches a foot high and is not nutritious. When there is a drought the Masai move upwards to the higher and cooler plateau regions in which their herds can graze on the better pastures. They build circular huts with sticks, bushes and mud for temporary shelter. The cattle are kept in a special enclosure at night and are protected from attack by wild animals by a strong fence.

The cattle kept by the Masai are the zebu cattle with humps and long horns. They are treated with great respect and affection and are never slaughtered for food or for sale. The beef is only consumed when they die a natural death from old age or disease. They are never used as draught animals and are kept entirely for the supply of milk and blood. Milking is done by women before day-break and at dusk. The yield is extremely low by any standard and usually not more than two pints are obtained at a single milking. The milk is drunk either fresh or sour. Cheese-making is still not known to the Masai. Blood from both bulls and cows is drunk. This is obtained by tying a leather cord around the neck of an animal until the veins swell. A vein is then punctured by a special arrow-head and the blood gushes out and is collected and drunk fresh or clotted.

Cattle are kept by every Masai family. They are considered far more valuable than anything else, and are symbols of wealth. The richest man has the largest herds of cattle, leaving aside the sheep and goats which, to the Masai tribes, are of little significance. Cattle are used in payment for wives, and when the father of a family dies, the mother divides the livestock among the sons. The Masai will not slaughter the cattle for food, so from the agricultural

The Masai tribesmen drink the blood as well as the milk of their animals but do not kill them for meat *Camera Press*

tribes such as the Kikuyu of Kenya, they obtain a small amount of millet, bananas, groundnuts and vegetables.

Because the number of cattle is more important to the Masai than their quality, the Masai will not willingly sell their cattle. So the large area of land which they occupy in East Africa is not used profitably. Great efforts are being made to get the Masai to care for their animals properly and raise them for sale, keeping only as many animals as the pasture can support. Many Masai are responding to modern techniques but the majority stubbornly continue in their old ways. Amongst most of the other African tribes, pastoralism exists side by side with agriculture.

**The Hausa, settled cultivators.** The Hausa are a tribe of settled cultivators who inhabit the savanna-lands of the Bauchi Plateau of northern Nigeria. They number almost six million and have been organized in settled agricultural communities for hundreds of years. They are more advanced in their civilization and ways of life than many of the other African negroes.

The Hausa live in towns or villages. The ancient Hausa city of Kano, with a population of 135,000 has long been a focus of routes and trade. They do not practise shifting cultivation as many tribes do. Instead, they clear a piece of land and use it for several years, growing a wide range of crops like maize, millet, Guinea corn, groundnuts, bananas and beans. Some Hausa also cultivate non-food crops e.g. cotton and tobacco. When the fertility of the plot declines, they plant a new field and allow the old one to lie *fallow*. This enables natural forces to act on it until fertility is restored. New crops are then sown in the old plot again and the harvests are good. In this manner, the Hausa rotate their crops between different fields at different parts of the year, which is a technique employed in advanced agricultural societies.

Besides cultivation, the Hausa also make use of domesticated animals. Herds of cattle and goats are kept for both milk and meat, but they are only subsidiary to crop cultivation. Though they do not contribute much to the income of the Hausa, because of their small numbers, their manure is used to fertilize the fields. Poultry are raised by the villagers and both eggs and chicken are consumed.

The farming year is very closely related to the season of rainfall. In Nigeria, the rainy season begins in May and lasts till September. The annual precipitation is about 40 inches, falling entirely in summer. The Hausa sow the seeds in late April when sufficient rain has fallen. The seedlings sprout with the heavy rain and grow rapidly throughout the rainy season. Weeding with traditional hoes is done at regular intervals till the crops are ripened and harvested in September, the beginning of the cool, dry season. The tall brown bushes are burnt down by the farmers in preparation for new fields for the following year. Sometimes fires may be caused by the dry, dusty Harmattan.

## Problems, Prospects and Development of the Savanna

There is little doubt that in years to come, world population pressure and the need for greater food production will necessitate greater economic development of the savanna. The deserts or the freezing tundra form climatic barriers too formidable for large scale human intervention to take place. But the savanna lands with an annual rainfall of over 30 inches and without any severe cold, should be able to support a wide range of tropical crops. ***Pioneer settlements*** in central Africa, northern Australia and eastern Brazil have shown that the savannas have immense agricultural potential for plantation agriculture of cotton, cane sugar, coffee, oil palm, groundnuts and even tropical fruits. Tropical Queensland, despite its scarcity of labour force has been very successful in its attempts to develop its huge empty land. The newly independent states of Kenya, Uganda, Tanzania and Malawi have already taken to large-scale production of cotton and sisal hemp. Both crops thrive well in savanna conditions. In West Africa, the commercial cultivation of groundnuts, oil palm and cocoa have been gradually extended into the savanna lands. New drought-resistant varieties will have to be introduced into these newly emergent countries to increase their foreign earnings in such tropical raw materials. In the cooler highlands, temperate crops have been successfully raised.

But farming in the savanna land is not without natural hazards. *Droughts* may be long and trying, as rainfall is often unreliable. Unless countermeasures can be taken in the form of adequate provision for irrigation, improved crop varieties and scientific farming techniques suitable for the tropical grasslands, crop failures can be disastrous for the people, who have very little to fall back on. The Sudan Climate, with distinct wet-and-dry periods is also responsible for the rapid deterioration of soil fertility. During the rainy season, torrential down-

pours of heavy rain cause leaching, in which most of the plant nutrients such as nitrates, phosphates and potash are dissolved and washed away. During the dry season, intense heating and evaporation dry up most of the water. Many savanna areas therefore have poor lateritic soils which are incapable of supporting good crops. Unless the soil is properly conserved through regular manuring, weeding and careful maintenance, crop yields are bound to decline.

The savanna is said to be the natural cattle country and many of the native people are, in fact, herdsmen or pastoralists. Cattle are kept in large numbers and fed on the tall grass or the bushes. They provide the people with milk, blood and meat. Unfortunately, the native zebu cattle are bony and yield little meat or milk. They often fall victim to tropical diseases, e.g. the ngana or sleeping sickness carried by the tsetse fly in Africa. The export of either beef or milk from the tropical grasslands is so far not important.

It seems necessary to introduce temperate cattle such as the English Shorthorn, Friesian or Guernsey to *cross* with the tropical *zebu*, if cattle rearing is to be successful in the savanna. In fact, a start has already been made in tropical Queensland which has become Australia's largest cattle producing state. Both meat and milk are exported. In other regions such as the *campos and llanos* of South America, though cattle ranching has been carried out for centuries, little progress has been made so far. The quality of the grass needs to be improved and a better network of communications is essential. Above all cattle breeding and disease control must be carried out on a scientific basis. In the African savanna, the attitude of such native herdsmen as the Masai who treat cattle as prestige animals, not for slaughtering, will pose many difficulties towards the commercialization of the cattle industry. But as an agricultural region, the savanna holds great promise for the future.

## QUESTIONS AND EXERCISES

1. The following are brief descriptions of *three* different types of climate.
   (a) A very large temperature range, with summer rain.
   (b) Distinct wet and dry seasons with concentrated summer rain.
   (c) High uniform temperature with well distributed heavy rainfall.
      i. Name the type of climate.
      ii. For any *two* of them, give a fuller description of the climate and the factors which give rise to it.

2. Explain why
   (a) The savanna lands have a parkland type of natural vegetation.
   (b) The savanna is the natural home of cattle.
   (c) The savanna grass decreases in height and luxuriance further away from the equator.
   (d) Rainfall in the Sudan Climate is concentrated in the summer.

3. Write a descriptive account of
   *Either:* The Masai, pastoralists of East Africa.
   *Or:* The Hausa, food growers of northern Nigeria.
   You should bear in mind the environmental influence on their mode of living

4. It is said that the savanna land holds great promise for the future. Do you think so? Why? Outline some of the probable difficulties that may be encountered in their development.

5. Write brief notes on the following.
   (a) The effects of Harmattan in West Africa.
   (b) The savanna is the 'Big Game Country.'
   (c) Tropical grasslands have great potential for the cultivation of tropical hot, crops, e.g. cotton, coffee, fruits.
   (d) The savanna is a transitional zone between the equatorial forests and the hot deserts.

# Chapter 18 The Hot Desert and Mid-Latitude Desert Climates

## Distribution

Deserts are regions of scanty rainfall which may be hot like the hot deserts of the Saharan type; or temperate as are the mid-latitude deserts like the Gobi. The aridity of the hot deserts is mainly due to the effects of off-shore Trade Winds, hence they are also called *Trade Wind Deserts*. The temperate deserts are rainless because of their interior location in the temperate latitudes, well away from the rain-bearing winds.

The major hot deserts of the world are located on the western coasts of continents between latitudes 15° and 30°N. and S. as shown in Fig. 131. They include the Sahara Desert, the largest single stretch of desert, which is 3,200 miles from east to west and at least 1,000 miles wide. Its total area of 3.5 million square miles is larger than all the 50 states of U.S.A. put together. The next biggest desert is the Great Australian Desert which covers almost half of the continent. The other hot deserts are the Arabian Desert, Iranian Desert, Thar Desert, Kalahari and Namib Deserts. In North America, the desert extends from Mexico into U.S.A. and is called by different names at different places, e.g. the Mohave, Sonoran, Californian and Mexican Deserts. In South America, the Atacama or Peruvian Desert is the driest of all deserts with less than 0.5 inches of rainfall annually.

Amongst the mid-latitude deserts, many are found on plateaux and are at a considerable distance from the sea. These are the Gobi, Turkestan and Patagonian Deserts. The Patagonian Desert is more due to its rain-shadow position on the leeward side of the lofty Andes than to continentality.

## Climate

**Rainfall.** Few deserts whether hot or mid-latitude have an annual precipitation of more than 10 inches. For example William Creek in Australia has 5.4 inches, Kotah in India has 4 inches. Yuma, Arizona, U.S.A. has 3.3 inches. In Salah in the mid-Sahara and Arica in the mid-Atacama have practically no rain at all. In the latter, less than 0.02 inches fell within a period of 17 years in three light showers! In another station less than 150 miles away at Iquique, not a single drop of rain was recorded for four years and then a torrential down-

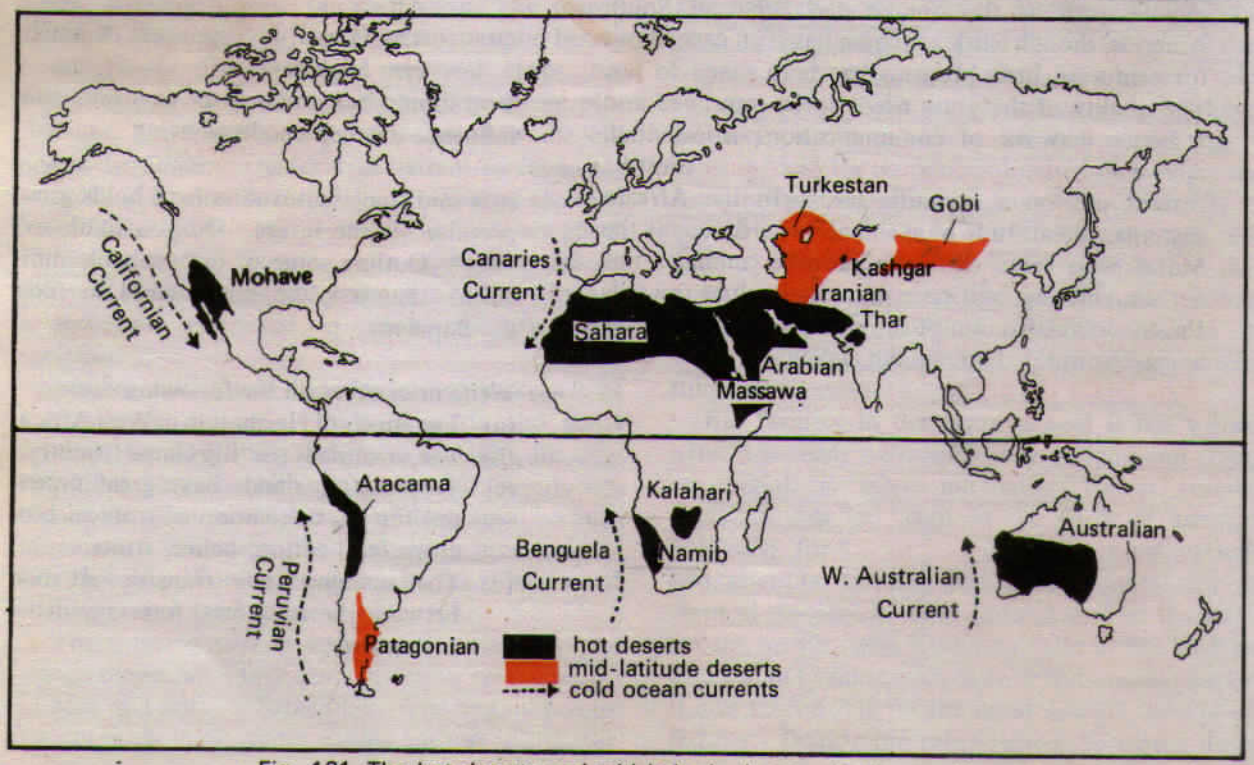



Fig. 131 The hot deserts and mid-latitude deserts of the world

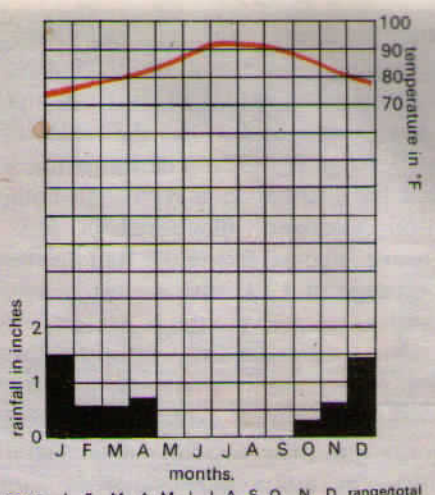
pour suddenly came one afternoon in which 2.5 inches of rain fell! The aridity of deserts is the most outstanding feature of the desert climate. We shall examine more closely why they are so dry.

The hot deserts lie astride the Horse Latitudes or the Sub-Tropical High Pressure Belts where the air is descending, a condition least favourable for precipitation of any kind to take place. The rain-bearing Trade Winds blow off-shore and the Westerlies that are on-shore blow outside the desert limits. Whatever winds reach the deserts blow from cooler to warmer regions, and their relative humidity is lowered, making condensation almost impossible. There is scarcely any cloud in the continuous blue sky. The relative humidity is extremely low, decreasing from 60 per cent in coastal districts to less than 30 per cent in the desert interiors. Under such conditions, every bit of moisture is evaporated and the deserts are thus regions of permanent drought.

Precipitation is both scarce and most unreliable Coastal stations like Massawa on the Red Sea, as illustrated in Fig. 132(a) receive light scattered showers from the on-shore winds, amounting to 5.9 inches for the year. On the western coasts, the presence of cold currents (indicated by arrows in Fig. 131) gives rise to mists and fogs by chilling the on-coming air. This air is later warmed by contact with the hot land, and little rain falls. The dessicating effect of the cold Peruvian Current along the Chilean coast is so pronounced that the mean annual rainfall for the Atacama Desert is not more than half an inch! Rain normally occurs as violent thunderstorms of the convectional type. It 'bursts' suddenly and pours continuously for a few hours over small areas. An inch or more may be recorded in one single shower! The thunderstorm is so violent, and comes so suddenly that it has disastrous consequences on desert landforms.

**Temperature.** The deserts are some of the hottest spots on earth and have high temperatures throughout the year. There is no cold season in the hot deserts and the average summer temperature is around 86°F. The highest shade temperature recorded is 136°F. on the 13 September 1922 at Al Azizia, 25 miles south of Tripoli, Libya, in the Sahara. Days are unbearably hot, and in the open barren sands, 170°F. is often recorded. The reasons for the high temperatures are obvious—a clear, cloudless sky, intense insolation, dry air and a rapid rate of evaporation.

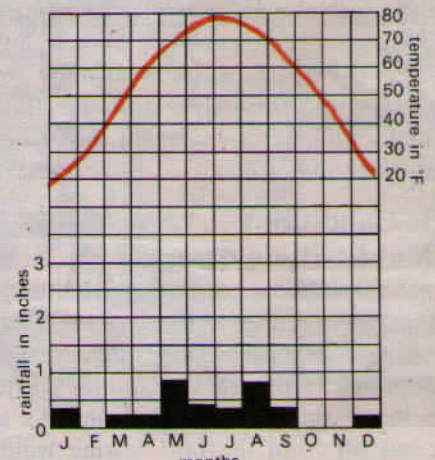
*Coastal deserts* by virtue of their maritime influence and the cooling effect of the cold currents




| | J | F | M | A | M | J | J | A | S | O | N | D | range/total |
|---|---|---|---|---|---|---|---|---|---|---|---|---|---|
| Massawa | | | | | | | | | | | | | |
| Temp. | 78 | 79 | 81 | 84 | 88 | 92 | 95 | 94 | 92 | 89 | 86 | 81 | 17°F |
| Precip. | 1.5 | 0.6 | 0.6 | 0.8 | 0 | 0 | 0 | 0 | 0 | 0.3 | 0.7 | 1.4 | 5.9" |

Place: Massawa, Ethiopia (16°N., 39°E.).
Altitude: 64 feet
Annual precipitation: 5.9 inches
Annual temperature range: 17°F. (95°–78°F.)

Fig. 132 (a) The Hot Desert Climate




| | J | F | M | A | M | J | J | A | S | O | N | D | range/total |
|---|---|---|---|---|---|---|---|---|---|---|---|---|---|
| Kashgar | | | | | | | | | | | | | |
| Temp. | 22 | 34 | 47 | 61 | 70 | 77 | 80 | 76 | 69 | 56 | 40 | 26 | 58°F |
| Precip. | 0.3 | 0 | 0.2 | 0.2 | 0.8 | 0.4 | 0.3 | 0.7 | 0.3 | 0 | 0 | 0.2 | 3.5" |

Place: Kashgar, China (39°N. 76°E.)
Altitude: 4,255 feet
Annual precipitation: 3.5 inches
Annual temperature range: 58°F. (80°–22°F.)

Fig. 132 (b) The Mid-Latitude Desert Climate

have much lower temperatures, e.g. Arica has a mean annual temperature of 66°F., Iquique 65°F., Walvis Bay, South-West Africa, only 63°F. The hottest months seldom rise beyond 70°F. and the annual temperature range is equally small, e.g. 9°F. in Arica, 10°F. in Iquique and 10°F. in Walvis Bay.

The desert interiors, however, experience much

higher summer temperatures and the winter months are rather cold. For example In Salah, in the Sahara, has a temperature of 99°F. in the hottest month but only 55°F. in the coldest month. The annual range is 44°F. The range for Yuma is 36°F. and for Jacobabad is 41°F. In comparison, the station Massawa, illustrated in Fig. 132(a), located near the coast, facing the Red Sea has only a moderate range of 17°F. Its hottest month is July (95°F.) and its coldest month is January (78°F.).

The diurnal range of temperature in the deserts is very great. Intense insolation by day in a region of dry air and no clouds causes the temperature to rise with the sun. The barren ground is so intensely heated that, by noon, particularly in summer, a reading of 120°F. is common. But as soon as the sun sets, the land loses heat very quickly by radiation, and the mercury column in the thermometer drops to well below the mean temperature. A daily temperature range of 30° to 40°F. is common, though in the Death Valley of California, an exceptionally great diurnal range of 74°F. has been recorded. Frosts may occur at night in winter. These extremes of temperature make desert living most trying. This explains why the desert people wear thick gowns all day long, to protect themselves from the glaring heat by day and chilling frost by night, not to mention the sand grains that are carried by the wind.

## Climatic Conditions in the Mid-Latitude deserts

The climatic conditions of the mid-latitude deserts are in many ways similar to those of the hot deserts. Aridity is the keynote. These inland basins lie hundreds of miles from the sea, and are sheltered by the high mountains all around them. As a result they are cut off from the rain-bearing winds. Occasionally depressions may penetrate the Asiatic continental mass and bring light rainfall in winter, or unexpected convectional storms may bless the parched lands with brief showers in summer. For example Kashgar in western China in the Gobi Desert, as illustrated in Fig. 132(b), has most of its 3.5 inches of annual precipitation in the summer. Due to their coldness and elevation, snow falls in winter.

From Fig. 132(b), it is clear that summers are very hot (80°F. in July at Kashgar) and winters are extremely cold with two months below freezing point. The annual range of temperature is 58°F., much greater than that of the hot deserts. Continentality accounts for these extremes in temperature. Winters are often severe, freezing lakes and rivers, and strong cold winds blow all the time. When the ice thaws in early summer, floods occur in many places. The greatest inhibiting factors to settlement are the winter cold and the permanent aridity, besides remoteness from the sea.

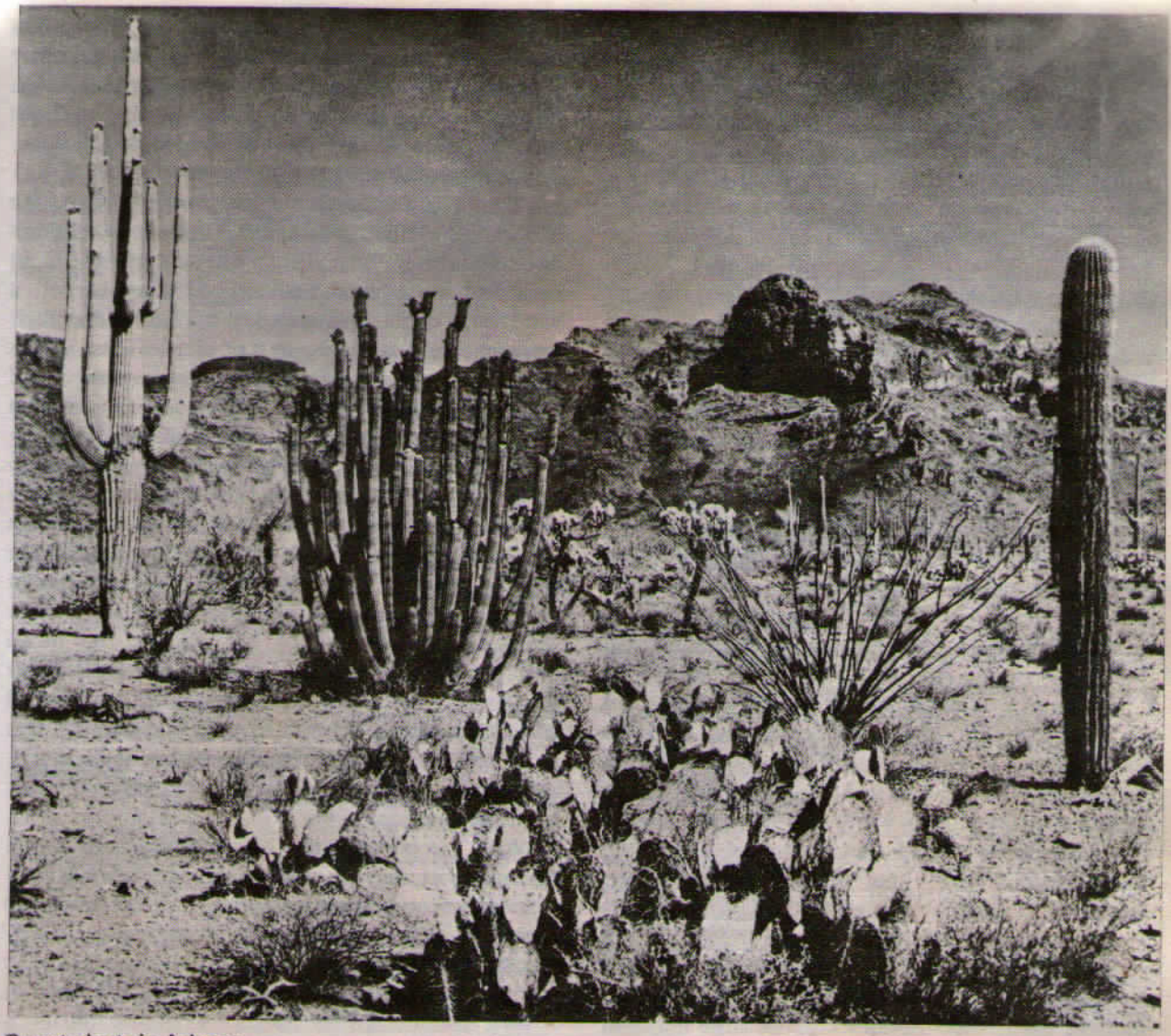
## Desert Vegetation

All deserts have some form of vegetation such as grass, scrub, herbs, weeds, roots or bulbs. Though they may not appear green and fresh all the time, they lie dormant in the soil awaiting rain which comes at irregular intervals or once in many years. The environment, so lacking in moisture and so excessive in heat, is most unfavourable for plant growth and a significant vegetation cannot be expected. But *very rarely* are there deserts where *nothing grows.*

The predominant vegetation of both hot and mid-latitude deserts is xerophytic or drought-resistant scrub. This includes the bulbous cacti, thorny bushes, long-rooted wiry grasses and scattered dwarf acacias. Trees are rare except where there is abundant ground water to support clusters of date palms. Along the western coastal deserts washed by cold currents as in the Atacama Desert, the mists and fogs, formed by the chilling of warm air over cold currents, roll inland and nourish a thin cover of vegetation.

Plants that exist in deserts have highly specialized means of adapting themselves to the arid environment. Intense evaporation increases the salinity of the soil so that the dissolved salts tend to accumulate on the surface forming hard pans. Absence of moisture retards the rate of decomposition and desert soils are very deficient in humus. Plants, whether annuals or perennials must struggle for survival against both aridity and poor soil.

Most desert shrubs have long roots and are well spaced out to gather moisture, and search for ground water. Plants have few or no leaves and the foliage is either waxy, leathery, hairy or needle-shaped to reduce the loss of water through transpiration. Some of them are entirely leafless, with pricks or thorns. Others like the cacti have thick succulent stems to store up water for long droughts. There are still others that shed their leaves during droughts. The seeds of many species of grasses and herbs have thick, tough skins to protect them while they lie dormant. They germinate at once when their seeds are moistened by the next rain. In short, all plants must adapt themselves to survive in such an inhospitable region as the desert.



Desert plants in Arizona

## Life in the Deserts

Despite its inhospitality, the desert has always been peopled by different groups of inhabitants. They struggle against an environment deficient in water, food and other means of livelihood. Some, like the Egyptians have attained a high level of civilization, others like the Bedouin Arabs have fared quite well with their flocks of sheep, goats, camels and horses. The Bushmen of the Kalahari and the Bindibu of Australia remain so primitive in their mode of living that they barely survive. They are, in fact, a relic of the Old Stone Age in the modern world. The desert inhabitants may be grouped under the following categories.

1. **The primitive hunters and collectors.** Of the primitive tribes, the Bushmen and the Bindibu are the best known. Both the tribes are *nomadic hunters and food gatherers*, growing no crops and domesticating no animals. The Bushmen roam the Kalahari Desert with their bows and poisoned arrows, spears, traps and snares. They are not only skilful and strong but have great endurance. In order to capture their prey, they have to be very patient and if necessary run many miles to track down the wounded animals. In this way, they hunt antelope, and other smaller animals. The women and children collect insects, rodents and lizards, and gather honey, roots, grass and grubs. Great skill is required in obtaining water in the desert. Dew is carefully gathered from leaves early in the morning and stored

in ostrich shells. Very often, it is necessary to dig a hole in damp sand and suck the water up from the ground through a hollow reed. This is often a very slow process. Bushmen either wear a loin cloth or go virtually naked. They travel in small family groups, and live together in open *sherms*. This is a hollow dug beneath a thorn tree, surrounded by bushes. At night a fire is lit to keep the family warm.

The Bindibu or Aborigines of Australia live in very much the same way as the Bushmen. They are lean and dark but healthy. They are skilled trackers and some of them use wooden throwing sticks or *boomerangs* and spears. They also domesticate the *dingo*, a wild dog that assists them in tracking down kangaroos, rabbits and birds. The women gather grass, roots, seeds, berries, moles and insects, to supplement their diet. Like the wandering Bushmen, the Bindibu move in family groups in search of fresh hunting grounds. But one distinct difference is that they always stay close to a water supply as they still have not devised a means of tapping and storing water. They live in *wurlies*, simple shelters made of branches and tufts and grass.

**2. The nomadic herdsmen.** These people represent a more advanced group of desert dwellers who pursue a livestock economy. They ride on animals instead of walking and are heavily clad against the blazing sun, the stormy winds and the chilly nights. The Bedouin of Arabia ride on horses and live in tents; the Tuaregs of the Sahara are camel riders and dwell in grass *zeriba*, while the Gobi Mongols ride on horses to herd their yaks and live in portable *yurts* (a kind of tent). The Bedouin are the best examples of a desert group who have fared well as nomadic herdsmen. Besides keeping large flocks of animals, they are also engaged in trade with the caravan merchants and the oases people. All round the year, the Bedouin wander with their herds in search of water and green pastures. Their wealth is their animals: sheep, goats, camels and perhaps a few horses. The animals provide them with all that they require, daily milk and cheese and on occasions meat as well. Their skin is used for hides or leather, for making tents, clothing, belts, footwear and water bags. From the hair and wool, the Bedouin make clothes, mats, ropes, rugs and carpets. These can also be exchanged at trading stations or oases for other necessities of life which the desert herdsmen cannot produce like dates, grain, beverages, medicines, firearms and other manufactured articles.

The Bedouin move in groups of about a hundred. They follow a regular pattern of routes, along which are scanty patches of pastures, wells or springs. In this manner, one group rarely clashes with the other in their search for new grounds to pitch their tents. Since they move so often, they always travel light and only the essentials are carried along.

**3. The caravan traders.** These were the travelling merchants of the desert. Their journeys across the wastes of the Sahara or Russian Turkestan sometimes lasted months or even years. They travelled at night as a team and were well armed. They carried a wide range of goods into remote interiors where their merchandise was highly sought after. These goods were sold or exchanged for hides, rugs, carpets and other valuable products of the deserts. Though profits were high, the risks were equally great.

The pack-animal used by the caravans to carry their goods across the deserts was the camel, aptly described as the *'ship of the desert'*. Unlike horses which have sharp hooves that sink readily in the sandy desert, the camel has broad padded feet that will not slip in the sand. A pack-camel, adequately fed, can carry a load of 350 pounds and travel 50 miles a day. And a racing camel can do twice the distance when ridden! The camel has several other advantages, it provides milk and hair. It can store up water in its stomach, and fat in its hump, so that it can go for long periods without either food or water.

With the introduction of modern air, road and rail transport, the role of the caravan traders is greatly reduced. Goods can be conveyed much more cheaply and with greater security by desert jeeps, vans or trucks. But between the interior oases and scattered out-posts beyond the reach of roads, the caravan routes remain the only form of available transport.

**4. The settled cultivators.** For crops to be cultivated in the desert, irrigation is indispensable. This is obtained either from oases, rivers or dams, through a network of canals. In Egypt, the Nile supports a population of 25 million, mainly concentrated in the Nile valley and delta. The life-giving waters of the Nile made it possible for the Egyptians to raise many crops as early as 5,000 years ago. When the Nile flooded in summer, the overflowed water was caught in basins with raised banks and led into the fields to irrigate the crops. This was basin irrigation, which was widely practised by the ancient Egyptian farmers and is still employed by the Egyptians today. Rice and cotton are cultivated in summer, followed by wheat, barley, beans and other minor crops in winter. Modern concrete dams constructed across the Nile e.g. Aswan and Sennar Dams are even more

effective for extensive irrigation works. The flood-water can be held back and controlled and then released at any part of the year to feed the fields that yield two, three or even more crops a year. In the same way, desert cultivators rely on the Indus in Pakistan, the Tigris-Euphrates in Iraq, and the Colorado in the Imperial Valley of California, and are able to irrigate millions of acres of arid land for crop production.

In the deserts, wherever there are oases, some form of settled life is bound to follow. These are depressions of varying sizes, where underground water reaches the surface. Some of them are abnormally large like the Tafilalet Oasis in Morocco which measures 5,000 square miles, supporting many settlements, including large towns. Others may be so small that they are no bigger than the mining pools that we are so familiar with, e.g. the Ghadames Oasis of Libya is only one square mile in size. Life in an oasis is secure and well organised. A wall is usually constructed around the oasis to keep out the violent dust storms called simooms. The oasis people live in mud-brick houses with flat roofs, closely packed together. The streets are narrow and winding, and the heart of the settlement is dominated by the suq (central market place), the mosque, school and shopping blocks. *Suqs* may also be set up miles from anywhere and people come from a number of surrounding settlements on special days to trade.

Around the settlement are the agricultural lands. Water is led to the fields by irrigation channels or drawn up from wells by camels or mules. The most important tree is the date palm which is grown in dug-out hollows so that its roots can penetrate deep into the ground in search of water. The fruit is consumed locally and also exported. Other crops cultivated include maize, barley, wheat, cotton, cane sugar, fruits and vegetables. With the development of motor routes across the deserts, many sophisticated foreign goods can now reach the oases.

**5. The mining settlers.** The lure of mineral wealth has attracted many immigrants into the desert. Mining camps and isolated settlements have sprung up following the discovery of certain mineral deposits. It was gold that brought immigrants scrambling into the Great Australian Desert. Water and food supplies have to be brought 300 miles from Perth to keep the mines going. Some of them like Kalgoorlie and Coolgardie have become towns of considerable size. In the Kalahari Desert, the discovery of diamonds and copper has brought many white men to the 'thirstland' as it is called. Even in the most

The oasis of El Golea. The dunes are gradually encroaching on the date palms *Camera Press*

arid Atacama, in northern Chile, large mining camps have been established for the mining of caliche (cemented gravels) from which *sodium nitrate*, a valuable fertilizer, is extracted and exported to all parts of the world. The mines are worked by local Indian labourers and supervised by foreign technicians. Besides nitrates, copper is also mined. These two products have directly or indirectly contributed to the growing size of the Chilean towns of Arica, Iquique, Antofagasta and Chuquicamata. The last named is the world's largest copper town. Similarly in the deserts of North America, *silver* is mined in Mexico, *uranium* in Utah and *copper* in Nevada. A host of other minerals and their by-products have, in fact, greatly altered the landscape and the economy of such arid regions.

In recent years, the discovery of oil in many parts of the Saharan and Arabian Deserts has transformed this forgotten part of the globe. In Algeria, oil wells have been sunk two miles deep to tap oil. In the Middle East, pipelines over 1,000 miles long have been laid to bring oil from the shores of the Persian Gulf across Saudi Arabia to Saida (Lebanon) and Banias (Syria) on the Mediterranean coast. With still half of the world's reserves of oil untapped in this region, the deserts here will virtually be paved with gold! In Iraq, Kuwait, and Saudi Arabia the desert landscape is fast changing. New roads, huge palaces, ultra-modern hospitals, air-conditioned apartments and swimming pools, are examples of a thriving new era created entirely by oil–*'liquid gold'*.

## QUESTIONS AND EXERCISES

1. Explain how the aridity of the desert is related to
   (a) off-shore Trade Winds
   (b) the Sub-Tropical High Pressure Belts (the Horse Latitudes)
   (c) cold ocean currents

2. Bring out any distinct differences between the hot deserts and mid-latitude deserts in
   (a) climate
   (b) vegetation
   (c) way of life

3. With reference to actual examples, describe the activities and modes of living of the different groups of people that inhabit the deserts. Attempt to account for their differences.

4. Explain any *three* of the following.
   (a) The hot deserts of the world are located on the western coasts of continents.
   (b) Patagonia is a desert in the rain shadow of the Andes.
   (c) The annual range of temperature is much greater at Kashgar (Gobi) than at Iquique (Atacama).
   (d) Desert plants must adapt themselves to survive.
   (e) Camels are the 'ships of the desert'.

5. Write brief notes on any *three* of these topics.
   (a) The Bindibu of the Great Australian Desert.
   (b) Date palm cultivation in an oasis.
   (c) The role of oil in the development of desert economy.
   (d) The Bedouin—the wandering herdsmen.
   (e) Agricultural development of any selected desert region.

# Chapter 19 The Warm Temperate Western Margin (Mediterranean) Climate

## Distribution

The Warm Temperate Western Margin Climate is found in relatively few areas in the world. They are entirely confined to the western portion of continental masses, between 30° and 45° north and south of the equator (Fig. 133). The basic cause of this type of climate is the shifting of the wind belts, explained in Chapter 13. Though the area around the Mediterranean Sea has the greatest extent of this type of 'winter rain climate', and gives rise to the more popular name Mediterranean Climate, the best developed form of this peculiar climatic type is, in fact, found in central Chile (Fig. 134). Other Mediterranean regions include California (around San Francisco), the south-western tip of Africa (around Cape Town), southern Australia (in southern Victoria and around Adelaide, bordering the St. Vincent and Spencer Gulfs), and south-west Australia (Swanland).

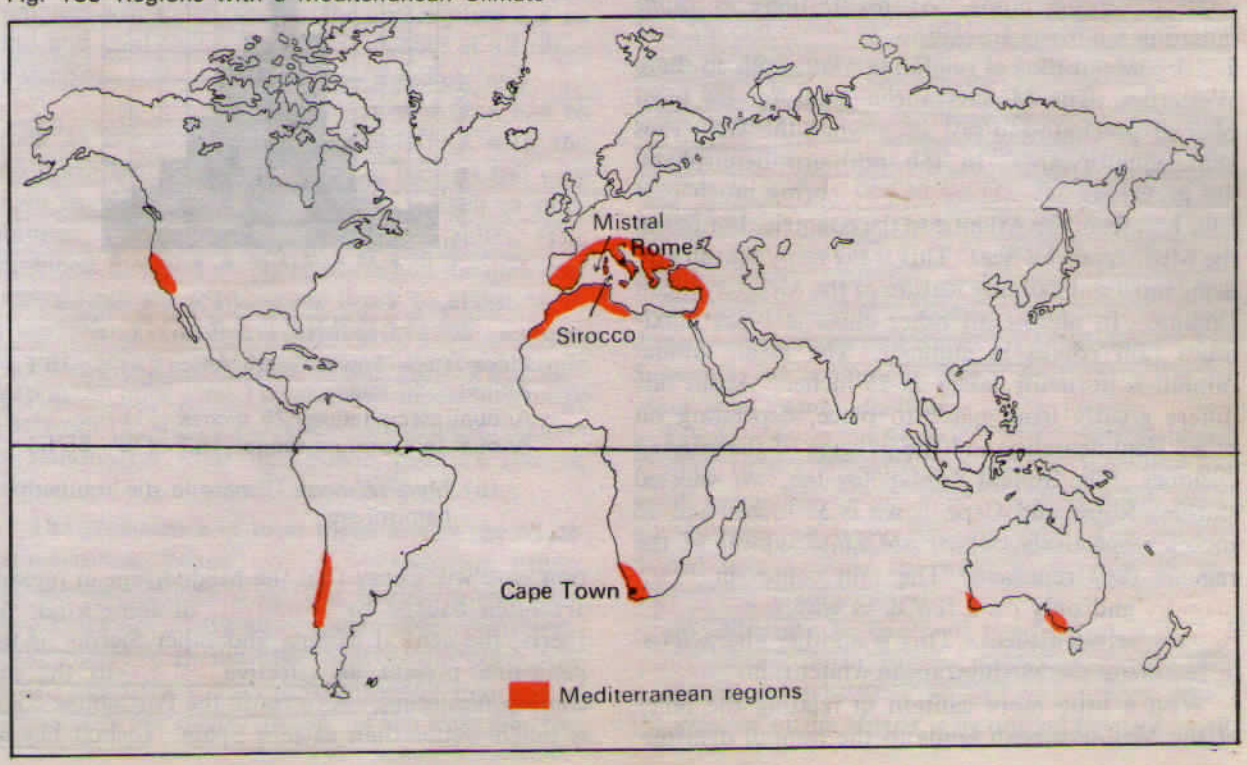
## Climate

The Mediterranean type of climate is characterized by very distinctive climatic features.

**1. A dry, warm summer with off-shore trades.** As illustrated in Fig. 135 (a) and (b), the summer months have a relatively high temperature (76°F. in July in Rome and 70°F. in January in Cape Town.) The highest temperatures are however experienced further away from the coast in the more continental eastern Mediterranean, in the interiors of the Balkan peninsula, the Anatolian Plateau and Mediterranean Middle East. For example, the July mean for Athens is 80°F. Larrissa (Greece) 81°F. and Beirut (Lebanon) 83°F. Elsewhere in central Chile, South Africa and Mediterranean Australia, due to their coastal position, the influence of the sea has modified the temperature and the January means (Southern Summer) are normally around 70°F.

In summer when the sun is overhead at the Tropic of Cancer, the belt of influence of the Westerlies is shifted a little polewards. Rain bearing winds are therefore not likely to reach the Mediterranean lands. The prevailing Trade Winds are off-shore and there is practically no rain. The air is dry, the heat is intense and the relative humidity is low. Days

Fig. 133 Regions with a Mediterranean Climate



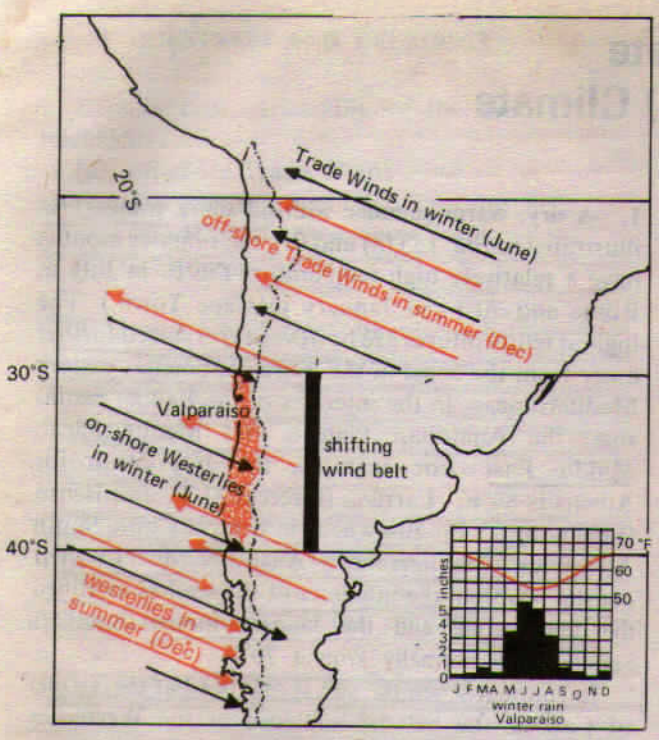
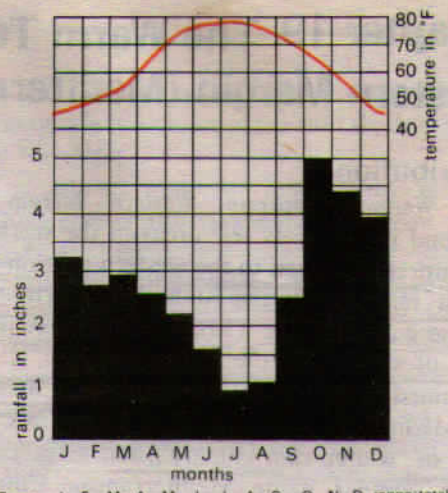



Fig. 134 Central Chile—a region with a typical Mediterranean Climate—showing the shifting of the wind belt with most rain falling in winter

are excessively warm and in the interiors, prolonged droughts are common. At night, there is rapid radiation but frosts are rare.

**2. A concentration of rainfall in winter with on-shore Westerlies.** The Mediterranean lands receive most of their precipitation in winter when the Westerlies shift equatorwards. In the northern hemisphere, the prevailing on-shore Westerlies bring much *cyclonic rain* from the Atlantic to the countries bordering the Mediterranean Sea. This is the rainy season and is the most outstanding feature of the Mediterranean Climate. In almost all other climatic types maximum rain comes in summer. The mean annual rainfall is normally taken as 25 inches. Again this differs greatly from place to place, depending on relief, continentality and the passage of the passing cyclones. The annual rainfall for the two selected stations Rome and Cape Town is 33 inches and 25 inches respectively, which are quite typical of the regions they represent. The rain comes in heavy showers and only on a few days with bright sunny periods between them. This is another characteristic feature of the Mediterranean winter rain.

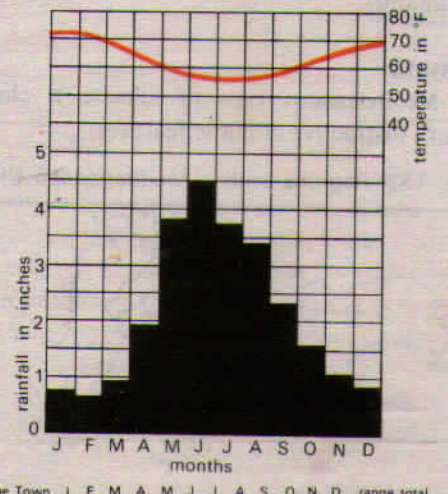
With a little more caution in relating the relief of the Mediterranean lands to the rainfall distribu-




| Rome | J | F | M | A | M | J | J | A | S | O | N | D | range/total |
|---|---|---|---|---|---|---|---|---|---|---|---|---|---|
| Temp. | 45 | 47 | 51 | 64 | 71 | 71 | 76 | 76 | 70 | 62 | 53 | 46 | 31°F |
| Precip. | 3.2 | 2.7 | 2.9 | 2.6 | 2.2 | 1.6 | 0.7 | 1.0 | 2.5 | 5.0 | 4.4 | 3.9 | 33" |

Place: Rome, Italy (42°N., 12°E.)
Altitude: 207 feet
Annual precipitation: 33 inches
Annual temperature range: 31°F. (76°–45°F.)

Fig. 135 (a) Mediterranean Climate in the northern hemisphere




| Cape Town | J | F | M | A | M | J | J | A | S | O | N | D | range total |
|---|---|---|---|---|---|---|---|---|---|---|---|---|---|
| Temp. | 70 | 70 | 68 | 63 | 59 | 56 | 55 | 56 | 58 | 61 | 64 | 68 | 15°F |
| Precip. | 0.7 | 0.6 | 0.9 | 1.9 | 3.8 | 4.5 | 3.7 | 3.4 | 2.3 | 1.6 | 1.1 | 0.8 | 25" |

Place: Cape Town, South Africa (34°S., 18°E.)
Altitude: 40 feet
Annual precipitation: 25 inches
Annual temperature range: 15°F. (70°–55°F.)

(b) Mediterranean Climate in the southern hemisphere

tion, you will notice that the Mediterranean regions are often backed by mountains of some kind. In Iberia, the central Meseta and other Sierras of the peninsula present an effective barrier to the oncoming Westerlies. As a result the Portuguese coast is much wetter than eastern Spain. Lisbon has an

annual rainfall of nearly 30 inches while Cartagena, along the eastern coast of Spain does not receive even half as much. Much heavier precipitation has been recorded in the highlands on windward slopes facing the Westerlies. The steep hills of the eastern Adriatic are the rainest part of Europe with 182 inches recorded at Crkvice, about 3,600 feet above sea level.

Rain in Mediterranean Europe normally begins in September, reaching its peak somewhere in October (5 inches in Rome). Though the downpours are infrequent they are often very torrential and in mountainous districts, destructive floods occur. The floods come so suddenly that there is practically no time to do anything about it. The disastrous flood of Lisbon in 1967 came in the middle of the night and caused great damage and loss of life in a few hours!

Snow rarely occurs on lowlands and coastal districts and even if it does fall on the highlands, it is moderate and is a source of water supply for hydro-electric power generation and for irrigation.

**3. Bright, sunny weather with hot dry summers and wet, mild winters.** Considering its mid-latitude position, the Mediterranean regions have a very favourable climate, unrivalled by any other climatic regions. The climatic features are transitional between those of the Trade Wind Hot Desert in the south and the Cool Temperate Maritime Climate in the north. Summers are warm and bright and winters are so mild and cool that many tourists come at all times of the year. The sky is almost cloudless and sunshine is always abundant. In July, Rome has as much as eleven hours of sunlight, and with the Mediterranean palm trees around, tourists feel very much as if they are in the tropics! Even in mid-summer, the intense heat is never sultry. The combined effects of on-shore winds and the maritime breezes keep the temperature down to about 50°F. in winter and not often exceeding 75°F. in summer. The climate is so mild that many of the local people sleep in the open air. The annual temperature range is between 15° and 25°F. The Mediterranean regions are famous for their health and pleasure resorts, frequented by millions all round the year.

**4. The prominence of local winds around the Mediterranean Sea.** Many local winds, some hot, others cold are common around the Mediterranean Sea. The causes are many and varied. The topography of the region with the high Alps in the north, the Sahara desert in the south, continental interiors in the east and the open Atlantic on the west give rise


Fig. 136 Local Winds of the Mediterranean Sea

to great differences in temperature, pressure and precipitation. The passing cyclones from the Atlantic, the anticyclones from the north, and the cold air masses from the continental interiors are often interrupted or channelled by relief features, resulting in the birth of local winds around the Mediterranean. These winds varying in *strength, direction and duration* affect the lives, crops and activities of the people there. Fig. 136 indicates the location and direction of some of these local winds and the more important ones are described below.

**(a) Sirocco.** This is a hot, dry dusty wind which originates in the Sahara Desert. Though it may occur at any time of the year, it is most frequent in spring and normally lasts for only a few days. The Sirocco blows outwards in a southerly direction from the desert interiors into the cooler Mediterranean Sea. It is usually associated with depressions from the Atlantic passing from the coast eastwards inland. After crossing the Mediterranean Sea, the Sirocco is slightly cooled by the absorption of the water vapour. Even then, it is still hot and dry with a temperature of over 105°F. Its sorching breath withers vegetation and crops. The damage is particularly serious when it comes at the times during which vines and olives are in blossom. The Sirocco is so prominent that it is called by many other local names, such as Chili in Tunisia, Ghibli in Libya, Leveche in Spain, Khamsin in Egypt and Malta. In the Adriatic and Aegean Sea, this hot wind, better known as Gharbi, gathers much moisture causing fog, heavy dew and rain. This may be 'blood rain' because the wind is carrying the red dust of the Sahara Desert.

**(b) Mistral.** In contrast, the Mistral is a cold wind from the north, rushing down the Rhone valley in violent gusts between 40 and 80 miles per hour. The velocity of the Mistral is intensified by the funnell-

ing effect in the valley between the Alps and the Central Massif, and in extreme cases trains may be derailed and trees uprooted. In winter when the Mistral is most frequent the temperature of the wind may be below freezing-point, though the sky may be clear and cloudless. As a protective measure, many of the houses and orchards of the Rhone valley and the Riviera have thick rows of trees and hedges planted to shield them from the Mistral.

A similar type of cold north-easterly wind experienced along the Adriatic coast is called the Bora. Like the Mistral, it is caused by a difference in pressure between continental Europe and the Mediterranean. This usually occurs in winter, when the atmospheric pressure over continental Europe is higher than that of the Mediterranean Sea. The Bora thus blows outwards into the Mediterranean. This dry, icy wind is even more violent than the Mistral and speeds of over 100 m.p.h. have been recorded. During strong Boras, ships may be blown aground and agricultural lands devastated. Tramontana and Gregale are similar cold winds of the Mediterranean Sea.

## Natural Vegetation

In a land where half the year is dry, one cannot expect the natural vegetation to be luxuriant. Trees with small broad leaves are widely spaced and never very tall. Though there are many branches they are short and carry few leaves. The absence of shade is a distinct feature of Mediterranean lands. Growth is slow in the cooler and wetter season, even though more rain comes in winter. Growth is thus almost restricted to autumn and spring when the temperature is higher and moisture is just sufficient. The long summer drought checks the growth. One fact is clear, plants whether trees or shrubs, evergreen or deciduous, have to devise ways of adapting themselves to a climatic environment with such a marked rhythmic recurrence of rain and drought. In many ways, the vegetational responses to climatic demands in the Mediterranean are similar to those of the adjacent deserts and the savanna further south. Plants are in a continuous struggle against heat, dry air, excessive evaporation and prolonged droughts. They are, in short xerophytic, a word used to describe the drought-resistant plants in an environment deficient in moisture.

**Types of Mediterranean vegetation.** Various kinds of vegetation are found in the Mediterranean regions.

**1. Mediterranean evergreen forests.** These are open woodlands with evergreen oaks, of which the cork oaks of Spain and Portugal are the best known. They are found only in the climatically most favoured regions with a rainfall of well over 25 inches. The trees are normally low, even stunted, with massive trunks, deeply fissured barks, small leathery leaves and a wide-spreading root system in search of water. The cork oaks are specially valued for their thick barks, used for making wine-bottle corks and for export around the world. In Australia, the eucalyptus forests replace the evergreen oak. The jarrah and karri trees are commercially the most important. The giant sequoia or redwood is typical of the Californian trees.

**2. Evergreen coniferous trees.** These include the various kinds of pines, firs, cedars and cypresses which have evergreen, needle-shaped leaves and tall, straight trunks. They appear more on the cooler highlands and where droughts are less severe. Deforestation has reduced their numbers considerably.

**3. Mediterranean bushes and shrubs.** This is perhaps the most predominant type of Mediterranean vegetation. Summers are so dry and hot that in places forests give place to short, evergreen shrubs and bushes. The low bushes grow in scattered clumps and are often thorny. The more common species are laurel, myrtle, lavender, arbutus and rosemary, of which a number are strongly scented or perfumed.

In many areas, due to man's interference in *forest depletion*, or to *overgrazing*, the original woodlands degenerate into a scrub vegetation with scattered, stunted trees and tall bushes. They are so different from the ordinary woodland or the true desert scrubland that special names have been given to them to distinguish their location in different parts of the Mediterranean lands. This type of vegetation is called maquis in southern France, and macchia in Italy. In California, the term chaparral is used and in Australia mallee scrub. In limestone uplands, where the soil is extremely thin and the scrub deteriorates into highly xerophytic ground creepers, a more exact term, garrigue, is used.

**4. Grass.** Conditions in the Mediterranean do not suit grass, because most of the rain comes in the cool season when growth is slow. Slow-growing vegetation, which cannot replenish its foilage readily, and which is without deep-penetrating roots, is least suited here. Even if grasses do survive, they are so wiry and bunchy that they are not suitable for animal farming. Cattle rearing is thus unimportant in the Mediterranean. The grass, which is replaced by certain drought-resistant varieties of shrubs and flowering herbs, can however support sheep or goats.

Olive cultivation in Andalusia, Spain. The small, gnarled trees are typical of the Mediterranean region *S.E.F. Torino*

Even this form of grazing has done more harm than good for it has promoted soil erosion and impoverished the hill-slopes of the Mediterranean. Animal fats are not important here and the chief cooking oil is obtained from olives. Dairy products are net import items.

## Economic Development of the Mediterranean Regions

Despite the semi-arid conditions over many parts of the Mediterranean lands, the climate as a whole is favourable. Its warm, bright summers and cool, moist winters enable a wide range of crops to be cultivated. One must not forget that the Mediterranean shore-lands were once the *cradle of world civilization*. Nowadays the area is important for fruit cultivation, cereal growing, wine-making and agricultural industries, as well as engineering and mining. We shall deal with some of them in greater detail below.

**1. Orchard farming.** The Mediterranean lands are also known as the world's orchard lands. A wide range of citrus fruits such as oranges, lemons, limes, citrons and grapefruit are grown. The fruit trees have long roots to draw water from considerable depths during the long summer drought. In exceptionally dry areas, *irrigation* helps to relieve the lack of moisture. In the Great Valley of California, the Vale of Chile, the Negev Desert of Israel and the northern shores of Mediterranean Europe, an elaborate system of irrigation canals enables both fruits and cereals to be successfully raised. The thick, leathery skin of the citrus fruits prevents excessive transpiration and the long, sunny summer enables the fruits to be ripened and harvested. The various Mediterranean oranges are so distinctive in their shape, size, taste and quality that they are called by different names in their area of production. Of the Mediterranean oranges, perhaps, the best known are the Sunkist oranges from California, exported for table consumption and for making orange squash. The Seville oranges of Spain are small but very sweet and are particularly suitable for making marmalade. Those from Israel, the Jaffa oranges, are equally delicious and are specially grown for export. In Tangiers, the tangerine is of great local importance. In the temperate monsoon lands of China and Japan, which were, in fact, the native home of the orange, commerical cultivation of the fruit is less significant, and only in recent years has there been any serious effort made to popularize their export as 'mandarin oranges. The Mediterranean lands account for

70 per cent of the world's exports of citrus fruits.

The olive tree is probably the most typical of all Mediterranean cultivated vegetation. It is so hardy and long-rooted that it can survive even on very poor limestone soils with less than 10 inches of annual rainfall. Like our coconut palm, the olive tree is very 'versatile' and has many uses. The olive can be eaten fresh or pickled with spices. The fleshy part can be crushed and olive oil extracted, a valuable source of cooking oil in a region deficient in animal fat. Soap and margarine can also be made with the oil. Besides olives, many nut trees like chestnuts, walnuts, hazelnuts and almonds are grown and the nuts picked as fruits or for the chocolate industry. Other important fruits are peaches, apricots, pears, plums, cherries and figs.

**2. Crop cultivation.** Besides orchard fruits, the Mediterranean climate also supports many field crops. Cereals are by far the most important. Wheat is the leading food crop. Though conditions for extensive wheat cultivation are not as ideal as those of the cool temperate regions, the Mediterranean farmers have utilized the seasonal climatic rhythm to their best advantage. The wheat grown is mainly hard, winter wheat. It is suitable for both bread-making and other food-products such as *macaroni, spaghetti and vermicelli.* The farmers usually sow the seeds in autumn, so that they germinate and grow steadily with the coming winter rain. By spring there is still sufficient moisture for the wheat to mature. The sunny weather of early summer ripens the grains and the wheat is harvested in almost guaranteed rainless weather. Barley is the next most popular cereal.

Summer crops are raised only where irrigation is possible. The water comes mainly from the melting snow that feeds the many rivers whose sources are in the highlands. Lowlands are intensively cultivated and the hill slopes are terraced. In Spain and Italy, the edges of the terraces are firmly piled with stones to prevent any soil from being washed away. Generally speaking, farms are small but there are also large holdings called *haciendas* in Spain which engage large numbers of paid labourers to work the farms. In a few localities, e.g. the Ebro basin in Spain, the Po Valley in Italy and in California, rice has been successfully cultivated and their yields are some of the highest in the world. In the more fertile plains, vegetables, especially beans, and flowers are grown for the local market. A little cotton and tobacco are also grown. The mountain pastures, with their cooler climate, support a few sheep, goats and sometimes cattle. Transhumance is widely practised.

**3. Wine production.** This is another speciality of the Mediterranean countries, because the best wine is essentially made from grapes. Some 85 per cent of grapes produced, go into wine. The long, sunny summer allows the grapes to ripen and then they are hand-picked. Viticulture is by tradition a Mediterranean occupation and the regions bordering the Mediterranean Sea account for three-quarters of the world's production of wine. In Spain, Portugal, France, and Italy, wine is the national drink. The average wine consumption of the Mediterranean countries is about 15 gallons per head per annum, whereas in U.S.A. it is not even one-tweniteth as much!

Although grapes may be grown in many parts of the temperate lands, commercial viticulture is almost entirely confined to the Mediterranean regions. It has been estimated that 40 million tons of the world's total production of 46 million tons of grapes annually are being processed into wine. The quality of the fermented grape juice is decided by a number of factors including the types of *vines* grown, the quality of the *soil,* the *climate* of the region, the method and extent of *fermentation.* The fragrance, taste and quality of the final product is so varied that the price range is tremendous. Wine may be as cheap as any soft-drink or as expensive as brandy. To differentiate the various kinds of wine, the principal wine areas of the world maintain their exclusive names. The wine from southern Spain

Grapes are grown in many Mediterranean countries. In Turkey some are dried to make sultanas. They are washed and then laid out in the sun *Paul Popper*

is called *sherry*, from Portugal *port wine*. *Chianti*, *asti* and *marsala* come from different parts of Italy. In France the greatest wine regions are located further north, e.g. *Champagne* in the Paris basin, *Bordeaux* in the Garonne basin, *Burgundy* in the Rhone-Saone valley.

The world trade in fresh grapes is comparatively small mainly from Mediterranean South Africa. Most of the inferior grapes are preserved as dried grapes and exported. They are known by several names e.g. *currants* from the Levantine grapes, *raisins* from California, and *sultanas* from Asia Minor.

The other industries associated with Mediterranean agriculture are fruit canning, flour milling and food processing.

## QUESTIONS AND EXERCISES

1. What is meant by the 'index plant' of a climatic type? In what ways are the following index plants representative of the type of climate indicated?
   (a) teak—Tropical Monsoon Climate
   (b) olive—Mediterranean Climate
   (c) cactus—Hot Desert Climate
   (d) spruce—Cool Temperate Continental Climate

2. The following statistics of the annual rainfall and annual temperature ranges of four Mediterranean lowland stations are taken from the Mediterranean shorelands. Attempt to explain their differences.

| Station | Latitude | Longitude | Annual rainfall | Annual temperature range |
|---|---|---|---|---|
| (a) Gibraltar | 36°N. | 5°W. | 36" | 20°F. |
| (b) Marseilles | 43°N. | 5°E. | 23" | 28°F. |
| (c) Athens | 38°N. | 24°E. | 16" | 32°F. |
| (d) Alexandria | 31°N. | 30°E. | 8" | 23°F. |

3. Outline the various types of natural vegetation found in the Mediterranean regions. Relate this to climate, soil and human interference.

4. Give an explanatory account of the following statements about economic activities of the Mediterranean lands.
   (a) Orchard farming is the predominant occupation.
   (b) The chief cereal cultivated is hard, winter wheat.
   (c) Pastoral farming is of little importance.

5. Write geographical notes on any *three* of the following.
   (a) The Mediterranean Climate is typified by dry, sunny summers and wet, mild winters.
   (b) Hot, dusty Sirocco and cold stormy Mistral.
   (c) Mediterranean woodlands, shrubs and scrub.
   (d) Three-quarters of the world's wine comes from the Mediterranean regions of Europe.

# Chapter 20 The Temperate Continental (Steppe) Climate

## Distribution

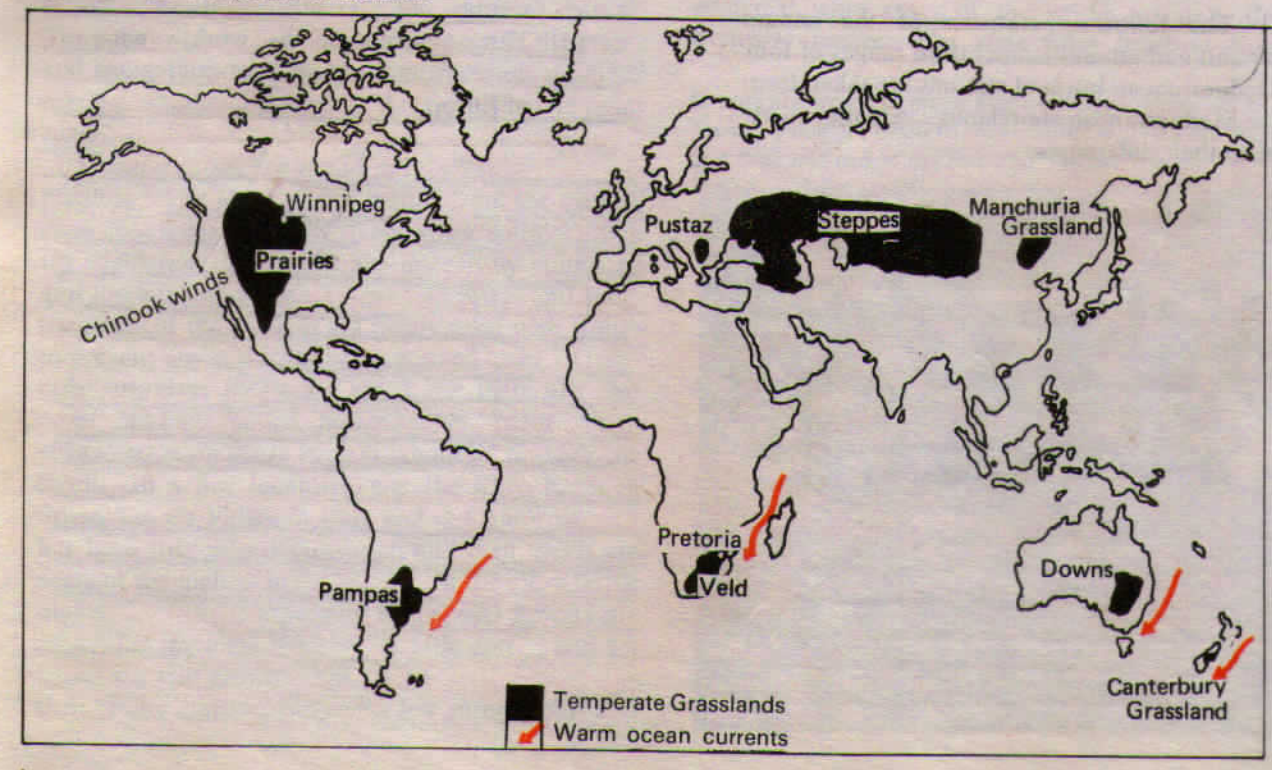
Bordering the deserts, away from the Mediterranean regions and in the interiors of continents are the temperate grasslands. Though they lie in the Westerly wind belt, they are so remote from maritime influence that the grasslands are practically treeless. These grasslands are so distinctive in their natural vegetation that, although those which occur in the southern hemisphere have a much more moderate climate, they are often dealt with together. In the northern hemisphere, the grasslands are far more extensive and are entirely continental. In Eurasia, they are called the Steppes, and stretch eastwards from the shores of the Black Sea across the great Russian plain to the foothills of the Altai Mountains, a distance of well over 2,000 miles. They are broken in a few places, being interrupted by the highlands. There are isolated sections in the Pustaz of Hungary and the plains of Manchuria. In North America, the grasslands are also quite extensive and are called Prairies. They lie between the foothills of the Rockies and the Great Lakes astride the American-Canadian border (Fig. 137).

In the southern hemisphere, due to the narrowness of the temperate portions of the southern continents, the grasslands are rather restricted and less continental. In the case of the Pampas of Argentina and Uruguay, the grasslands extend right to the sea and enjoy much maritime influence. In South Africa, the grasslands are sandwiched between the Drakensberg and the Kalahari Desert; and are further subdivided into the more tropical Bush-veld in the north, and the more temperate High Veld in the south. The word 'veld' is a Dutch word given by the early pioneer Dutch farmers who came to settle here. It means 'field' and is pronounced as 'felt'. In Australia, the grasslands are better known as Downs and are found in the Murray-Darling basin of southern Australia.

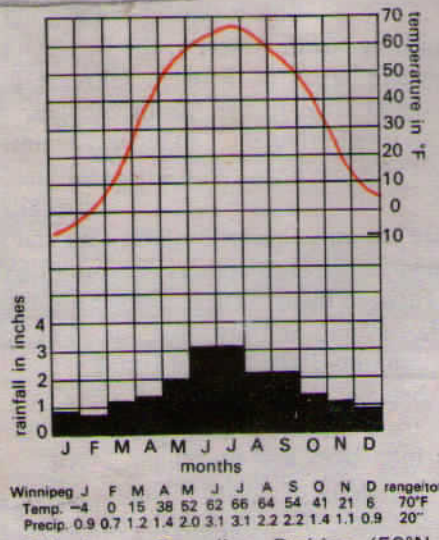
## Climate

**Temperature.** Their location in the heart of continents means that they have little maritime influence. Their climate is thus continental with extremes of temperature. Summers are very warm, over 66°F.

Fig. 137 The Temperate Grasslands



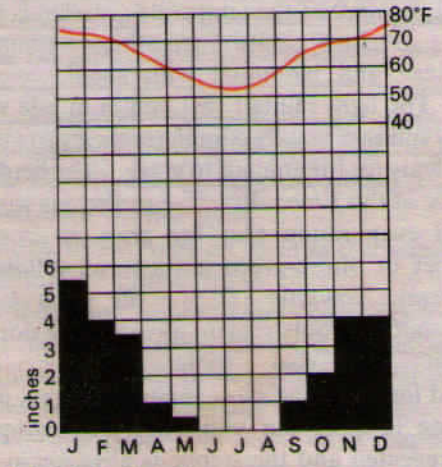
in Winnipeg for July, as illustrated in Fig. 138(a) and 72°F. for January for Pretoria as shown in Fig. 138(b). Winters are very cold in the continental steppes of Eurasia because of the enormous distances from the nearest sea. The winter months are well below freezing and in Winnipeg the January reading is −4°F., 36° below freezing-point.




| Winnipeg | J | F | M | A | M | J | J | A | S | O | N | D | range/total |
|---|---|---|---|---|---|---|---|---|---|---|---|---|---|
| Temp. | −4 | 0 | 15 | 38 | 52 | 62 | 66 | 64 | 54 | 41 | 21 | 6 | 70°F |
| Precip. | 0.9 | 0.7 | 1.2 | 1.4 | 2.0 | 3.1 | 3.1 | 2.2 | 2.2 | 1.4 | 1.1 | 0.9 | 20" |

Place: Winnipeg, Canadian Prairies (50°N., 97°W.)
Altitude: 760 feet
Annual precipitation: 20 inches
Annual temperature range: 70° (66°−4°F.)

Fig. 138 (a) Steppe Climate in the northern hemisphere




| Pretoria | J | F | M | A | M | J | J | A | S | O | N | D | range total |
|---|---|---|---|---|---|---|---|---|---|---|---|---|---|
| Temp. | 72 | 71 | 68 | 62 | 57 | 53 | 52 | 57 | 63 | 68 | 69 | 71 | 20°F |
| Precip. | 5.5 | 4.0 | 3.5 | 1.0 | 0.5 | 0 | 0 | 0 | 1.0 | 2.0 | 4.0 | 4.0 | 26" |

Place: Pretoria, Transvaal, Republic of South Africa (25°S., 28°E.)
Altitude: 4,350 feet
Annual precipitation: 26 inches
Annual temperature range: 20°F. (72°−52°F.)

(b) Steppe Climate in the southern hemisphere

In contrast, the steppe type of climate in the southern hemisphere is never severe. The winters are so mild that the mean temperature for any of the winter months is usually between 35° and 55°F. Temperatures below freezing point even in mid-winter (July in the southern hemisphere) are exceptional. Pretoria, the station chosen to illustrate the steppe type of climate in the southern hemisphere has 52°F. in mid-winter (July), the coldest month of the year. Statistics from other parts of the southern continents also show a mild winter. For example the July mean (mid-winter) for Johannesburg is 49°F., for Buenos Aires, 49°F., and for Mildura (Murray-Darling basin), 49°F. These statistics establish the moderating effects of oceans on the climates of the southern hemisphere.

The annual range of temperature is great, a direct result of continentality. Winters are so cold that parts of the Eurasian Steppes are snow-covered for several months. The snow melts with the return of spring and by mid-summer, temperatures soar to over 65°F. It is really hot for its latitude. For example, the mid-summer temperatures for Kiev is 67°F. The stations in the southern hemisphere record even higher temperatures, e.g. 69°F. in Johannesburg, 74°F. in Buenos Aires and 77°F. in Mildura.

It is clear from the two selected stations given that there is a tremendous difference between the annual temperature range of the northern and southern hemisphere, again a factor of continentality. The range in Winnipeg, in Fig. 138(a), is 70°F., nearly three times as great as that of Pretoria, in Fig. 138(b), at 26°F. Readings taken in various other stations of the northern and southern hemispheres confirm this trend. The annual range for Mukden in Manchuria is 69°F. In comparison, the annual range of the more maritime stations of Johannesburg, Buenos Aires and Mildura in the southern hemisphere are very much smaller, 20°F., 25°F., 28°F. respectively.

**Precipitation.** In its continental position, the annual precipitation of the Steppe Climate can be expected to be light. The average rainfall may be taken as about 20 inches, but this again varies according to location from 10 inches to 30 inches. Winnipeg, in Fig. 138(a), has 20 inches with a distinct summer maximum from convectional sources, when the continental interiors are intensely heated. The heaviest rain comes in the middle of the year with 3.1 inches each in June and July. Most of the winter months have about an inch of precipitation, brought

by the occasional depressions of the Westerlies and coming in the form of snow. In many other continental stations, the annual precipitation is even less, though the general pattern remains the same with most of the rain falling in the summer.

The maritime influence in the steppe type of climate of the southern hemisphere is even better brought out by the rainfall regime. Its annual precipitation is always more than the average 20 inches because of the warm ocean currents that wash the shores of the steppe-lands here. Pretoria, in Fig. 138(b), has an annual precipitation of 26 inches with the wettest months in November, December, January and February, the summer season of the southern hemisphere. There are three months (June, July and August) without any rain. This is the period of drought that may have such a disastrous effect on the sheep rearing industry here. The dry season is particularly pronounced in temperate grasslands adjoining deserts, for example in Australia. Mildura, on the fringe of the mallee scrub of the Great Australian Desert, and also in the rain shadow area of the Great Dividing Range, has an annual rainfall of only 10.6 inches. Irrigation is essential. The other southern hemisphere stations, have moderate rainfall, e.g. 30 inches in Johannesburg and 38 inches in Buenos Aires.

On the eastern slopes of the Rockies in Canada and U.S.A. a local wind, similar to the Fohn in Switzerland, called the Chinook, comes in a southwesterly direction to the Prairies and has a considerable effect on the local pastures. It actually comes with the depressions in winter or early spring from the Pacific coast ascending the Rockies and then descending to the Prairies. It is a hot wind and may raise the temperature by 40°F. within a matter of 20 minutes. It melts the snow-covered pastures and animals can be driven out of doors to graze in the open fields. The agricultural year is thus accelerated. Local farmers welcome the Chinook for frequent Chinooks mean mild winters.

## Natural Vegetation

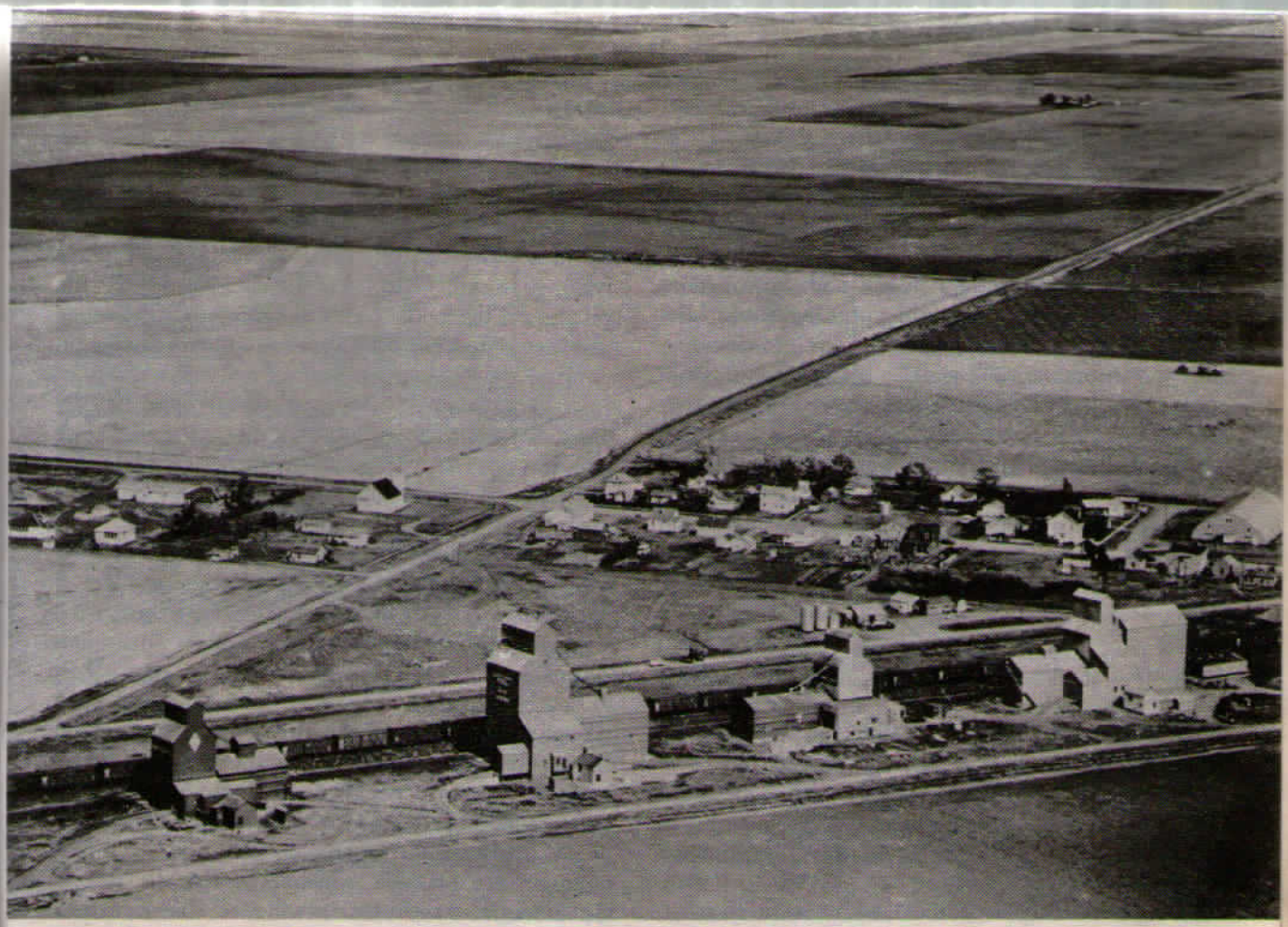
Though the term 'steppe vegetation' geographically refers to the scanty vegetation of the sub-arid lands of continental Eurasia, many authors, including the late Professor Sir Dudley Stamp, have extended the term to include the temperate grassland all over the world. In this connection, our reference to steppe grassland is taken to mean the temperate grasslands of the mid-latitudes, the Steppes, Prairies, Pampas, Veld and Downs.

It is natural to expect the steppes to be grass-covered, differing only in the *density* and *quality* of the grass. Their greatest difference from the tropical savanna is that they are practically treeless and the grasses are much shorter. Where the rainfall is moderate, above 20 inches, the grasses are tall, fresh and nutritious and are better described as long prairie grass. This is typical of the grass of the wheat-lands in North America, the rich black earth or chernozem areas of Russian Ukraine and the better watered areas of the Asiatic Steppes. Where the rainfall is light (less than 20 inches) or unreliable, or the soil is poor, as in the continental interiors of Asia the short steppe type of grass prevails. The grasses are not only shorter but also wiry and sparse, often found in discontinuous clumps, with bare soil exposed between them. These areas are less suitable for arable farming and are used for some form of ranching as in the High Plains of U.S.A.

The climatic requirements of grass are quite different from those of trees. They require less moisture than trees and an annual precipitation of 10 to 20 inches is adequate. Their growth is not abruptly checked by summer droughts or winter cold. The steppe grass can lie dormant throughout the prolonged drought. They sprout and come to life as soon as the temperature is warm enough for plant growth (43°F.) and grow steadily with very little moisture.

The *appearance* of the temperate grasslands varies with seasons. In spring, the grass begins to appear, green, fresh and blooming with small, colourful flowers. The light rainfall that comes in late spring and early summer greatly stimulates their growth and there is plenty for the animals to graze. The herdsmen are busiest at this time. In summer, there is so much heat and evaporation that the grass is scorched. The carpet of bluish-green grass turns yellow and soon brown. Towards autumn, the grass withers and dies, but the roots remain alive and lie dormant throughout the cold winter. The winter is harsh and long, but the snow is never of great depth. Everything is quiet but with the next spring, the cycle is repeated and the steppe is alive again.

Trees are very scarce in the steppes, because of the scanty rainfall, long droughts and severe winters. The rolling plain is an endless stretch of grass, whether green or brown, except along the water courses where a few low willows, poplars or alders break the monotony. Polewards, an increase in precipitation gives rise to a transitional zone of wooded steppes where some conifers gradually



The prairies, Saskatchewan, Canada. Notice the grain elevators by the railway line *National Film Board of Canada*

appear. Even then, the trees are very scattered and few in number. Towards the equator, the steppe grass becomes shorter and sparser, till it merges into the desert with thorny scrub.

In the cultivated regions, such as the wheat farms of the Prairies, double rows of trees are planted around the house to shield the occupants from the strong winds which come unobstructed across miles of level ground. This provides the greatest contrast in a land which is essentially grass. There are no hedges and few fences and the rows of planted trees form an unusual landmark from the air!

## Economic Development

The temperate grasslands were once the home of grazing animals; wild horses in the Asiatic Steppes, swift-footed bison in the Prairies and untamed buffaloes in the Pampas. Even as recently, as the last century, these grasslands were dominated by nomadic and semi-nomadic peoples like the *Kirghiz* of the Asiatic Steppes. They roamed far and wide with their herds and earned a precarious living from whatever pastures they could find. The *Red Indians* of North America were mostly hunters who moved around after the bison and other animals. Cultivation was unknown and the region was one of the most sparsely populated parts of the world. In recent years great changes have taken place in the grasslands and few areas, in fact, have managed to retain their original landscape. The grasslands have been ploughed up for extensive, mechanized wheat cultivation and are now the 'granaries of the world'. Besides wheat, maize is increasingly cultivated in the warmer and wetter areas. The tufted grasses have been replaced by the more nutritious lucerne or alfalfa grass for cattle and sheep rearing. These temperate grasslands are now the leading ranching regions of the globe. We shall now describe more closely each of these economic activities.

1. **Nomadic herding.** This type of migratory animal

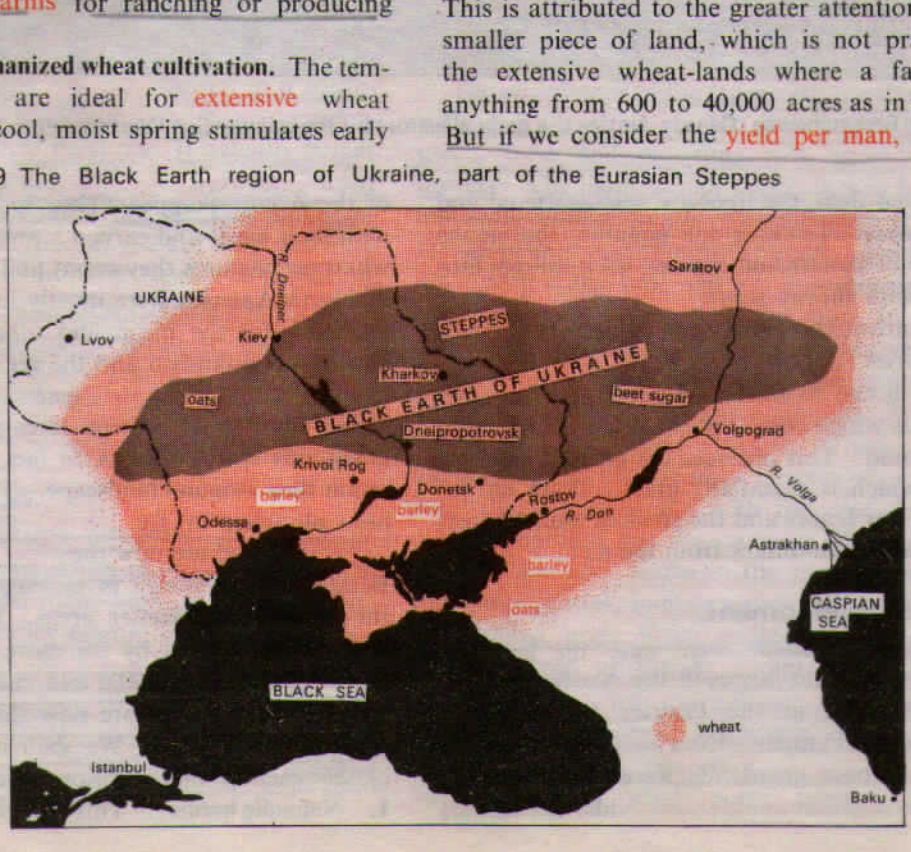
grazing has almost disappeared from the major grasslands. The herders were wandering tribes e.g. the Kirghiz, the Kazakhs, and the Kalmuk. They used to travel over long distances like the Bedouin of the Arabian Desert, in search of grass and water for their animals–cattle, sheep, goats and horses. From these domesticated animals they obtained meat, milk, wool, hides, bones and horn. You would be surprised at the number of things they made out of these. The wool was woven into felt for tents and garments. The leather was used for making boots, saddles and belts, which were very essential in a country where the chief riding animal was the horse. The bones and horns were not wasted but made into tools, utensils and weapons. Many of their home-made products were exchanged at trading posts or with the caravans for guns, canned food, grains, tea, coffee, sugar, medicines and other essential goods.

The harsh environment of the nomads, with long droughts and unreliable showers made the Kirghiz a tough and fearless people, 'the Tartars', and they long resisted subjugation by the Russians. Now, however, under the Communist regime they are being forced to settle down. The steppes which they used to wander have been made into huge collective farms and state farms for ranching or producing cereals.

**2. Extensive mechanized wheat cultivation.** The temperate grasslands are ideal for extensive wheat cultivation. The cool, moist spring stimulates early growth and the light showers in the ripening period help to swell the grains to ensure a good yield. The warm, sunny summer is not only advantageous for harvesting, but also enables the straw to be dried for farm use. In addition, the levelness of the Steppes and other temperate grasslands all over the world makes ploughing and harvesting a comparatively easy job. Mechanical ploughs loosen the soil and get the fields ready for sowing in the shortest possible time. In the Prairies, the Argentinian Pampas, the Ukrainian Steppes and the Downs of Australia *combine-harvesters*, reap, thresh, winnow and sack the grains almost as soon as the stalks are gathered.

One distinct drawback of this form of extensive mechanized farming is the consequent low yield. For example, the average yield of wheat in the Prairies is about 23 bushels per acre (1 bushel is approximately equivalent to 60 lb. in weight or 8 gallons in volume). In the Pampas and the Australian Downs, the yields are even lower, not more than 20 bushels per acre! In comparison, the wheat yield in countries that practise intensive farming are much higher, at times almost thrice the yield. It is 50 bushels per acre in the United Kingdom, 57 bushels in Denmark and almost 59 bushels in the Netherlands! This is attributed to the greater attention given to a smaller piece of land, which is not practicable in the extensive wheat-lands where a farmer owns anything from 600 to 40,000 acres as in the Prairies. But if we consider the yield per man, this is very

Fig. 139 The Black Earth region of Ukraine, part of the Eurasian Steppes



A ship is loaded with grain for export at Port Arthur, Ontario *Paul Popper*

much higher in the extensive farms. In this respect, the sparsely populated temperate grasslands of the mid-latitudes produce the greatest quantity of wheat per capita amongst the world's wheat-growing nations. They are, naturally the greatest wheat exporters. Three-quarters of Canada's 10 million tons of annual wheat production is exported, mainly to Europe which does not produce sufficient wheat to feed her very dense population, despite her high wheat yield. Her wheat needs are so great that shipments of wheat and flour arrive at her ports from almost every part of the temperate grasslands, from the U.S.A., Argentina, Uruguay, Australia and the U.S.S.R.

Three-quarters of the world's wheat is winter wheat, i.e. wheat sown in winter or late autumn. It is a hard wheat with a low moisture content, being ripened in the hot, sunny, continental summer. It is best for bread-making and is extensively traded. Polewards, where the winter temperatures are too cold for the wheat seedlings to survive, spring wheat is grown. It is the less important soft wheat, more suitable for making cakes, biscuits and pastes rather than bread. In North America, winter wheat is dominant south of the Great Lakes in U.S.A., while spring wheat is sown mainly in the Canadian Prairie provinces of Alberta, Saskatchewan and Manitoba. Scientific plant breeding has now devised cold-resistant varieties that can mature within 110 days. This has resulted in the northward extension of the wheat cultivation into the Peace River region in Canada. In the warmer, wetter regions, maize is increasingly grown.

**3. Pastoral farming.** When pioneer settlers first moved into the temperate grasslands, there were very few animals. The natural conditions suit animal farming. Subsequently, cattle, sheep, pigs and horses were introduced, and they proved very successful. With the development of refrigerated ships in the late nineteenth century, the temperate grasslands became major pastoral regions, exporting large quantities of beef, mutton, wool, hides. Milk, butter, cheese and other dairy products are also important in some parts of the North American grasslands. The development was particularly spectacular in the southern hemisphere, (Figs. 141, 142 and 143)

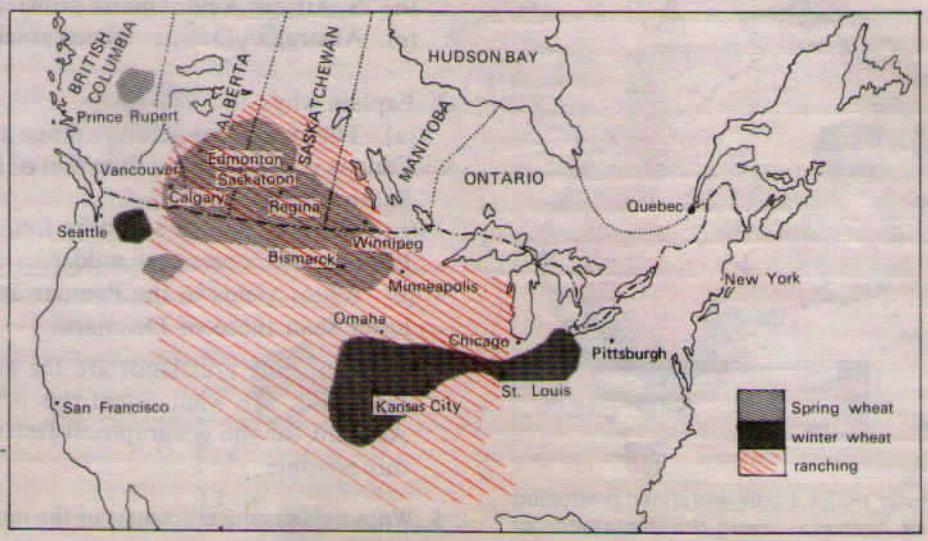



Fig. 140 Wheat and beef production in the North American grasslands

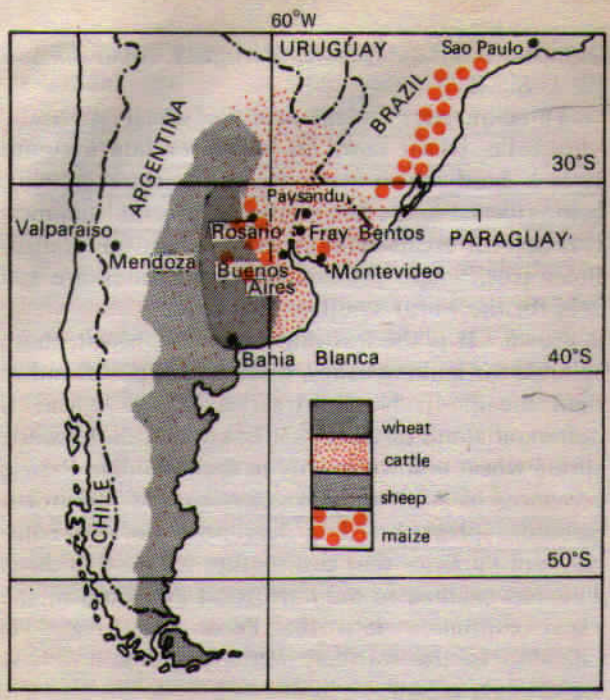



Fig. 141 Sheep, cattle, wheat and maize production in southern South America

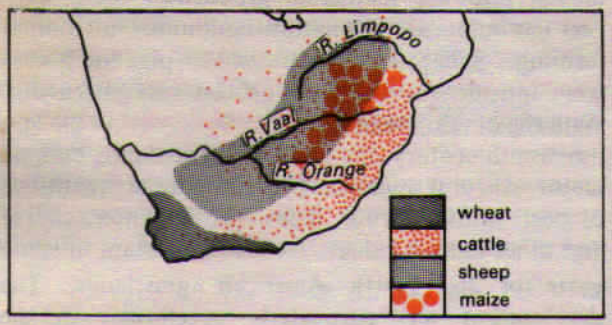



Fig. 142 Agriculture in the veld of southern Africa

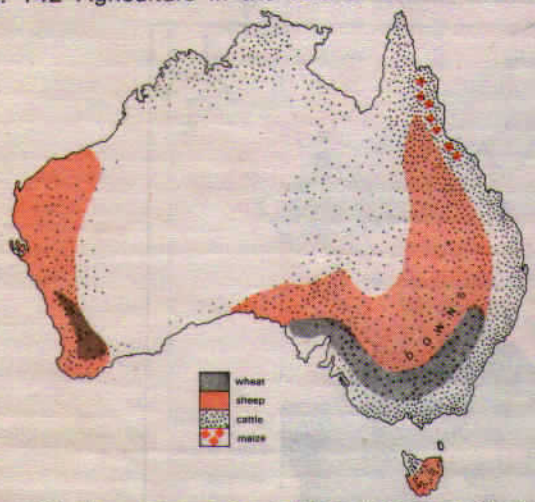



Fig. 143 The wheat, maize, cattle and sheep producing areas of Australia. Note the importance of the Downs

where the winters are milder and the rainfall is more evenly distributed. The original tuft-grass was ploughed up and replaced by sown alfalfa. The semi-wild cattle in the Pampas were either crossed with or replaced by the imported pedigree stock from Europe. Soon the Pampas became so involved with the pastoral industry that it took the lead in the world's export of beef. Large *estancias* (ranches) were established, linked to the *frigorificos* (meat-packing factories) in the coastal ports by a dense network of roads and railways. The growth was rapid and towns like Buenos Aires, Bahia Blanca, Fray Bentos and Montevideo became known throughout the world. This is also true of other temperate grasslands. Much beef is produced in the Great Plains of U.S.A., and Australia became the world's leading wool exporter, accounting for a third of its total production. In the Eurasian Steppes, too, increasing emphasis is being placed on the ranching of animals for meat production.

## QUESTIONS AND EXERCISES

1. Compare and contrast tropical and temperate grasslands in respect of
   (a) their seasonal responses to climatic changes
   (b) their economic importance

2. Each of the following temperate grasslands is paired with an important aspect of its economic life.
   For any *three* of them, give a reasoned account
   (a) Asiatic Steppes: nomadic herding
   (b) Canadian Prairies: spring wheat cultivation
   (c) Argentine Pampas: beef cattle ranching
   (d) S. African Veld: maize growing
   (e) Australian Downs: sheep grazing

3. Explain why
   (a) The annual temperature range of Winnipeg, Canada is much greater than that of Pretoria, South Africa.
   (b) When Chinooks are more frequent in the Prairies, the winters are milder.
   (c) Wheat yields in the Pampas are much lower than those of Denmark.

4. The temperate grasslands are the granaries of the world. To what extent this is true? Account for the geographical factors that make this possible.

5. Write a geographical account of the international trade in wheat.

# Chapter 21 The Warm Temperate Eastern Margin (China Type) Climate

## Distribution

This type of climate is found on the eastern margins of continents in warm temperate latitudes, just outside the tropics (Fig. 144). It has comparatively more rainfall than the Mediterranean climate in the same latitudes, coming mainly in the summer. It is, in fact, the climate of most parts of China—a modified form of monsoonal climate. It is thus also called the *Temperate Monsoon or China Type* of climate. In south-eastern U.S.A., bordering the Gulf of Mexico, continental heating in summer induces an inflow of air from the cooler Atlantic Ocean. Though less pronounced, the overall climatic features resemble those of the China type. It is sometimes referred to as the **Gulf type** of climate.

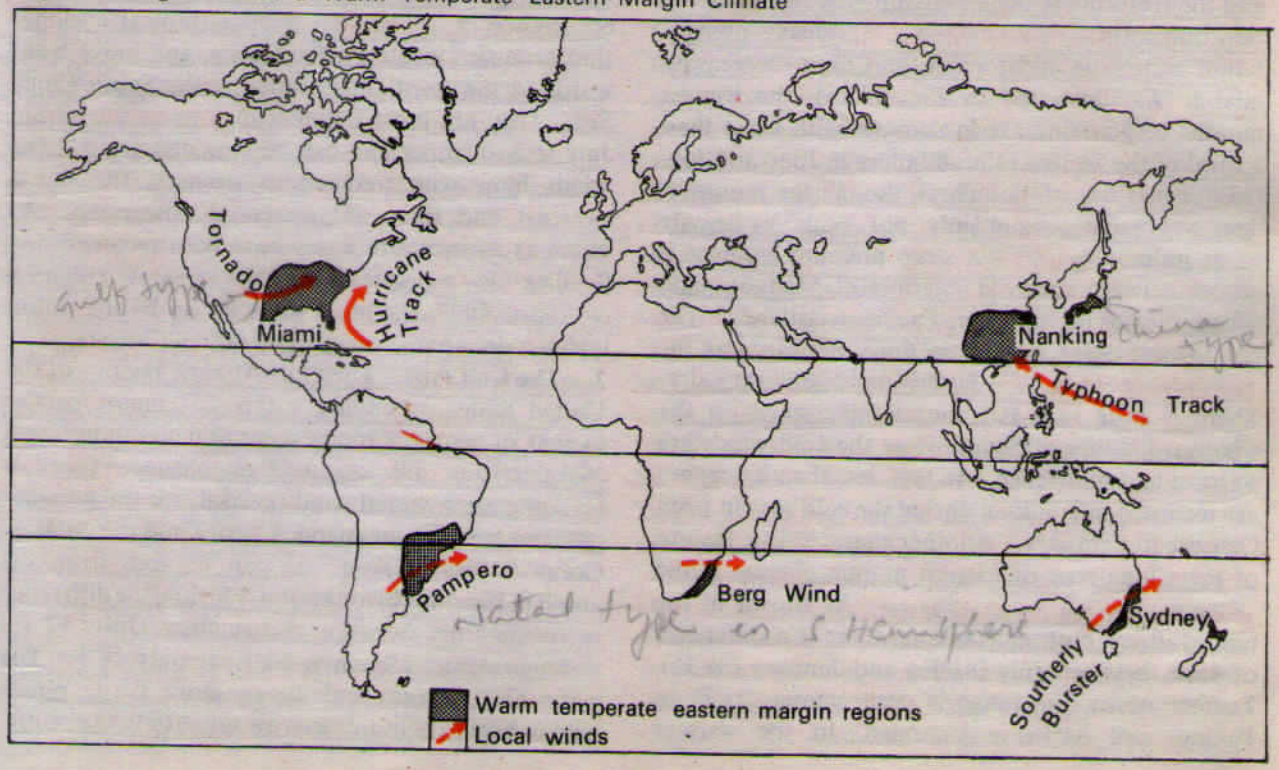
In the southern hemisphere, this kind of climate is experienced along the warm temperate eastern coastlands of all the three continents: in New South Wales with its eucalyptus forests; in Natal where cane sugar thrives; and in the maize belt of the Parana-Paraguay-Uruguay basin. As the regions are influenced by the on-shore Trade Winds all the year round, without any monsoon variations, the climate cannot be described as temperate monsoon. It is sometimes referred to as the **Natal type** of climate.

## Climate

The Warm Temperate Eastern Margin Climate is typified by a **warm moist summer and a cool, dry winter.** The mean monthly temperature varies between 40°F. and 78°F. and is strongly modified by **maritime influence.** Occasionally, the penetration of cold air from the continental interiors may bring down the temperature to freezing point. Though frosts are rare, they occasionally occur in the colder interiors. For most of the time, it is pleasantly warm. The relative humidity is a little high in mid-summer when the heat becomes oppressive and can be very trying to the white settlers, e.g. in Natal.

Rainfall is more than moderate, anything from 25 inches to 60 inches. This is adequate for all agricultural purposes and the Warm Temperate Eastern Margin Climate supports a wide range of crops. Areas which experience this climate are very

Fig. 144 Regions with a Warm Temperate Eastern Margin Climate



densely populated. Another important feature is the fairly uniform distribution of rainfall throughout the year. There is rain every month, except in the interior of central China, where there is a distinct dry season. Rain comes either from convectional sources or as orographic rain in summer, or from depressions in prolonged showers in winter. Local storms, e.g. typhoons, and hurricanes, also occur.

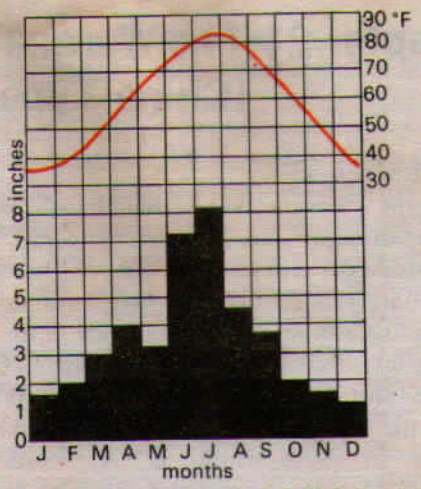
There is a good deal of variation in detail within the eastern margins and it is essential to examine them by reference to specific areas, where the local factors affect the climates. We shall sub-divide them into three main types.

**1. The China type:** central and north China, including southern Japan (temperate monsoonal).

**2. The Gulf type:** south-eastern United States, (slight-monsoonal).

**3. The Natal type:** all the warm temperate eastern margin (non-monsoonal areas) of the southern hemisphere including Natal, eastern Australia and southern Brazil—Paraguay—Uruguay and northern Argentina.

**1. The China type.** This is the most typical climate of the warm temperate eastern margin. The great land mass of the Asiatic continent with its mountainous interior induces great pressure changes between summer and winter. Intense heating in 'the heart of Asia' sets up a region of low pressure in summer and the tropical Pacific air stream is drawn in as the rain-bearing South-East Monsoon. Heavy precipitation occurs in most parts of China, decreasing inland. As illustrated in Fig. 145(a), the wettest months of Nanking are in summer with more than a third of the annual rainfall falling in June and July (15.3 inches out of 42 inches), though the monsoon does not 'burst' as suddenly, nor 'pour' as heavily as in India. In *winter*, a steep pressure gradient is set up between the cold interiors of Mongolia and Siberia, and the warmer Pacific coastlands. The continental polar air stream flows outwards as the North-West Monsoon, bitterly cold and very dry. There is little rain but considerable snow on the windward slopes of Shantung as the cold winds are warmed and moistened. In fact, less than 8.4 inches are recorded in Nanking during the cold season from October to February. Another characteristic feature of the China-type of eastern margin climate is the great annual temperature range. As shown in the temperature graph of Nanking, there is a difference of 45°F. between July (81°F.) and January (36°F.). Further north, the range is even greater, 55°F. in Peking, and 54°F. in Changan. In the warmer




| Nanking | J | F | M | A | M | J | J | A | S | O | N | D | range/total |
|---|---|---|---|---|---|---|---|---|---|---|---|---|---|
| Temp. | 36 | 39 | 47 | 58 | 69 | 76 | 81 | 81 | 73 | 63 | 51 | 40 | 45°F |
| Precip. | 1.6 | 2.0 | 3.0 | 4.0 | 3.2 | 7.2 | 8.1 | 4.6 | 3.7 | 2.0 | 1.6 | 1.2 | 42" |

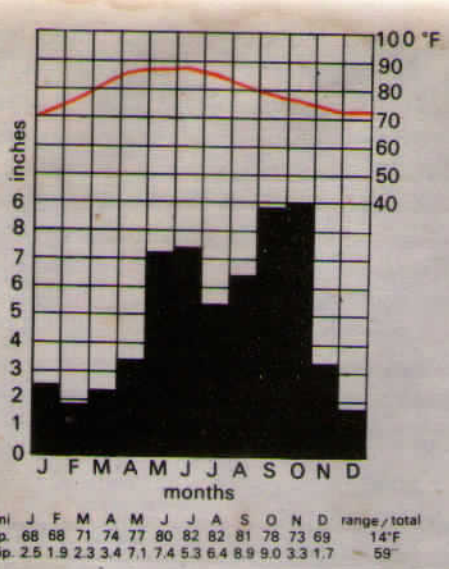
Place: Nanking, China (32°N., 119°E.)
Altitude: 34 feet
Annual precipitation: 42 inches
Annual temperature range: 45°F. (81°–36°F.)

Fig. 145 (a) Warm Temperate Eastern Margin Climate in the northern hemisphere (China type)

south and along the coast, the temperature differences are much less, e.g. 28°F. in Canton, 27°F. in Swatow and only 22°F. in Hong Kong.

Another climatic feature associated with the China type of climate in southern China is the occurrence of typhoons—intense tropical cyclones that originate in the Pacific Ocean, and move westwards to the coastlands bordering the South China Sea. They are most frequent in late summer, from July to September and can be very disastrous. The winds blow with tremendous strength, the sky is overcast and there are torrential downpours. As much as 24 inches in a day have been recorded and flooding is widespread. In the Swatow typhoon of August 1922, the huge waves set up by the violent typhoon drowned as many as 50,000 inhabitants.

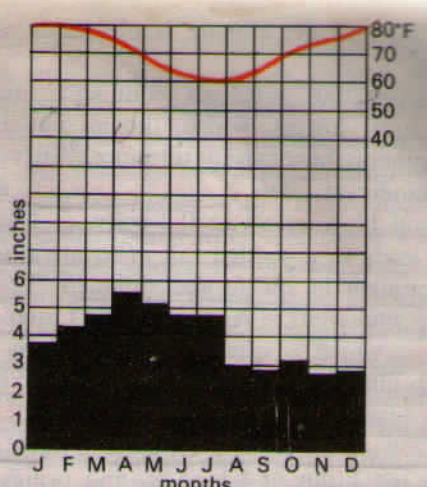
**2. The Gulf type.** The Gulf-Atlantic regions of the United States experience a type of climate similar to that of central China except that the monsoonal characteristics are less well established. There is no complete seasonal wind reversal, for the pressure gradient between mainland America and the Atlantic Ocean is less marked. As can be seen from the graph in Fig. 145 (b) for Miami, Florida, the difference in temperature between mid-summer (July, 82°F.) and mid-winter (January, 68°F) is only 14°F. The warm Gulf Stream and the on-shore Trade Winds help to bring about this narrow range of temperature.




| Miami | J | F | M | A | M | J | J | A | S | O | N | D | range / total |
|---|---|---|---|---|---|---|---|---|---|---|---|---|---|
| Temp. | 68 | 68 | 71 | 74 | 77 | 80 | 82 | 82 | 81 | 78 | 73 | 69 | 14°F |
| Precip. | 2.5 | 1.9 | 2.3 | 3.4 | 7.1 | 7.4 | 5.3 | 6.4 | 8.9 | 9.0 | 3.3 | 1.7 | 59" |

Place: Miami, Florida, U.S.A. (26°N., 80°W.)
Altitude: 5 feet
Annual precipitation: 59 inches
Annual temperature range: 14°F. (82–68°F.)

(b) Warm Temperate Eastern Margin Climate in the northern hemisphere (Gulf type)




| Sydney | J | F | M | A | M | J | J | A | S | O | N | D | range / total |
|---|---|---|---|---|---|---|---|---|---|---|---|---|---|
| Temp. | 72 | 71 | 69 | 65 | 59 | 55 | 53 | 55 | 59 | 64 | 67 | 70 | 19°F |
| Precip. | 3.7 | 4.3 | 4.8 | 5.6 | 5.1 | 4.8 | 4.8 | 3.0 | 2.9 | 3.2 | 2.8 | 2.9 | 48" |

Place: Sydney, New South Wales, Australia (34°S., 151°E.)
Altitude: 138 feet
Annual precipitation: 48 inches
Annual temperature range: 19°F. (72°–53°F.)

(c) Warm Temperate Eastern Margin Climate in the southern hemisphere (Natal type)

Summers are warm and pleasant, Miami, being an important holiday resort, and it rarely snows in winter.

The annual rainfall is heavy with 59 inches in Miami, and New Orleans; 52 inches in Montgomery and 41 inches in Charleston. There is no distinct dry period as in monsoon lands, and the abundant moisture has stimulated extensive cultivation of cotton and maize, in the Cotton and Corn Belts both of which are the world's leading areas for these crops. From the rainfall pattern in Fig. 145 (b), it is clear that there is a tendency towards a summer maximum, brought by the on-shore Trade Winds which swing landwards from the Atlantic. The amount of rain is increased by the frequent thunderstorms in summer and by hurricanes in September and October.

Some stations, e.g. Montgomery in Alabama, also show a secondary maximum in late winter when cyclonic activities are greatest. Sometimes, violent tornadoes occur, due to intense local heating on land. Though these whirling storms follow only a narrow path in the central plain (Mississippi basin), they leave behind a trail of destruction.

**3. The Natal type.** There are three distinct areas on the eastern coasts of the southern continents, lying just south of the Tropic of Capricorn which experience this type of climate. The narrowness of the continents and the dominance of maritime influence eliminate the monsoonal elements which characterize the corresponding climates of the northern hemisphere. The South-East Trade Winds bring about a more even distribution of rainfall throughout the year as illustrated by the climatic graph for Sydney, Australia. It has a mean monthly precipitation of 4 inches, which is adequate for most agricultural activities. The annual amount of 48 inches is fairly representative of this climatic type in the southern hemisphere. The annual precipitation of Durban in Natal is 45 inches and that of Asuncion in Paraguay is 52 inches. The passage of depressions across the southern edges of the warm temperate eastern margins results in a slight autumn or winter maximum, typified by Sydney (Fig. 145(c)) which has its wettest months in March, April, May, June and July (the autumn-winter part of the year). The rain comes in prolonged showers. Much of the water seeps into the ground and there is little run-off; so the regions are well suited to agriculture and are some of the best settled parts of the southern continents.

Another feature to note is the small annual temperature range, without any really cold month. The annual range for Sydney is 19°F. and the coldest month is 21°F. above freezing. The range is smaller for Durban, only 13°F., with July, the coldest month at 63°F. In Asuncion, it is even less, the range is

only 8°F., and the climate is pleasantly warm all the time.

However, the southern continents also have violent local storms, which, though not as severe as the typhoon, hurricane or tornado, are nevertheless, quite significant. The Southerly Burster, a violent cold wind blowing along the coast of New South Wales, leads to a sudden fall in temperature. It is most frequent in spring and summer. The corresponding cold wind in Argentina and Uruguay is the Pampero, which is often accompanied by thunder and lightning besides the rain and dust. In south-eastern Africa, a hot, dry wind called the Berg Wind comes down from the interior plateau. It is comparable to the Fohn or Chinook, and brings unpleasantly high temperatures and oppressive weather.

## Natural Vegetation

The eastern margins of warm temperate latitudes have a much heavier rainfall than either the western margins or the continental interiors and thus have a luxuriant vegetation. The lowlands carry both evergreen broad-leaved forests and deciduous trees quite similar to those of the tropical monsoon forests. On the highlands, are various species of conifers such as pines and cypresses which are important soft-woods. As the perennial plant growth is not checked by either a dry season as in the Mediterranean, or a cold season as in the cool temperate regions, conditions are well suited to a rich variety of plant life including grass, ferns, lianas, bamboos, palms and forests. The well distributed rainfall all the year round makes the regions look green at all times.

It is interesting to note that the warm temperate eastern margins are the homes of a number of valuable timber species. In eastern Australia the most important are eucalyptus trees, with scanty foliage and thick fern undergrowth. Some of the eucalyptus are very tall, over 250 feet and they make hardy timber. The Australian Alps of Victoria and the Blue Mountains of New South Wales have great reserves of temperate eucalyptus forests that make up part of the timber exports of Australia. From the forests of south-eastern Brazil, eastern Paraguay, north-eastern Argentina come valuable warm temperate timbers such as the Parana pine, and the quebracho (axe-breaker, an extremely hard wood used for tanning) and wild yerba mate trees, from which the leaves are gathered for making Paraguay tea. Today, large yerba maté plantations have been established to produce Paraguay tea, an increasingly important export item of Paraguay. In Natal, the warm Mozambique current encourages heavy precipitation along the coast and many species of palm trees thrive. The highlands yield extensive forests of chestnuts, ironwood and blackwoods. An unusual occupation is the commercial cultivation of wattle trees in plantations for tanning extracts and for use in Natal's coal mines as pit-props.

The forests of China and southern Japan also have considerable economic value and include oak, camphor, camelia and magnolia. Unfortunately the tremendous population pressure in the two countries has caused much of the original forest to be cleared for fuel or crop cultivation. Deforestation has resulted in many barren hill-slopes that are still feeling the impact of soil erosion. The Gulf states of U.S.A. have lowland deciduous forests. The trees grow close together with thick undergrowth and leafy branches. Walnut, oak, hickory and maple are some of the more common species, while in the more sandy regions grow pines. Much of the forest cover has given way to the cultivation of sub-tropical crops like cotton, maize and fruits.

## Economic Development

The warm temperate eastern margins are the most productive parts of the middle latitudes. There is adequate rainfall, no prolonged drought, and the cold season is warm enough for most crops to survive. Thus the growing season is almost continuous, though summer is the busiest part of the farming year. Monsoon China together with southern Japan and other parts of the eastern margin climatic zone accounts for almost a third of the world population. Food has to be raised to feed the teeming population. The hills are terraced, fields are irrigated, and agriculture is extended to the limits of production. It is no exaggeration to say that the temperate monsoon lands are the most intensively tilled parts of the earth. Besides the widespread cultivation of maize and cotton in the Corn and Cotton Belts of U.S.A. fruit and tobacco are also grown. Rice, tea and mulberries are extensively grown in monsoon China. Elsewhere are found other products of economic importance, e.g. cane sugar in Natal, coffee and maize in South America and dairying in New South Wales and Victoria. Let us now examine some of the regions more closely.

**1. Farming in monsoon China.** Undoubtedly this is the world's greatest rice growing area. A third of the world's rice is grown in China, though the huge population of 750 million leaves very little for export. In fact, in normal years, imports of rice and

Terraced Land for rice farming in Japan

other food grains are essential. The Chinese peasants raise 'wet padi' or *'swamp rice'* in flooded fields that call for endless hard labour for the greater part of the year. It is said that nowhere else is there so much manual labour devoted to raise a food crop that gives so little economic return. Farming is usually on a subsistence basis. Despite increasing mechanization in padi-cultivation, very few farmers actually make use of new machines because they are expensive and may be impractical in some areas. The only progress that has been made is towards double or treble cropping, which has increased the annual total rice production. When compared with the rapid population growth of the rice-eating nations, the increased production has in no way relieved the critical food problem of Monsoon Asia. Furthermore, milled rice which forms the stable food of the Orient is a seriously deficient diet; the people are therefore not only inadequately fed also physically undernourished.

Monsoon China has all the ideal conditions for padi cultivation; a warm climate, moderately wet throughout the year, and extensive lowlands with fertile moisture-retentive alluvial soil, which if necessary, can be easily irrigated. The land has been tilled from generation to generation, and yet there is little deterioration in soil fertility. The muddy irrigation water from the river basins is silty and constantly brings new soil to the fields. The water is greatly enriched during floods, though these are far less frequent now, with the improvement made in flood control by the Communist regime. In practice, the Chinese peasants add all kinds of organic wastes to enrich their fields. Rice straw, ashes, clippings, animal dung, refuse, and last but not least, human manure.

The most intensively farmed areas are the basins of the Si-kiang, Yang-tze Kiang and Hwang Ho, which are also the most densely peopled areas. The eastern coastlands are equally important. As the flat lands are insufficient for rice cultivation, farmers move up the hill-slopes and grow padi on terraced uplands. The artificial terraces retain the excess water as it flows down the slope. Besides rice the other important crops are *tea*, grown for home consumption and *mulberry leaves* gathered for feeding silk worms, though sericulture is declining.

**2. Agriculture in the Gulf states.** Agriculture in the Gulf states of America differs from that of monsoon China, though they have a similar climate. Lack of population pressure and the urge to export, make rice cultivation a relatively unimportant occupation. It is grown only in a few areas in the southern coastlands of the Mississippi delta. Americans are bread-eaters and one can well imagine how insignificant is rice in the economy of the Gulf states. The most important crops are corn, cotton and tobacco.

**(a) Corn.** The chief food crop raised is, in fact corn or maize. The humid air, the sunny summer and the heavy showers suit the crop well. It is grown right from the Gulf coast to the Mid-west south of the Great Lakes, with the greatest concentration in the Corn Belt of Nebraska, Iowa, Indiana and Ohio. The region accounts for more than half the world's production of corn, but only 3 per cent of the world's export. This is because most of the corn is used for fattening animals, mostly cattle and pigs. Many farmers do not harvest the corn but instead allow the cattle or pigs 'to hog the corn down' in the field itself. The fattened animals are then sold to the meat plants in Chicago and Cincinnati to be slaughtered and processed into 'corned beef' or frozen and chilled beef. Very little corn is consumed as a staple food in America, though the cereal originated in America as the food crop of the native Indian people. Apart from its ease of cultivation, in respect of soil, climatic and labour requirements, corn's most outstanding feature is its prolific *yield*. It gives almost twice as much food (mainly starch) per acre as wheat or other cereals. This explains

why it is so widely cultivated in both the warm temperate and the tropical latitudes.

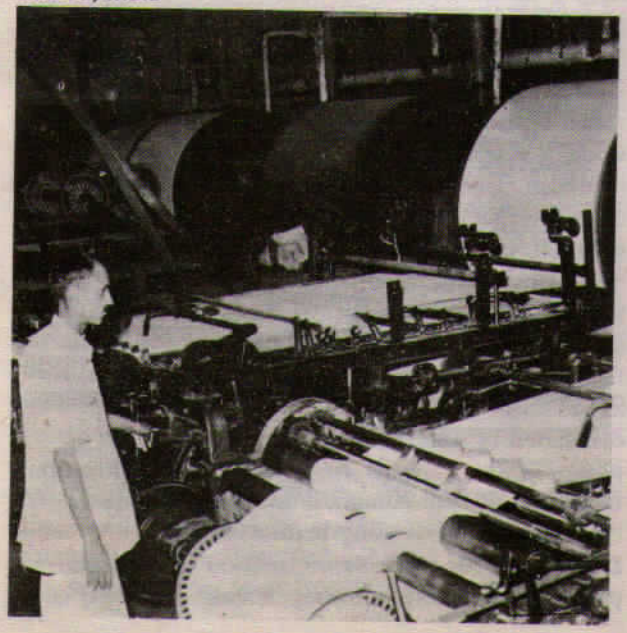
**(b) Cotton.** Of the cash crops grown in the Gulf states, none is comparable with **cotton**. In the Deep South, the fibre is so vital to the economic well-being of the southerners that 'cotton is king'! It shapes the destiny of the southern states, being directly responsible for their trade, prosperity and politics. In the early days of America millions of **Negroes** were brought from Africa as salve labour for the cotton plantations, because the climate was too hot for the white settlers to harvest the cotton themselves. Although slavery was abolished in the nineteenth century, the Negroes are still poor and underprivileged. This is the cause of the present problems between the blacks and the whites in America.

The Gulf type of climate is undoubtedly the best for cotton growing. Its long, hot growing season with **200 days frost free** and a moderately high temperature of about 75 F. permits the crop to grow slowly and mature within six months. Like most fibres, cotton likes ample rain and an annual precipitation of around **40 inches** is essential. In fact, an adequate moisture supply coming from frequent light showers with bright sunshine between them gives the highest yield. Fine quality cotton also comes from irrigated fields in the drier west provided sufficient water is supplied during the growing season. The Cotton Belt is thus limited by the 20-inch isohyet on the west and the 77 *F. isotherm* in the north, within which there are at least 200 days without frost. In the very south, in the Gulf-lands, the heavy rainfall damages the lint. This area is therefore less suitable for cotton and is devoted to citrus fruits, cane sugar and market gardening, as in Florida. The commerical cultivation of cotton is now **concentrated** only in the most favourable areas which are the Mississppi flood plains, the clayey Atlantic coastlands of Georgia and South Carolina, the Black Prairies of Texas and the Red Prairies of Oklahoma. Fig. 146 shows the chief cotton areas.

Generally speaking, the best cotton comes from the maritime districts where the sea breezes and the warming effect of the ocean are most strongly felt. The *Sea Island Cotton* grown in the islands off the coast of Georgia and South Carolina is **long-stapled** (the fibres are between 1·5 and 2·3 inches in length) and is the best in the world. Further inland, the staples are shorter (about an inch long). This is typical of the bulk of the 'American' cotton. Besides the problem of **soil exhaustion** and erosion caused by prolonged cotton cultivation, the most dreaded enemy of the Cotton Belt is the **boll-weevil**. The pest multiplies so rapidly that a pair of boll-weevils, if left unchecked, will breed over 10 million grubs within a single season! The pest is responsible for the **westward migration of the Cotton Belt**. When it first appeared in 1892 in the eastern U.S.A. it attacked the Sea Island Cotton. Aerial spraying with insecticides and the thorough burning of old cotton stalks, have been found effective in eliminating the boll-weevil.

**(c) Tobacco.** Another interesting crop closely associated with the Gulf type of climate is **tobacco**, which incidentally is also a native crop of America. Though it is cultivated in many parts of the world, and the finished products range from Turkish tobacco to Havana cigars and Malaysian cheroots, there is none so universally known as the *Virginia tobacco*. It is the raw material from which most of the world's cigarettes are blended to suit the smokers' taste. The **humid atmosphere**, the warmth and the **well-drained soils** of the Gulf states, enable tobacco to be successfully cultivated in many of the eastern states of U.S.A., e.g. Virginia, Maryland, Georgia, North and South Carolina, Kentucky and Tennessee. No less than half the tobacco that enters international trade comes from these states. Regardless of the views that doctors and school teachers may hold, cigar and cigarette-smoking has long been a universal habit that cannot be

**U.S.A. is not the only important cotton producer. India's largest industry is cotton textiles. Here yarn is being processed at the Birla mills** ***New Delhi Press Information Bureau, India***



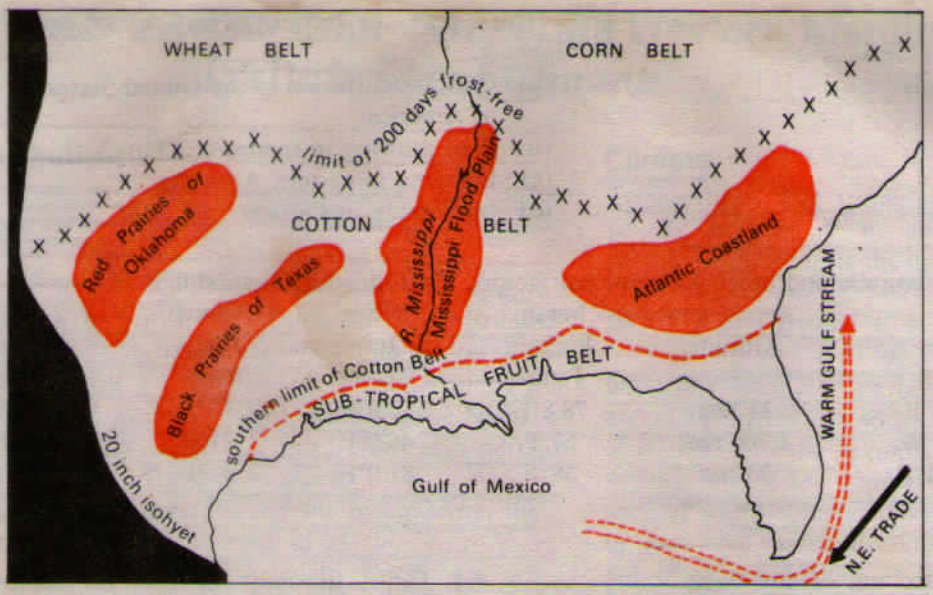



Fig. 146 The Cotton Belt of the U.S.A.

dispensed with. It is the basis of an industry and provides, through duty, a valuable source of income to the government.

**3. Crop cultivation in the eastern margins of the southern hemisphere.** A close look at the economic map of the southern hemisphere will at once reveal the agricultural importance of its eastern margins which experience a Natal type of climate. The warm moist summers and frost-free winters not only support many crops but also animals. In the coastlands of Natal, **cane sugar** is the dominant crop, followed by *cotton and tobacco* in the interior. Recent expansion of these crops has come about with improved *irrigation*. **Maize** is extensively cultivated for use both as 'mealie' an important food item for Africans and 'silage', an animal fodder for cattle rearing. But in comparison with the maize yield of the Corn Belt of U.S.A., the African yield is rather low, often only half. Improvements can be made, if farmers attempt some form of **crop rotation** to arrest the rapid rate of soil exhaustion in regions of maize monoculture. Scientific manuring and better methods of cultivation would raise yields.

In South America where rainfall is less than 40 inches there is much grassland on which many **cattle and sheep** are kept for meat, wool and hides. It is the continuation of the Argentinian Pampas. The **mild winters** mean that the animals can be kept out-of-doors all the time. The extensive natural pastures provide valuable forage for both cattle and sheep. The products from these two kinds of domesticated animals account for over three-quarters of the annual exports of Uruguay. The remaining exports come mainly from **wheat and flax**. Further north in southern Brazil, the rainfall increases to more than 40 inches and forest gradually replaces grass. Here the important occupations are the cultivation of *verba mate* (Paraguay tea) and the **lumbering** of *araucaria or Parana pine*. Cattle and sheep are reared, and maize and cane sugar are grown.

In eastern Australia the moist Trade Winds bring heavy rainfall to the coastal districts and these are thickly wooded. Giant eucalyptus trees rise one above the other right up the Eastern Highlands. But with the influx of European immigrants, much of the forest has been cleared for settlement and **dairying**. The eastern margin of New South Wales was, in fact, the earliest part of the continent to be colonised, beginning with Port Jackson, the present site of Sydney. The region is now the chief source of Australia's *milk, butter and cheese*, besides cotton, cane sugar and maize which are increasingly grown in the north.

## QUESTIONS AND EXERCISES

1. What do you understand by the China type of climate? Locate on a world map the regions which experience this type of climate, and describe the broad pattern of their agricultural activities.

2. Describe the main factors which affect the climate and vegetation of any *three* of the

following regions.

(a) the Gulf states of U.S.A.
(b) the Iberian peninsula
(c) Borneo
(d) Tasmania
(e) Ceylon

3. Give a reasoned account of any *two* of the following.

(a) Cotton cultivation in the United States of America.
(b) Padi growing in monsoon China.
(c) Dairying in eastern Australia.
(d) Lumbering in Canada.

4. Analyse, in relation to latitude and other geographical factors, the following climatic figures.

| Station | Location | Altitude | Mean January Temp. | Mean July Temp. | Annual Temp. *Range* | Annual Rainfall |
|---|---|---|---|---|---|---|
| Singapore | 1°N., 104°E. | 33 feet | 78.8°F. | 82.0°F. | 3.2°F. | 95.1 ins. |
| Santiago | 33°S., 71°W. | 1,700 feet | 67°F. | 46.0°F. | 21°F. | 14.2 ins. |
| Shanghai | 31°N., 121°E. | 23 feet | 38°F. | 81.0°F. | 43°F. | 44.7 ins. |

5. Give an explanatory account of any *three* of the following.

(a) Local storms (e.g. typhoon, hurricane, pampero) are often associated with the Warm Temperate Eastern Margin Climate.
(b) The predominant forest trees of eastern Australia are eucalypts.
(c) U.S.A. accounts for more than 50 per cent of world production of corn (i.e. maize) but only 3 per cent of world exports.
(d) Farming in monsoon China is usually on a subsistence basis, and the peasants are permanently 'land-hungry'.

# Chapter 22 The Cool Temperate Western Margin (British Type) Climate

## Distribution

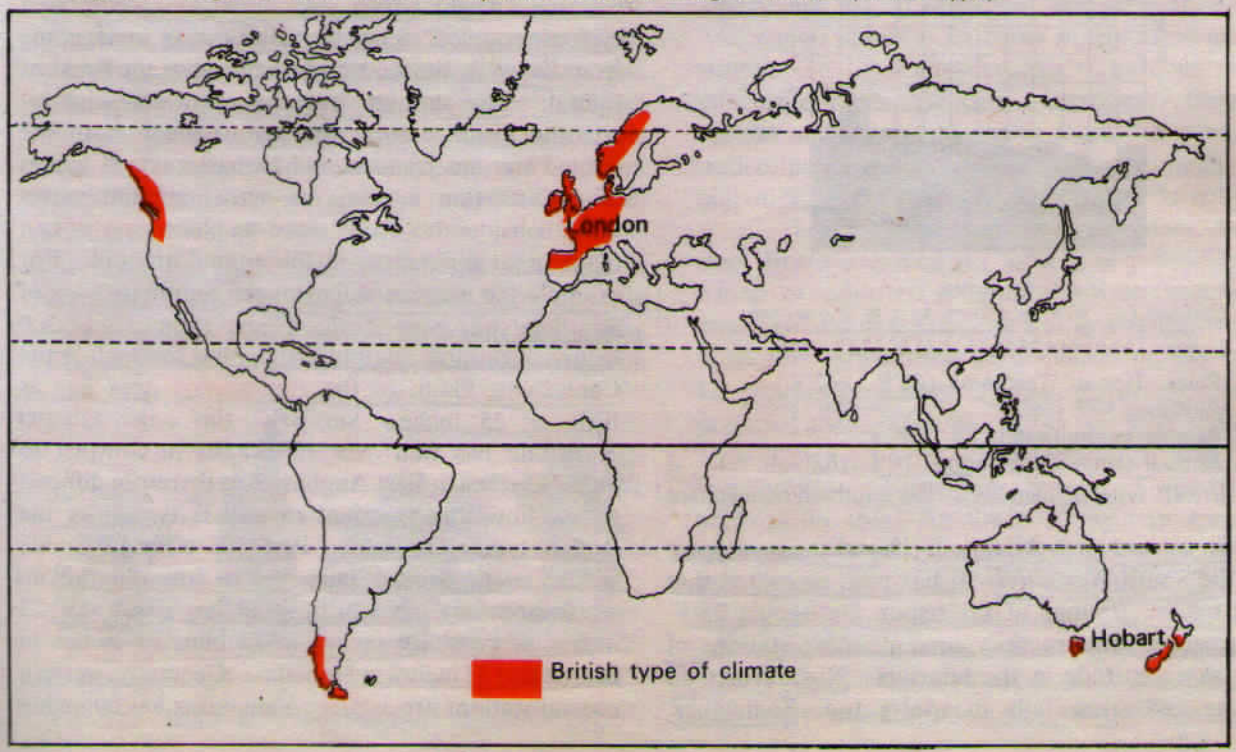
The cool temperate western margins are under the permanent influence of the Westerlies all round the year. They are also regions of much cyclonic activity, typical of Britain, and are thus said to experience the British type of climate. From Britain, the climatic belt stretches far inland into the lowlands of North-West Europe, including such regions as northern and western France, Belgium, the Netherlands, Denmark, western Norway and also north-western Iberia. There is so much oceanic influence on both the temperature and the precipitation that the climate is also referred to as the North-West European Maritime Climate. In North America, the high Rockies prevent the on-shore Westerlies from penetrating far inland and the British type of climate is confined mainly to the coastlands of British Columbia.

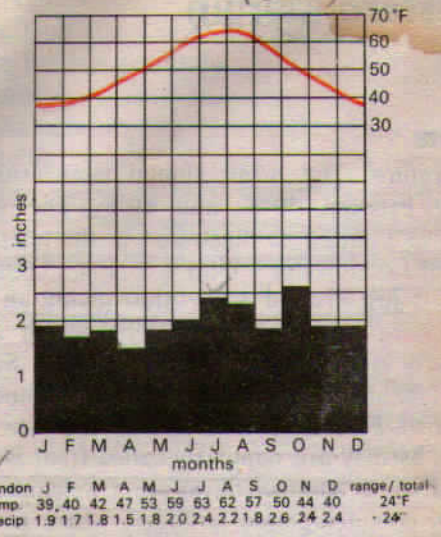
In the southern hemisphere, the climate is experienced in southern Chile, Tasmania and most parts of New Zealand, particularly in South Island. The surrounding large expanses of water have increased the maritime nature of the climate here (Fig. 147).

## Climate

**Temperature.** The mean annual temperatures are usually between 40°F. and 60°F. The warmest month in London as illustrated in the temperature graph of London Fig. 148(a) is 63°F. and the coldest month is just around 40°F., thus giving an annual temperature range of only 24°F., which is comparatively small for its latitude (51°N.) Summers are, in fact, never very warm. Monthly temperatures of over 65°F. even in mid-summer are rare. 'Heat waves', as they are popularly called (that is a short spell of warm summer days) are a welcome feature in such cool temperate latitudes, where people do not often see enough of the sun. The climate is ideal for maximum comfort and *mental alertness*. People can work for long hours without feeling drowsy and lethargic as they do in the tropics. There appears to be some direct relationship between climate and Man's output of work. It is no wonder that the cool temperate regions are some of the most advanced parts of the world. Winters are abnormally mild, and no stations actually record mean January temperatures below freezing-point in north-western Europe. This is attributable to the warming effect

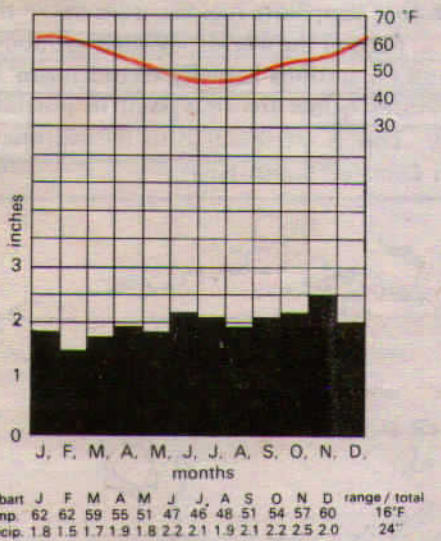
Fig. 147 Regions with Cool Temperate Western Margin Climate (British type).






Place: London, British Isles (51°N., 0°W.)
Altitude: 18 feet
Annual precipitation: 24 inches
Annual temperature range: 24°F. (63°–39°F.)

Fig. 148 (a) British type of climate in the northern hemisphere.




Place: Hobart, Tasmania (43°S., 147°E.)
Altitude: 177 feet
Annual precipitation: 24 inches
Annual temperature range: 16°F. (62°–46°F.)

(b) British type of climate in the southern hemisphere.

of the warm North Atlantic Drift and the prevalence of the South-Westerlies. It has been estimated that the marine stations of the region are almost 25°F. warmer in January than corresponding stations of the same latitude in the interiors. Night frosts do occur and snow falls in winter too. Sometimes, unusual cold spells, caused by the invasion of cold polar continental air from the interiors, may hit the western margins for a number of weeks. The climate of the maritime regions as a whole may be described as equable with moderately warm summers and fairly mild winters.

It is quite apparent from Fig. 148(b) of Hobart, Tasmania that the British type of climate in the southern hemisphere is even more equable. Lack of continental land masses in Tasmania, New Zealand and southern Chile means that extremes of temperature are not likely at all. Hobart has mid-summer temperatures of not more than 62°F. while its coldest month in July (winter in the southern hemisphere) is barely below 46°F. The annual temperature range is reduced to only 16°F., which is unusual for the middle latitudes. This is in fact, the average figure for all the maritime stations in the southern continents where insularity overrides all other factors. The annual ranges of other southerly stations are Dunedin 15°F., Christchurch 18°F., Valdivia 14°F. and Punta Arenas 17°F (the last two stations are in southern Chile). The oceanic influences not only keep the winters very mild but also keep the summers cool. Some geographers have described these southerly islands as 'the favoured isles' which has much truth in it.

**Precipitation.** The British type of climate has adequate rainfall throughout the year with a tendency towards a slight winter or autumn maximum from cyclonic sources. Since the rain-bearing winds come from the west, the western margins have the heaviest rainfall. The amount decreases eastwards with increasing distance from the sea. Though both the quoted stations London and Hobart have 24 inches of precipitation a year, the actual amount varies quite considerably from place to place. Relief can make great differences in the annual amount. For example the western slopes of the Southern Alps of South Island, New Zealand have as much as 200 inches of rainfall (mainly orographic rain) while the Canterbury Plain, in the rain-shadow area has as little as 25 inches. Similarly, the Lake District of Britain has well over 100 inches in contrast to only 24 inches in East Anglia. It is therefore difficult to say how much annual rainfall is typical of the British type of climate. Perhaps, a useful guide would be to confine ourselves to lowland regions which normally have 20 to 40 inches a year e.g. 23 inches in Paris, 28 inches in Dublin, 33 inches in Seattle and 37 inches in Dunedin. Generally, western coastal stations are wetter. Vancouver has 60 inches

of rain, Bergen 84 inches and Valdivia 105 inches. They are exceeded in the annual amount only by the highland stations as mentioned earlier.

**The seasons.** As in other temperate regions there are four distinct *seasons* in the British climate type. Light snowfalls can be expected in the winter months normally only of short duration because of the comparatively mild weather. But over the highlands such as the Scandinavian Mountains and the American Rockies, snowfall is heavy and feeds the mountain glaciers that move down the valleys. Winter is the season of cloudy skies, foggy and misty mornings, and many rainy days from the passing depressions. Out at sea, gales are frequent and can be dangerous to shipping. Spring is the driest and the most refreshing season when people emerge from the depressing winter to see everything becoming green again. This is followed by the long, sunny summer. Sun-bathers, picnickers and sightseers are out in the open to enjoy themselves. With the roar of gusty winds and the fall of 'golden' leaves, autumn is ushered in, and the cycle repeats itself. This type of climate with its four distinct seasons is something that is conspicuously absent in the tropics.

## Natural Vegetation

The natural vegetation of this climatic type is deciduous forest. The trees shed their leaves in the cold season. This is an adaptation for protecting themselves against the winter snow and frost. Shedding begins in autumn, the 'fall' season, during which the leaves fall and are scattered by the winds. The golden-brown leaves and the 'naked' branches present a very interesting scene. When they are in leaf the deciduous trees have typical rounded outlines with thick trunks and out-spreading branches that yield valuable temperate hardwood (Fig. 149). Some of the more common species include oak, elm, ash, birch, beech, poplar, and hornbeam. In the wetter areas grow willows, alder and aspen. Elsewhere are found other species, e.g. chestnut, sycamore, maple, and lime.

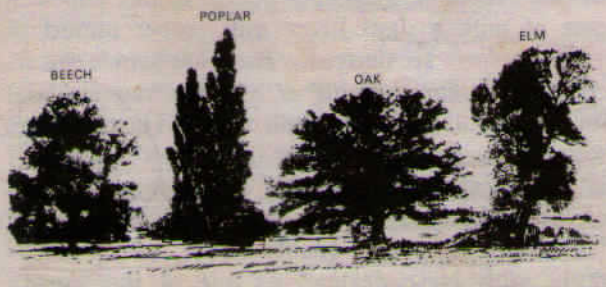



Fig. 149 Some deciduous trees

Unlike the equatorial forests, the deciduous trees occur in pure stands and have greater lumbering value from the commercial point of view. The open nature of the forests with sparse undergrowth is useful in logging operations. Easy penetration means much cost can be saved in the movement of the logs. The deciduous hardwoods are excellent for both fuel and industrial purposes. In Tasmania, the temperate eucalypts are also extensively felled for the lumbering industry. Higher up the mountains in the Scandinavian highlands, the Rockies, southern Andes and the Southern Alps of New Zealand, the deciduous trees are generally replaced by the conifers which can survive a higher altitude, a lower temperature and poorer soils.

## Economic Development

A very large part of the deciduous woodlands have been cleared for fuel, timber or agriculture. The dense population necessitates the removal of the lowland forests, particularly for the plough. In Britain there is only 4 per cent of the original forest left. A large range of cereals, fruits and root crops are raised, mainly for home consumption rather than for export. North-West Europe, which includes some of the most crowded parts of the globe, has little surplus for export. It is, in fact, a net importer of food-crops, especially wheat from almost all parts of the wheatlands for bread-making and other food items. The region differs from many others in its unprecedented industrial advancement. The countries are concerned in the production of machinery, chemicals, textiles and other manufactured articles rather than agriculture, fishing or lumbering, though these activities are well represented in some of the countries. Fishing is particularly important in Britain, Norway and British Columbia. Since the manufacturing aspect of industrial geography will be dealt with in much greater detail in Chapter 27, we shall deal here with the agricultural development of the region.

**1. Market gardening.** Though market gardening is practised throughout the world wherever there is a large urban population, nowhere else is it so highly specialized as in North-West Europe. Several factors account for this. All the north-western European countries (Britain, France, West Germany, Benelux and Denmark) are highly industrialized and have high population densities. There are more towns and cities than in other continents despite its small size. It is understandable that the demand for fresh vegetables, green salads, eggs, meat, milk and fruits

will be tremendous. The city dwellers, the factory workers and the civil servants who make up the bulk of the urban population consume large quantities of fresh provisions daily and these must be provided by local farmers if *freshness* of the produce is to be ensured.

In north-western Europe *intensive market gardening* is carried out in many specialized areas e.g. the Vales of York and Evesham in the United Kingdom where climatic, soil and other factors best suit this form of agriculture. Farms are normally small, located near large cities or industrial areas. Soils, whether silty, loamy or podzolic, are carefully maintained at a high degree of fertility. Very selective fertilizers are applied depending on the type of crops in cultivation. Farming is carried out intensively, aiming at high yield and maximum cash returns. As the crops are perishable, a good network of transport is indispensable. The produce such as lettuces, cabbages, cauliflowers, tomatoes, onions, peas and fruits are seldom shipped but conveyed by high-speed conveyances such as trucks or vans. Perhaps a more appropriate term to use is truck farming, which is commonly used in the United States.

In a few instances warmer weather or better soils, as in south-west England (Devon and Cornwall), can also induce farmers to take to market gardening despite their remoteness from the more populated districts. Early vegetables, early potatoes and tomatoes reach London from the Canary Islands, the Channel Islands, and from Brittany, in north-west France. Similarly, bulbs and flowers from the polderlands of the Netherlands and eggs, bacon and other dairy products from Denmark are sent to most of the major industrial centres of Europe in almost perfect condition for household consumption. The horticultural industry in the Netherlands is so highly specialized that Dutch tulips and bulbs are flown by the K.L.M. (Dutch Airlines) to Rome, Paris, Zurich, and London. In Australia, high-speed boats ply across the Bass Strait daily from Tasmania to rush vegetables, tomatoes, apples and beans to most of the large cities in mainland Australia. It is no wonder the Australians nicknamed Tasmania the 'garden state'.

**2. Mixed farming.** Throughout Britain and north-western Europe, farmers practise both arable farming (cultivation of crops on ploughed land) and pastoral farming (keeping animals on grass meadows). Crops may be raised for cash sales or as fodder for cattle or sheep. The proportion of crops and animals in the farm at any time depends to a great extent on the type of *soil*, the *price* of the cereals and the *demand* for animals and animal products. The farmers also plant a few fruit trees (apples, pears, plums), rear pigs, keep poultry, mainly for eggs, and even have bees for honey. There is such a great variety in the farms that the term mixed farming is most aptly applied.

Amongst the cereals, wheat is the most extensively grown, almost entirely for home consumption because of the very dense population in north-western Europe. At one time, some of the European countries (France, Denmark and the Netherlands) used to be wheat exporters, but the keen competition from the new wheat-lands of the New World forced most of the farmers to divert their interest to other more profitable uses of their land such as market gardening, dairying or an intensive form of mixed farming. With the rise of industry, more arable farms are being devoured by factories and wheat is now a net import item in Europe.

The next most important cereal raised in the mixed farm is barley. The better quality barley is sold to the breweries for beer-making or whisky distilling and is raised preferably in the drier areas. *Malting barley* is thus grown in south-eastern Britain near the hop-growing area (hops are also used for beer) where rainfall is less than 30 inches. On heavy soils or wetter regions, barley is grown mainly as an animal fodder, sometimes mixed with oats as 'dredge corn'. Both are raised in crop rotations with a leguminous crop (beans or clover) and a root crop (turnips or beet sugar).

The most important animals kept in the mixed farm are cattle. North-western Europe was originally the home of many world renowned cattle breeds, e.g. Guernsey, Ayrshire and Friesian, which are first class dairy cattle for milk production. The countries bordering the North Sea (Britain, Denmark, the Netherlands) are some of the most advanced dairying countries where cattle are kept on a scientific and intensive basis. Europeans drink more milk than anybody else except the New Zealanders. In the United Kingdom, a person drinks almost a pint of milk a day! From milk, other important dairy products are derived. These are *butter, cheese, cream, and skimmed milk or casein*, a raw material for making plastics, paper and drugs. The temperate western margin type of climate is almost ideal for intensive dairying. Cheese is a specialized product of the Netherlands, from Edam and Gouda. From Denmark comes high-quality butter, of which she ranks with New Zealand as one of the world's greatest exporters. In Devon and Cornwall clotted

An English farm. Notice the well-wooded countryside *Central Office of Information London*

cream is made, which is less perishable than fresh milk. It can be sent over longer journeys without being contaminated. The Swiss have also made excellent use of their alpine pastures for keeping dairy cattle. Fresh milk is converted into various forms of condensed or evaporated milk, and exported around the world for baby-feeding, confectionery, ice-cream and chocolate making.

Besides dairying, some cattle are kept as beef cattle, e.g. the Hereford and Aberdeen Angus, but their numbers are very small in comparison with those of Argentina or Australia, where meat production is the primary concern. The high rate of beef consumption in Europe (about 40 lb. a year per head of population in the United Kingdom) necessitates large imports of frozen and chilled beef. In the mixed farms in Europe, farmers keep cattle also with a view of enriching their fields with the *animal dung*. The pigs and poultry act as scavengers that feed on the left-overs from root-crops and dairy processes. In this way, Denmark is able to export large quantities of *bacon* from pigs that are fed on the *skimmed milk*, a by-product of butter-making. Fresh chickens' eggs from the farms and more recently, from large poultry yards also form part of the export products of Denmark. Sheep are kept both for wool and mutton. In British Columbia, mixed farming is restricted only to the most favoured parts of the Western lowlands, the region being so mountainous and thickly forested.

**3. Sheep rearing.** This is well developed in some parts of the British type of climate. Britain is the home of some of the best known sheep breeds, e.g. Leicesters, Lincolns and Southdowns which are dual-purpose, noted for mutton as well as wool. With the

A sheep station near Hawkes Bay, New Zealand *N.Z. High Commission Malaysia*

greater pressure exerted on land by increased urbanization, industrialization and agriculture, sheep rearing is being pushed further and further into the less favoured areas. The principal sheep areas are on foothills, well-drained uplands, chalk and limestone scarplands, and the light, sandy coasts. In Britain, the major sheep areas are the Pennines, (Swaledale breeds) Scottish Highlands (the Blackface), the Southern Uplands (Cheviot), the Welsh Mountains (Black Welsh) and the scarplands of south-eastern England (Romney Marsh). Britain was once an exporter of wool and her woollen textiles industry began with local Pennine wool, but today with a greater population and a more intensive use of her better agricultural land, she has neither surplus wool nor mutton for export. She has become instead an important exporter of British pedigree animals to the newer sheep lands of the world. This is equally true of other north-western European sheep areas, in which industrialization has effectively altered the pattern of land use.

In the southern hemisphere, sheep rearing is the chief occupation of New Zealand, with its greatest concentration in the Canterbury Plain. It has been estimated that for every New Zealander there are 20 sheep. Many factors have led to this unprecedented growth during the past century including extensive meadows, a mild temperate climate, well-drained level ground, scientific animal breeding, and last, but most vital, the development of refrigeration, which enables frozen or chilled Canterbury lamb and Corriedale mutton to reach every corner of the globe. Though New Zealand has only 4 per cent of the world's sheep population, it accounts for two-thirds of the world's mutton exports, and one sixth of world wool exports. In Tasmania and southern Chile, sheep

rearing has always been a predominant occupation with surplus sheep products for the international trade.

**4. Other agricultural activities.** Apart from market gardening and mixed farming which have been singled out for greater individual treatment, the British type of climate also supports a number of other important crops. Amongst the food crops, potatoes feature prominently in the domestic economy of the cool temperate regions. It is the staple food in supplementing wheat or bread for millions of people. In terms of starch, it yields far more food than any cereals and can be cultivated over a wide range of climatic and soil types. But normally a cooler and more northerly latitude is preferred because the crop will be less prone to the attack of 'blight', a virus disease that is particularly infectious in warm and humid countries. Since the introduction of the crop by the Spanish conquerors from the Andean states of Peru and Bolivia in the sixteenth century, potato-growing has spread far and wide in Europe. Today almost two-thirds of the world's annual production of potatoes comes from Europe, of which Poland, Germany, France and United Kingdom are the major producers. Besides its principal use as a substitute for bread, large quantities of potatoes are also consumed as animal fodder and as a source of industrial alcohol.

Another interesting crop that is found almost exclusively in north-western Europe (including European U.S.S.R.) and parts of U.S.A. is beet sugar. The need for such a crop was greatly felt during the Napoleonic Wars around 1800 when military blockades caused a scarcity of sugar. High prices of imported tropical sugar (from cane sugar) drove many governments of the temperate lands to think seriously about the vital importance of securing a certain amount of self-sufficiency in their sugar requirements. The first beet sugar factory in Europe was established in 1801. Farmers were given subsidies (aids or allowances) to induce them to devote at least part of their farm to the crop. Since then beet-sugar has become an integral part of many European farms. It is grown either on special beet farms for cash sales or in conjunction with cereals in crop rotation. The beet is crushed for sugar and the green tops are used as animal fodder. The crop thrives best in the warmer and drier east of Britain and in mainland Europe. The highest sugar yield is obtained when the autumn is both dry and sunny. Attempts to grow the crop in the colder north or the wetter west have so far been rather unsuccessful, except in some sheltered localities. In Britain most of the beet-sugar factories are located in the Fens and East Anglia.

## QUESTIONS AND EXERCISES

1. The following statements attempt to describe a type of climate.

'.....Westerlies come all the year round .....there is a tendency towards an autumn or winter maximum of rainfall.....light snow falls in winter.....ports are never frozen.....but frosts do occur on cold nights.....the seasons are very distinct..... and the climate is very favourable for maximum human output..... '.

(a) Name the type of climate that it describes.

(b) Locate with the aid of a sketch map a region where such a type of climate is best represented.

(c) Explain why such a type of climate is ideal for human habitation.

2. Describe and explain with the aid of sketch maps the essential differences between the various climatic types found within the cool temperate zone.

3. (a) What are the characteristic features of temperate deciduous forests?

(b) Name the various species of deciduous forests and account for some of their industrial uses.

(c) Explain why there is comparatively little of the original forest left.

4. Write a geographical account of any *three* of the following economic activities.

(a) mixed farming
(b) beet sugar cultivation
(c) cool temperate orchard farming
(d) sheep rearing
(e) woollen textile industry

5. Give an explanatory account of any *two* of the following.

(a) The Netherlands is a major exporter of butter and cheese.

(b) Sheep outnumber the population of New Zealand by 20:1.

(c) No country produces and exports more wool than Australia.

(d) Market-gardening is a product of urbanization.

# Chapter 23 The Cool Temperate Continental (Siberian) Climate

## Distribution

The Cool Temperate Continental (Siberian) Climate is experienced only in the northern hemisphere where the continents within the high latitudes have a broad east-west spread (Fig. 150). On its poleward side, it merges into the Arctic tundra of Canada and Eurasia at around the Arctic Circle. Southwards, the climate becomes less severe and fades into the temperate Steppe climate dealt with in Chapter 19.

The predominant vegetation of this Siberian or "sub-Arctic" type of climate is evergreen coniferous forest. It stretches in a great, continuous belt across North America, Europe and Asia. The greatest single band of the coniferous forest is the taiga (a Russian word for coniferous forest) in Siberia. In Europe the countries that have a similar type of climate and forest are mainly in northern Europe, Sweden and Finland. There are small amounts of natural coniferous forest, due to high altitude, in Germany, Poland, Switzerland, Austria and other parts of Europe. In North America, this sub-Arctic belt stretches from Alaska across Canada into Labrador, and is found on the high Rocky Mountains farther south.

The Siberian Climate is conspicuously absent in the southern hemisphere because of the narrowness of the southern continents in the high latitudes. The strong oceanic influence reduces the severity of the winter and coniferous forests are found only on the mountainous uplands of southern Chile, New Zealand, Tasmania and south-east Australia.

## Climate

**Temperature.** The climate of the Siberian type is characterized by a bitterly cold winter of long duration, and a cool brief summer. Spring and autumn are merely brief transitional periods. The isotherm of 50°F. for the warmest month forms the poleward boundary of the Siberian climate and the winter months are always below freezing. The stations chosen to illustrate this type of climate are Moscow, in continental Europe and Churchill, in northern Canada, bordering Hudson Bay. The coldest month in Moscow is January with 12°F. (20° below freezing point). The warmest month (July) is as high as 66°F.; thus there is an annual range of 54°F., which is common in the Siberian type of

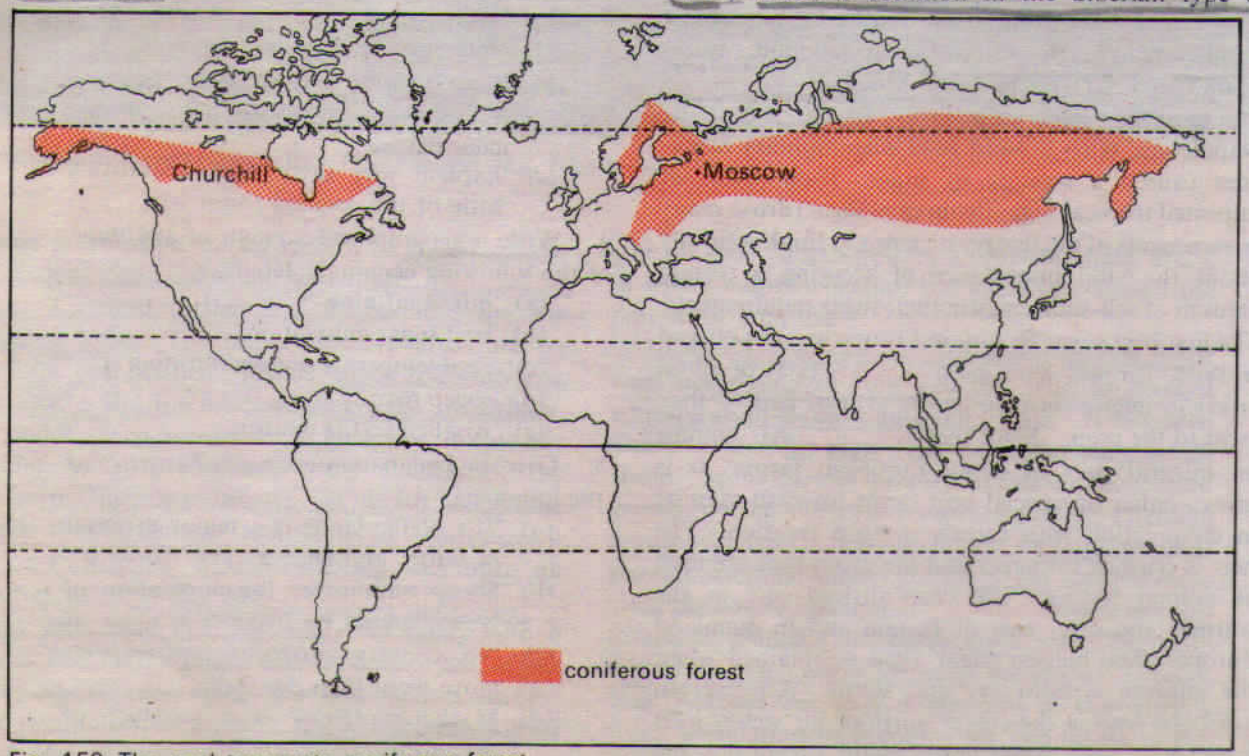


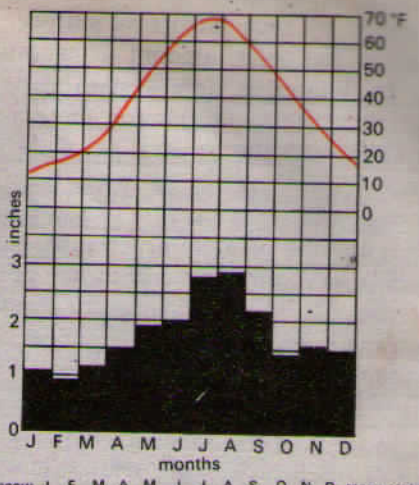

Fig. 150 The cool temperate coniferous forest

climate. In comparision, the annual temperature range for Churchill is even higher, reaching 73°F. (–19°F. in January and 54°F. in July). This is due to the more northerly position of Churchill. The extremes of temperature are so great in Siberia that it is often referred to as the 'cold pole of the earth'. Some of the lowest temperatures in the world are recorded in Verkhoyansk (68°N. 113°E. and only 330 feet in altitude) where –90°F. was once recorded. This is, in fact, 170°F. colder than Kuala Lumpur! It is almost unimaginable. In North America, the extremes are less severe, because of the continent's lesser east-west stretch. The lowest mid-winter means in the cold Mackenzie Valley are not lower than –70°F.

With such low temperatures in the cold season, heavy snowfall can be expected. Frosts occur as early as August and by September lakes and ponds are already ice-bound. All over Russia, nearly all the rivers are frozen. The number of days in which the rivers are frozen increases from south to north. In normal years, the Volga is ice-covered for about 150 days, while those further north (e.g. the lower courses of the Ob, Lena and Yenisey) are ice-covered for more than 210 days or 7 months! Occasionally cold, northerly polar winds such as the blizzards of Canada and buran of Eurasia blow violently at 50 m.p.h. or more and at a temperature of 50°F. below freezing-point. The powdery snow-flakes are blown around in the lower atmosphere and visibility is greatly reduced. Conditions are so unbearable that Siberia is very sparsely populated but it is gradually being developed.

**Precipitation.** The interiors of the Eurasian continent are so remote from maritime influence that annual precipitation cannot be high. Generally speaking, a total of 15 to 25 inches is typical of the annual precipitation of this sub-Arctic type of climate. It is quite well distributed throughout the year, with a summer maximum from convectional rain when the continental interiors are greatly heated (mid-summer temperatures of 60° to 75°F. are quite usual and the maximum recorded in Siberia is a real surprise—102°F.!) In winter the precipitation is in the form of snow, as mean temperatures are well below freezing all the time.

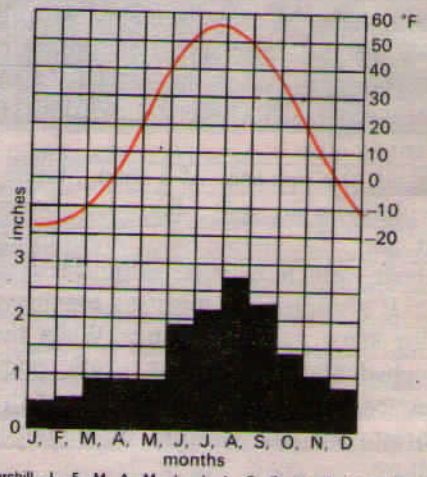
The precipitation rhythm can best be grasped from the two representative stations chosen, in Fig. 151 (a) and 151 (b). Moscow with an annual precipitation of 21 inches has most of the rainfall concentrated in the warmer months (June—September). There is no month without some form of moisture. In a region




| Moscow | J | F | M | A | M | J | J | A | S | O | N | D | range / total |
|---|---|---|---|---|---|---|---|---|---|---|---|---|---|
| Temp. | 12 | 15 | 24 | 38 | 53 | 62 | 66 | 63 | 52 | 40 | 28 | 17 | 54°F |
| Precip. | 1.1 | 0.9 | 1.2 | 1.5 | 1.9 | 2.0 | 2.8 | 2.9 | 2.2 | 1.4 | 1.6 | 1.6 | 21" |

Place: Moscow, U.S.S.R. (56°N., 37°E.)
Altitude: 480 feet
Annual precipitation: 21 inches
Annual temperature range: 54°F. (66°–12°F.)

Fig. 151 (a) Siberian Climate in Eurasia




| Churchill | J | F | M | A | M | J | J | A | S | O | N | D | range/total |
|---|---|---|---|---|---|---|---|---|---|---|---|---|---|
| Temp. | -19 | -17 | -6 | 14 | 30 | 43 | 54 | 52 | 42 | 27 | 6 | -11 | 73°F |
| Precip. | 0.5 | 0.6 | 0.9 | 0.9 | 0.9 | 1.9 | 2.2 | 2.7 | 2.3 | 1.4 | 1.0 | 0.7 | 16" |

Place: Churchill, Manitoba, Canada (58°N., 94°W.)
Altitude: 44 feet
Annual precipitation: 16 inches
Annual temperature range: 73°F. (54°–19°F.)

Fig. 151 (b) Siberian Climate in Canada.

where overall temperature is low, evaporation is not rapid and the relative humidity is high, this small amount of precipitation is adequate for tree growth. The conifers, which require little moisture, and transpire an equally small amount, are best suited to this type of sub-Arctic climate.

In Churchill, Fig. 151 (b), the annual precipitation is just 16 inches with a distinct summer maximum.

The total precipitation of the Siberian climate is determined by such factors as altitude, latitude, proximity to the poles, amount of exposure to influences by Westerlies, (on western parts of continents), temperate monsoons (on the eastern parts of continents) and the penetration of the cyclones. European U.S.S.R. usually has more than 20 inches of annual precipitation because of some on-coming Westerlies and the periodic penetration of cyclones. Eastern Siberia also has over 20 inches, being moistened by the S.E. Monsoon from the Pacific Ocean. Central Siberia and Canada have about 15 inches, due to their continentality and lack of sea influence. Polewards and southwards, the amount again decreases to only 12 inches or less. The cold, dry air of the north is incapable of holding moisture, and in the south are the semi-arid steppes.

Snow falls nearly everywhere in U.S.S.R. in the long, cold winter. The amount varies from place to place. It is heaviest in the northern tundra and in the Siberian taiga, where a thickness of several feet is common. Permanent snowfields like those of the Alps or the Himalayas are absent, because any accumulation of snow is melted with the return of spring and the warm summer. Frozen rivers are thawed, causing a rise in the water level and extensive floods occur. The lower courses of the Ob, Lena and Yenisey are marshy and ill-drained. On the other hand, the presence of a thick mantle of snow is not without its blessings. Snow is a poor conductor of heat and protects the ground from the severe cold above, which may be as much as 30°-50°F. colder! It also provides moisture for the vegetation when the snow melts in spring. When the ground is ploughed and the leached, acidic podzolic soil is improved, the continental interiors of the coniferous forest belt are capable of supporting some agriculture.

## Natural Vegetation

No other trees are so well adapted as the conifers to withstand such an inhospitable environment as the Siberian type of climate. The coniferous forest belts of Eurasia and North America are the richest sources of softwood for use in building construction, furniture, matches, paper and pulp, rayon and other branches of the chemical industry. The world's greatest softwood producers are U.S.S.R., U.S.A., Canada and the Fenoscandian countries (Finland, Norway and Sweden). In the production of wood pulp (by both chemical and mechanical methods), the U.S.A. is the leader. But in the field of newsprint, Canada has outstripped all other producers, accounting for almost half of the world's total annual production. The more accessible coniferous forests have reached the limit of production but the relatively inaccessible taiga of Siberia will remain the richest reserve of temperate softwood.

There are four major *species* in the coniferous forests.

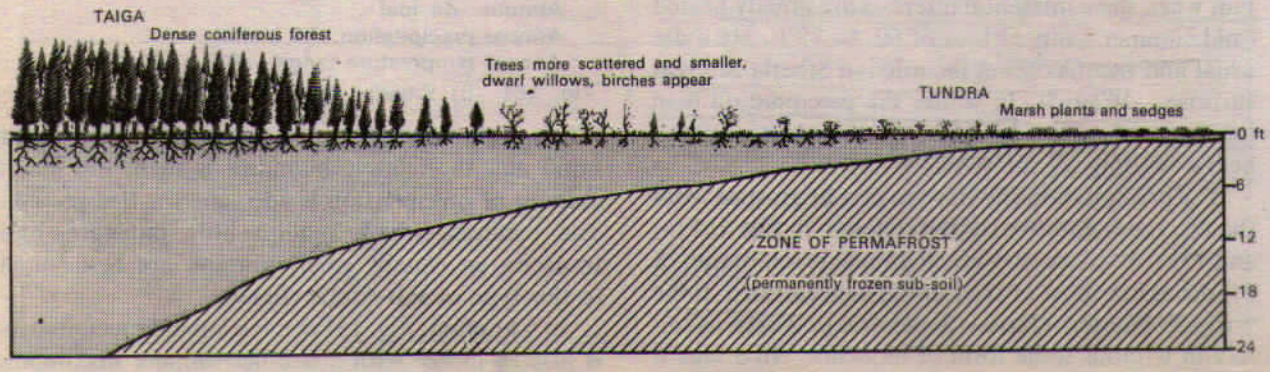
1. Pine, e.g. white pine, red pine, Scots pine, Jack pine, lodgepole pine.
2. Fir, e.g. Douglas fir and balsam fir.
3. Spruce.
4. Larch.

Their presence in pure stands and the existence of only a few species are a great advantage in commercial forest exploitation.

### Coniferous forests

**1. Coniferous forests are of moderate density.** Unlike the equatorial rain forests which are luxuriant and contain trees of various heights, the coniferous forests are more uniform and grow straight and tall, up to a height of about 100 feet. Where the poleward limit of tree growth is approached the trees are widely spaced, and give way to tundra vegetation (Fig. 152).

Fig. 152 Diagram to show changes in vegetation in journey Polewards from the Taiga Zone



Coniferous forests on the eastern Rockies, Alberta, Canada *National Film Board of Canada*

**2. Almost all conifers are evergreen.** The low annual temperature with more than half the year below the growing-point temperature of 43°F., means that evergreens are at an advantage. Growth can begin as soon as growing-point is reached in spring. The conifer has a two-year fructification cycle. The seeds are pollinated in one year and dispersed in the following year. There is no annual replacement of new leaves as in deciduous trees. The same leaf remains on the tree for as long as five years. Food is stored in the *trunks*, and the bark is thick to protect the trunk from excessive cold.

**3. Conifers are conical in shape.** This is another adaption to survive the sub-Arctic climate. The sloping branches prevent snow accumulation which may snap the branches. It also offers little grip to the winds.

**4. Leaves are small, thick, leathery and needle-shaped.** This is to check excessive transpiration. The leaf surface is reduced to the minimum, as transpiration can be quite rapid in the warm summer due to intense continental heating.

**5. There is little undergrowth.** The podzolized soils of the coniferous forests are poor. They are excessively leached and very *acidic*. The evergreen leaves provide little leaf-fall for humus formation, and the rate of decomposition of the leathery 'needles' in a region of such low temperature is slow. All these factors are deterrents to the growth of much undergrowth. Absence of direct sunlight and the short duration of summer are other contributary factors to a sparse undergrowth, but where trees are widely spaced near the tree-line, heath and tundra plants cover the intervening ground.

Besides the continental interiors of the higher latitudes, coniferous forests are also found in other climatic regions wherever altitude reduces the temperature. The conifers are, in fact, the dominant trees of the mountainous districts in both the temperate and tropical countries. But on very steep slopes where soils are immature or non-existent, even the conifer cannot survive.

## Economic Development

The coniferous forest regions of the northern hemisphere are comparatively little developed. In

Canada, eastern Europe and Asiatic Russia, large tracts of coniferous forests are still untouched. Only in the more accessible areas are the forests cleared for lumbering. The various species of pine, fir, larch and spruce are felled and transported to the saw-mills for the extraction of temperate soft-woods. There is little agriculture as few crops can survive in the sub-Arctic climate of these northerly lands. The long, cold winter, the frozen soils and the low mean annual temperature throughout the year exclude all but the hardiest crops. Only in the more sheltered valleys and the lands bordering the steppes are some cereals (barley, oats, rye) and root crops (potatoes) raised for local needs. Many of the Samoyeds and Yakuts of Siberia, and some Canadians are engaged in hunting, trapping and fishing. We shall deal with two of the major activities in greater detail.

**1. Trapping.** Many fur-bearing animals inhabit the northerly lands of Canada and Eurasia. Wherever the cold is keenest, the quality and thickness of the fur also increases. Consequently, the most severe winters produce the finest furs which fetch the highest prices. In Canada trappers and hunters, armed with modern automatic rifles, reside in *log cabins* in the midst of the coniferous forests to track down these animals. Their lives are hard and precarious at times, but the rewards are great if the 'harvests' are good. Muskrat, ermine, mink, and silver fox are the most important fur-bearing animals sought after in Canada. The Hudson Bay Company has many stations scattered in the northern regions to trade in furs with the Canadian trappers and hunters. To ensure a more regular supply of furs many fur farms have been established in Canada. Animals such as the silver fox and ermine are kept in captivity, and skinned when the furs reach a marketable stage. They fetch high prices in sophisticated cities like New York, London, Paris, Rome and Zurich, where the pelts are processed as attractive fur coats and women's handbags. In Siberia other fur-bearing animals are trapped. These are squirrels, otters, bears, sables, lynxes, martens, and foxes. As in Canada, fur-farming has now replaced hunting of wild animals in many parts of Siberia as the main source of furs.

**2. Lumbering.** This is probably the most important occupation of the Siberian type of climate. The vast reserves of coniferous forests provide the basis for the lumbering industry. The trees are felled for many purposes.

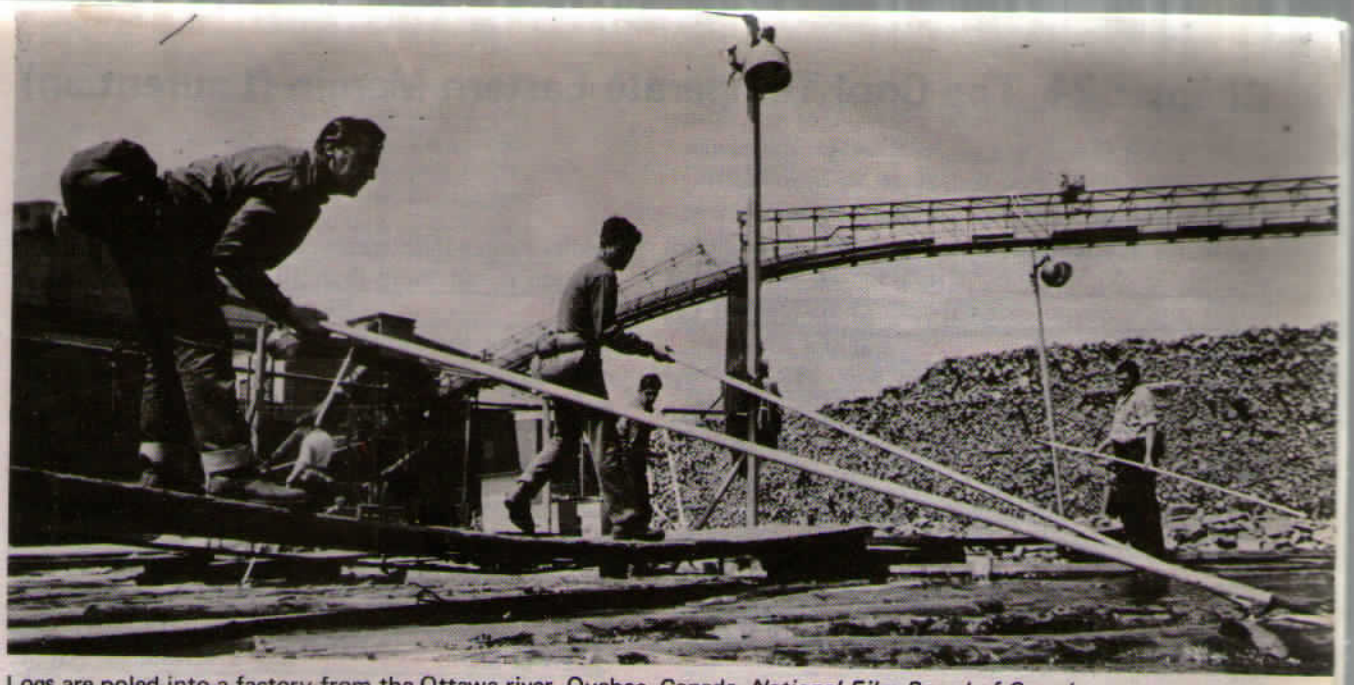
**(a) Saw-milling.** This processes the logs into sawn timber, plywood, planks, hardboard and other constructional woods.

**(b) Paper and pulp industry.** Timber is pulped by both chemical and mechanical means to make wood pulp the raw material for paper-making and newsprint. The development of the printing industry has made paper and pulp indispensable. Canada and U.S.A. are leading producers of the world's supplies of newsprint and wood pulp respectively.

A lumberjack uses a power-saw to cut up a fallen tree, Quebec, Canada *National Film Board of Canada*

**(c) As a fuel.** Less than a quarter of the world's softwood is burnt as fuel, because its industrial uses are far more significant. In contrast, almost three-quarters of the world's hardwoods are burnt as fuel, particularly tropical hardwoods where the trees occur in mixed stands.

**(d) As an industrial raw material.** Timber has a wide range of uses. In Sweden, matches form a major export item. From other temperate countries, timber is used for making furniture, wood-carvings, toys, crates and packing cases. From the by-products of the timber, many chemically processed articles are derived such as rayon turpentine, varnishes, paints, dyes, liquid resins, wood-alcohols, disinfectants and cosmetics.



Logs are poled into a factory from the Ottawa river, Quebec, Canada *National Film Board of Canada*

of the coniferous forests is characterized by the following features.

**1.** The conifers are limited in species. Pine, spruce and fir are the most important in the northern forests, while larch is more predominant in the warmer south. They occur in homogeneous groups and not mixed as in the tropical forests. This not only saves time and costs, but also enchances the commercial value of the felled timber.

**2.** In these northerly latitudes, agriculture is almost impossible and lumbering replaces farming in the continental interiors. Even where crops are cultivated, farmers are idle in the winter months and can supplement their income by doing part-time lumbering in the forests, as they do in most parts of Europe.

**3.** Lumbering is normally carried out in the *winter* when the sap ceases to flow. This makes felling much simpler. The snow-covered ground also makes logging and haulage a relatively easy job. The logs are dragged to the rivers and float to the saw-mills downstream when the rivers thaw in spring. This has greatly assisted the development of the lumbering industry in eastern Canada and Sweden. Unfortunately, over the greater part of Siberia, all the rivers drain polewards into the Arctic Ocean which is frozen for three-quarters of the year, and there are few saw-mills there. With the use of the Northern Sea Route, which links Murmansk and Vladivostok via the Arctic Ocean, development is increasing. Cheap hydro-electricity for driving the saw-mills is harnessed in the mountainous uplands of North America and Europe and has greatly assisted the lumbering industry.

## QUESTIONS AND EXERCISES

1. Compare and contrast deciduous forests and coniferous forests in respect of the following.
   (a) distribution
   (b) vegetational characteristics
   (c) climatic influence
   (d) economic development

2. Distinguish between hardwoods and soft-woods. What industrial uses are made of them? Account for their large scale production for export in any one country.

3. Give a reasoned account of any *three* of the following.
   (a) The annual temperature range of Moscow is 54°F.
   (b) The annual precipitation of Leningrad is not more than 19 inches.
   (c) The lower courses of the Siberian rivers are frozen for as long as seven months.
   (d) One of the coldest spots on the globe, is Verkhoyansk with a record lowest temperature of –90°F.

4. What is meant by
   (a) the taiga
   (b) the veld
   (c) the selvas

Account for the distribution and characteristics of any *two* of them.

5. Describe the role played by forest products in the economy of *either* Canada *or* Sweden.

# Chapter 24 The Cool Temperate Eastern Margin (Laurentian)

## Distribution

The Cool Temperate Eastern Margin (Laurentian) Climate is an intermediate type of climate between the British and the Siberian type of climate. It has features of both the maritime and the continental climates. It is apparent from Fig. 153 that the Laurentian type of climate is found only in two regions. One is north-eastern North America, including eastern Canada, north-east U.S.A., (i.e. Maritime Provinces and the New England states), and Newfoundland. This may be referred to as the North American region. The other region is the eastern coastlands of Asia, including eastern Siberia, North China, Manchuria, Korea and northern Japan. It may be referred to as the Asiatic region.

In the southern hemisphere, this climatic type is absent because only a small section of the southern continents extends south of the latitude of 40°S. The only possible location is in eastern Patagonia, south of Bahia Blanca (lat. 39°S.) to Tierra del Fuego (lat. 54°S.). But the climatic barrier of the southern Andes is so complete, that the Westerlies hardly ever reach Patagonia. The region is subjected to aridity rather than continentality. Its annual precipitation is not more than 10 inches, so that it is a rain-shadow desert. Elsewhere in the southern hemisphere, the climate is so equable and the oceanic influence is so profound that neither the continental nor the eastern margin type of climate exists.

## Climate

The Laurentian type of climate has cold, dry winters and warm, wet summers. Winter temperatures may be well blow freezing-point and snow falls to quite a depth. Summers are as warm as the tropics (70° – 80°F.) and if it were not for the cooling effects of the off-shore cold currents from the Arctic, the summer might be even hotter. Though rain falls throughout the year, there is a distinct summer maximum from the easterly winds from the oceans. Of the annual precipitation of 30 to 60 inches, two-thirds come in the summer. Winter is dry and cold, because the winds are dry Westerlies that blow out from the continental interiors. We shall now examine in closer detail the variations of the Laurentian type

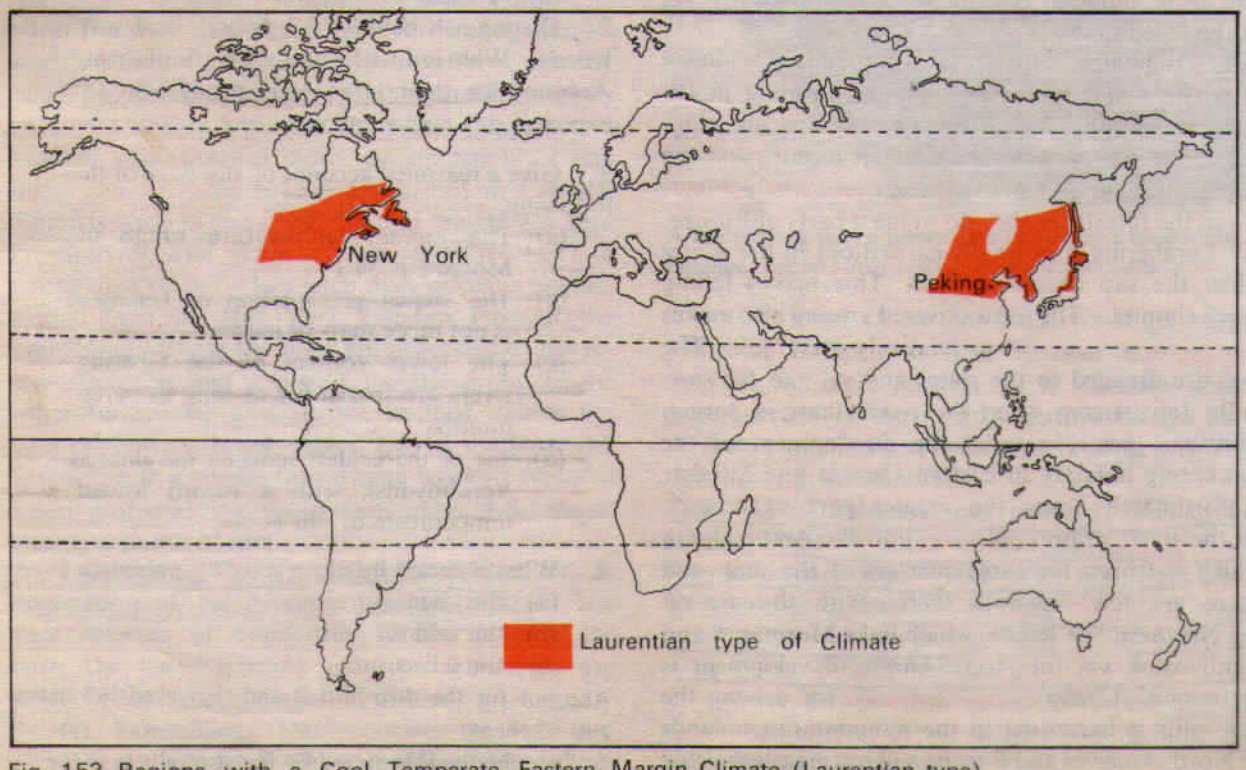
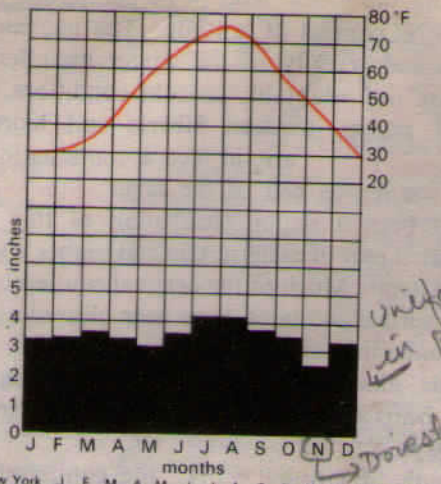


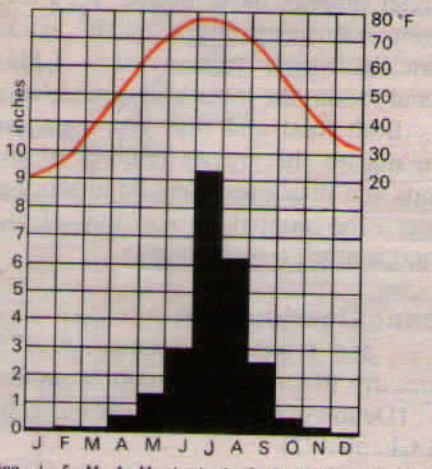

Fig. 153 Regions with a Cool Temperate Eastern Margin Climate (Laurentian type)




| New York | J | F | M | A | M | J | J | A | S | O | N | D | range / total |
|---|---|---|---|---|---|---|---|---|---|---|---|---|---|
| Temp. | 31 | 31 | 39 | 49 | 60 | 69 | 74 | 72 | 67 | 56 | 44 | 34 | 43°F |
| Precip. | 3.3 | 3.4 | 3.6 | 3.4 | 3.1 | 3.6 | 4.2 | 4.2 | 3.7 | 3.5 | 2.5 | 3.3 | 41" |

Place: New York, U.S.A (41°N., 74°W.)
Altitude: 314 feet
Annual precipitation: 41 inches
Annual temperature range: 43°F. (74° – 31°F.)

Fig. 154 (a) Laurentian type of Climate in North America




| Peking | J | F | M | A | M | J | J | A | S | O | N | D | range / total |
|---|---|---|---|---|---|---|---|---|---|---|---|---|---|
| Temp. | 24 | 29 | 41 | 57 | 68 | 76 | 79 | 77 | 68 | 55 | 39 | 37 | 55°F |
| Precip. | 0.1 | 0.2 | 0.2 | 0.6 | 1.4 | 3.0 | 9.4 | 6.3 | 2.6 | 0.6 | 0.3 | 0.1 | 25" |

Place: Peking, North China (40°N., 116°E.)
Altitude: 131 feet
Annual precipitation: 25 inches
Annual temperature range: 55°F. (79° – 24°F.)

Fig. 154 (b) Laurentian type of climate in Asia

of climate between the North American region and the Asiatic region.

**The North American region.** The most remarkable characteristic of the Laurentian climate of the North American region is its uniformity in precipitation (about 3 to 4 inches monthly) with a late summer maximum. New York in Fig. 154(a) has an annual precipitation of 41 inches with the wettest months in July and August (4.2 inches each). No month is really dry, and the driest month, November, has 2.5 inches of rain. This uniformity of precipitation is largely due to the Atlantic influence and that of the Great Lakes. The warm Gulf Stream increases the moisture content of easterly winds from the open Atlantic. The prevailing Westerlies which penetrate across the Rockies carry depressions over the Great Lakes to the New England states. These winds thus promote wet conditions especially in winter, which are vital for the agricultural activites of north-eastern North America. The meeting of the warm Gulf Stream and the cold Labrador Current on coastal waters off Newfoundland produces dense mist and fog and gives rise to much precipitation. St. John's, its capital has as much as 54 inches of annual precipitation. It is said that Newfoundland experiences more drizzles than any other part of the world.

In summer the Westerlies bring less depressions and extend their continental influence to the coast. Temperatures are normally high in summer for the latitude. New York has a mean July temperature of 74°F. and sometimes even as high as 90°F. Once, on 7 August 1918, the absolute maximum of 104°F. was reached. Such high temperatures in a cool temperate maritime region, where the relative humidity is high, can be very trying. Prolonged heat waves cause discomfort and frustration in crowded cities. In winter, the temperature drops and snow falls. New York has two months below freezing-point, and an annual temperature range of 43°F. Away from the maritime influence, the cold increases. The mean January temperatures for Quebec, Ottawa and Montreal are 10°F., 12°F. and 14°F. respectively. The temperature ranges widen accordingly.

**The Asiatic region.** In contrast, the rainfall distribution of the Asiatic region is far less uniform. Winters are cold and very dry while summers are very warm and exceptionally wet. Peking, a typical station of the Laurentian Climate in northern China will bring out these facts very clearly. It has seven dry months from October to April with a total rainfall of less than 2.1 inches which is only one-twelfth of the annual total of 25 inches. The remaining five months receive more than an inch a month, with 9.4 inches in July alone. The rainfall regime, is, in fact, similar to that of the tropical

Japan - Plum rain (June) & Typhoon rain (Sept)

monsoon type in India, where the whole year's rainfall is concentrated in the three summer months. The mountainous interior of China has such pronounced continental effects that the intense heating in summer creates a region of extreme low pressure, and moisture-laden winds from the Pacific Ocean and the Sea of Japan blow in as the South-East Monsoon. The Laurentian type of climate here is often described as the Cool Temperate Monsoon Climate. It has a very long, cold winter, and a big annual range of temperature. The July mean for Peking is 79°F. while that of January is only 24°F. The temperature range is therefore more than 55°F. The dry, cold wind that blows out from the heart of Asia in winter carries fine, yellowish dust and deposits it as a thick mantle of loess in Shansi, Shensi and other neighbouring provinces at the bend of the Hwang Ho. Much of the winter precipitation in northern China, Korea and Hokkaido, Japan, is in the form of snow. In the mountainous districts, the snow piles to a depth of 5 to 10 feet.

The climate of Japan is modified by its insularity, and also by the meeting of warm and cold ocean currents. It receives adequate rainfall from both the South-East Monsoon in summer and the North-West Monsoon in winter. The latter is the dry, cold wind from mainland Asia, but after crossing the Sea of Japan it has gathered sufficient moisture to give heavy relief rain or snow on the western coasts of Japan. The rainfall is more evenly distributed, as in Tokyo, with two maxima, one in June, the Plum Rain (6.5 inches), and the other in September, the Typhoon Rain (9 inches). On the windward slopes of the Japanese Alps on the west, some stations, e.g. Kanazawa, have more than 102 inches of rain, much of it falling as snow. The maritime influence also effectively moderates the temperature range. Tokyo has a range of 40°F. (79°F. in August and 39°F. in January) with none of the months below freezing-point. The warm Kuroshio has played an important part in making the climate of Japan less extreme. In meeting the cold Oyashio from the north, it also produces fog and mist, making north Japan a 'second Newfoundland'. Fishing replaces agriculture as the main occupation in many of the idented coastlands.

## Natural Vegetation

The predominant vegetation of the Laurentian type of climate is cool temperate forest. The heavy rainfall, the warm summers and the damp air from fogs, all favour the growth of trees. Generally speaking, the forest tend to be coniferous north of the 50°N. parallel of latitude. The increase in the length and severity of the winter excludes forests that are not adaptable to cold conditions. In the Asiatic region (eastern Siberia and Korea), the coniferous forests are, in fact, a continuation of the great coniferous belt of the taiga. Lumbering has always been a major occupation of this sparsely populated part of eastern Asia and timber is a leading export item. Much of the original coniferous forests of fir, spruce and larch have been cleared as a result of lumbering rather than agriculture. Eastern Canada, along the banks of the St. Lawrence River is the heart of the Canadian timber and wood pulp industry.

South of latitude 50°N., the coniferous forests give way to deciduous forests. Oak, beech, maple and birch are the principal trees. Like their counterparts on the western margins, the deciduous forests are fairly open. A long growing season of over six months and an adequate supply of moisture from maritime sources encourage rapid growth of ferns and other temperate undergrowth. The occurrence of trees in almost pure stands, and the predominance of only a handful of species greatly enhance the commercial value of these forests. As a result, they have been extensively felled for the extraction of temperate hardwood. In many parts of Manchuria, Korea and Japan, the forests have made way for the plough. Both food and cash crops are raised. In Canada, due to the greater reserves of coniferous softwoods and their overriding importance in industrial uses, the annual production of deciduous hardwood is much less significant.

## Economic Development

Lumbering and its associated timber, paper and pulp industries are the most important economic undertaking. (Details of lumbering have already been dealt with in Chapter 22).

Agriculture is less important in view of the severity of the winter and its long duration. Fortunately the maritime influence and the heavy rainfall enable some hardy crops to be raised for local needs. Potatoes thrive over large areas of the podzolized soils, while hardy cereals like oats and barley can be sown and successfully harvested before the onset of the cold winter. A number of other interesting crops are produced in the Asiatic region such as soya beans (northern China, Manchuria and Korea are amongst the world's leading producers), groundnuts, sesame, rape seeds, tung oil and mulberry. In the North

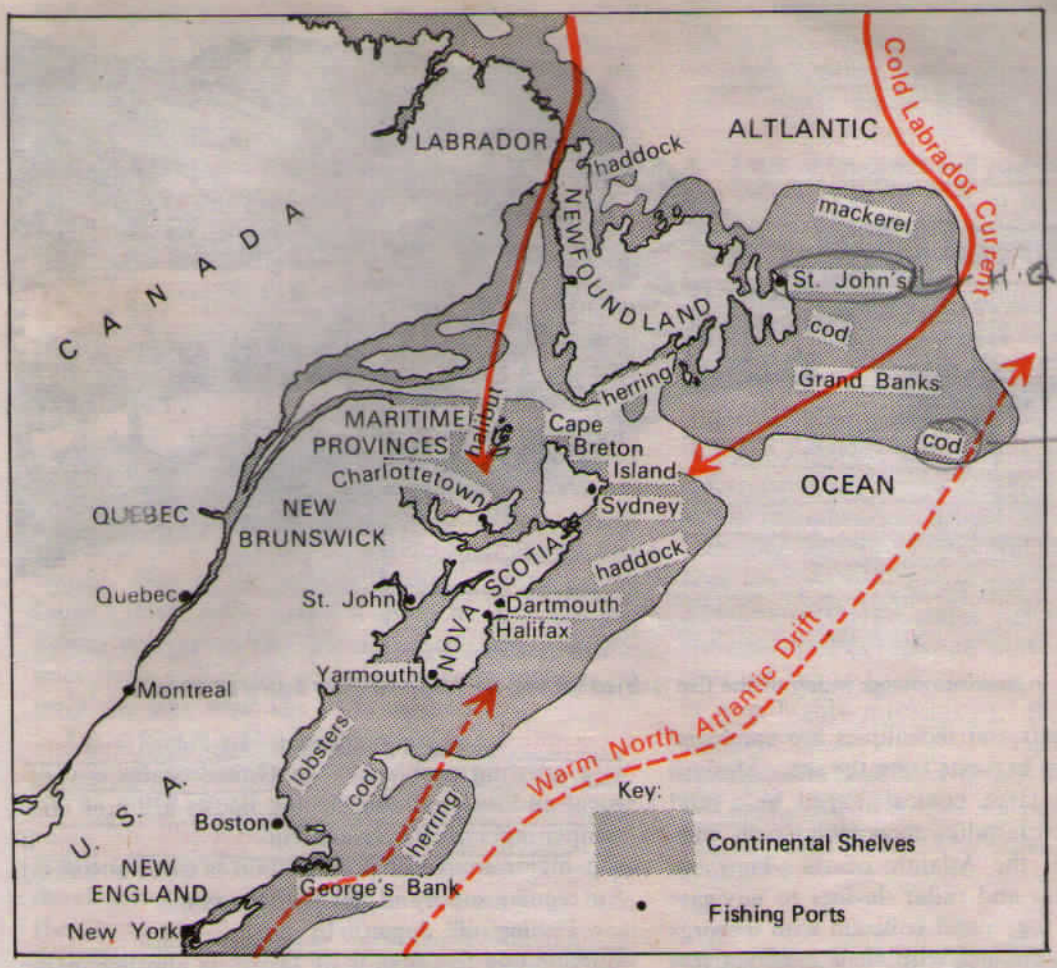



Fig. 155 Fishing: the North American region

American region, arable farming is not carried out on a sizable scale, except in the more favoured localities. Farmers are engaged in *dairy farming, hay cultivation* and, in mild maritime areas, *fruit growing*. The fertile Annapolis valley in Nova Scotia is the world's most renowned region for apples. Fishing is, however, the most outstanding economic activity of the Laurentian climatic regions.

## Fishing

### Fishing off Newfoundland, the Maritime Provinces and New England

This is one of the world's largest fishing grounds particularly on the Grand Banks of Newfoundland (Fig. 155). The reasons for its importance are geographical. Fish feed on minute marine organisms, collectively called plankton, which is present in abundance only in shallow waters adjacent to land masses, where sunlight can penetrate through. The gently sloping continental shelves (less than 600 feet deep) which stretch for over 200 miles south-east of Newfoundland, and off the coasts of the Maritime Provinces and New England contain a rich collection of microscopic plankton. Fish of all types and sizes feed and breed here and support a thriving fishing industry not only in Canada and U.S.A., but also in countries like Norway, France, Britain, Portugal, Denmark, Russia and Japan, who send fishing fleets to the Grand Banks.

As less than 1 per cent of Newfoundland is cultivated, fishing provides employment for almost the entire population. It is not only the chief source of wealth to Newfoundland, but also a major export item of all the Maritime Provinces. Both pelagic fish which live near the surface and demersal fish which live near the bottom of shallow seas are caught. The chief fish caught is *cod* which is consumed fresh or dried, salted, smoked, canned or packed in ice for export to mainland America, Central and South America and southern Europe. Cod liver oil is exported too. Other fishes caught are haddock, halibut, hake, herring, plaice, and mackerel. Various

A fishing settlement in Newfoundland. Much of the fish is dried for export *National Film Board of Canada*

kinds of fishing craft and techniques are employed to obtain maximum harvests from the sea. Modern trawlers, dragging large conical-shaped nets, and drifters, carrying curtain-like rectangular nets, operate extensively off the Atlantic coasts. They are equipped with radio and radar devices to navigate through the dense fog, avoid collision with icebergs and also maintain contact with their headquarters on land. Off-shore fishermen also use traps, lines and nets to catch crabs, lobsters and shrimps for home consumption and increasingly for export. Further inland, in lakes and rivers, such as the St. Lawrence and the Great Lakes, freshwater fish, e.g. salmon, trout, eels and sturgeons are caught.

In Newfoundland and along the Atlantic coasts are many fishing ports. St. John's, chief port of Newfoundland with a population of nearing 100,000, is the headquarters of the Grand Banks fishing industries. It also had interests in sealing and whaling but these have declined. In the fishing ports of Halifax and Yarmouth in Nova Scotia and in the New England ports are processing plants that cut, clean, salt, pack or preserve fish for disposal by refrigerated boats, trains or trucks to all parts of the continent. They are bases for large fleets of trawlers. A modern trawler may well cost anything around a million dollars and have men stay on board in floating factories far out at sea for days and even weeks. Fishing in this part of the world is highly specialized and very efficient. In fact over-fishing is a growing problem. The United States government and international fishing bodies are now contemplating strict measures in fish conservation if this major source of protein food is to be sustained for regular supply in the years to come.

**Fishing off Japan.** In the north-west Pacific, surrounding the islands of Japan, is another major fishing area of the world. Nowhere else in the world are there so many people engaged in fishing as in this part of the north-west Pacific. The mountainous nature of Japan and parts of mainland eastern Asia have driven many to seek a livelihood from the sea. The scarcity of meat (there is little pasture in Japan for livestock farming of any kind) and *religious reasons* have popularized fish as the principal item of diet and the chief protein food of the Japanese and the Chinese as well. Large quantities of fish and fish products are either canned or preserved for export to neighbouring countries. The Japanese also make use of fish wastes, fish meal and seaweeds as fertilizers in their farms. Japan is one of the few countries that has taken to seaweed cultivation. Coastal farms that are submerged in water grow weeds for sale as fertilizers, chemical ingredient and even as food.

Another interesting aspect of Japanese fishing is pearl culture. The divers of southern Japan dive down into the coastal waters and bring to the surface

shell-fish called pearl oysters and extract the highly prized *pearls* for sale as ornaments. The lining of the oyster shells, called *mother-of-pearl*, is used for the manufacture of pearl buttons, and other decorative articles. As natural pearls in oysters are difficult to obtain in large numbers, the Japanese have begun to breed the young oysters. By injecting tiny 'seeds' into them, the oysters are made to secrete the pearl material, which accumulates to form 'cultured pearls. These are collected and exported.

The Japanese interest in fishing is not confined to their own territorial waters, they venture far and wide into the Arctic, Antarctic and the Atlantic waters. Large whaling fleets complete with processing plants and experienced crews stay out in the open seas and return only occasionally for refuelling or replenishment of fresh provisions. As a nation, Japan accounts for a sixth of the world's total annual fish caught. She is the world's greatest fishing nation today. Her active participation in international fishing enterprises and her advanced fishing techniques speak well of her relentless drive to make good from the seas what she lacks on land.

Let us find out why this is possible.

1. Japan is not well endowed with natural resources, for as much as 80 per cent of her land is classed 'non-agricultural'. She has to take to the sea if she wants to survive. This has compelled the people to develop the seas, and fishing has for centuries been the traditional occupation of many coastal Japanese.
2. The continental shelves around the islands of Japan are rich in plankton, due to the meeting of the warm Kuroshio and the cold Oyashio currents and provide excellent breeding grounds for all kinds of fish including herring, cod, mackerel, bonito, salmon, sardine and tuna, as well as crabs and lobsters.
3. The indented coastline of Japan, provides sheltered fishing ports, calm waters and safe landing places, ideal for the fishing industry. In Hokkaido, where the Laurentian type of climate is too cold for active agriculture, fishing takes first place. Hakodate and Kushiro are large fishing ports, complete with refrigeration facilities.
4. Lack of lowlands and pastures means that only a few animals can be kept to supply meat and other protein food. *Fish*, in all its varied forms, fresh, canned, dried, frozen, and in the form of fish pastes, fish sauce and spiced condiments takes the place of meat as Japan's primary source of protein food. There is a great demand for it locally, and for export to other east Asiatic neighbours which lack the techniques of large scale commercial fishing.
5. The Japanese fishermen began with small fishing boats, using nets, traps and lines. With the progress made in industries, fishing has also become more scientific, aiming at heavy hauls, high returns and economy of *time, effort and money*. Though three-quarters of the fishermen practise off-shore pelagic fishing either full-time or part-time, in small boats, most of the commercial deep-sea demersal fishing is now highly mechanized. Powered trawlers and modern refrigeration plants backed by sound financial organizations have greatly increased the annual fish yield. Japan is now not only a major producer and exporter of fish and marine products, but also a centre for marine and fishing research.

A cultured pearl farm in Japan

## QUESTIONS AND EXERCISES

1. (a) Locate on a world map the extent of the Cool Temperate Eastern Margin (Laurentian) Climate.
   (b) Explain why this type of climate is confined to the northern hemisphere
   (c) Describe its climate.

2. Compare and contrast the climate of any *two* of the following pairs of areas.
   (a) Laurentian Climate in the North American region and the Asiatic region.
   (b) Tropical monsoon Climate of India and the Warm Temperate Eastern Margin (China type) Climate in S. China.
   (c) The Steppe type of climate in Eurasia and the Siberian type of climate in northern Canada.
   (d) The Tundra Climate of Greenland and Trade Wind Desert Climate of central Australia.

3. (a) Name the major fishing areas of the world.

(b) What types of fishing can normally be distinguished in such major fishing grounds?

(c) Name a few methods used to catch the fish.

(d) For any *one* major fishing area you have selected, explain the geographical factors which have contributed to its importance.

4. Write brief notes on any *three* of the following.

(a) The economy of the forests of the Laurentian regions.

(b) Fishing in Japan.

(c) Soya bean cultivation in Manchuria.

(d) Fruit growing in the Maritime Provinces of Canada.

5. The following statistics are a guide to four different types of climate in the northern hemisphere.

(a) Name the type of climate that each of them represents.

(b) Locate a probable station for each.

(c) For any *two* of them describe their climatic characteristics.

| Stations | July temp. | January temp. | Annual temp. range | Annual Rainfall | Month of max. rainfall |
|---|---|---|---|---|---|
| A | 81°F | 78°F. | 3°F | 96" | April and October |
| B | 55°F. | 12°F. | 43°F. | 8" | June, July, August |
| C | 91°F. | 56°F. | 35°F. | 3" | irregular |
| D | 74°F. | 30°F. | 44°F. | 41" | July, August, September |

# Chapter 25 The Arctic or Polar Climate

## Distribution

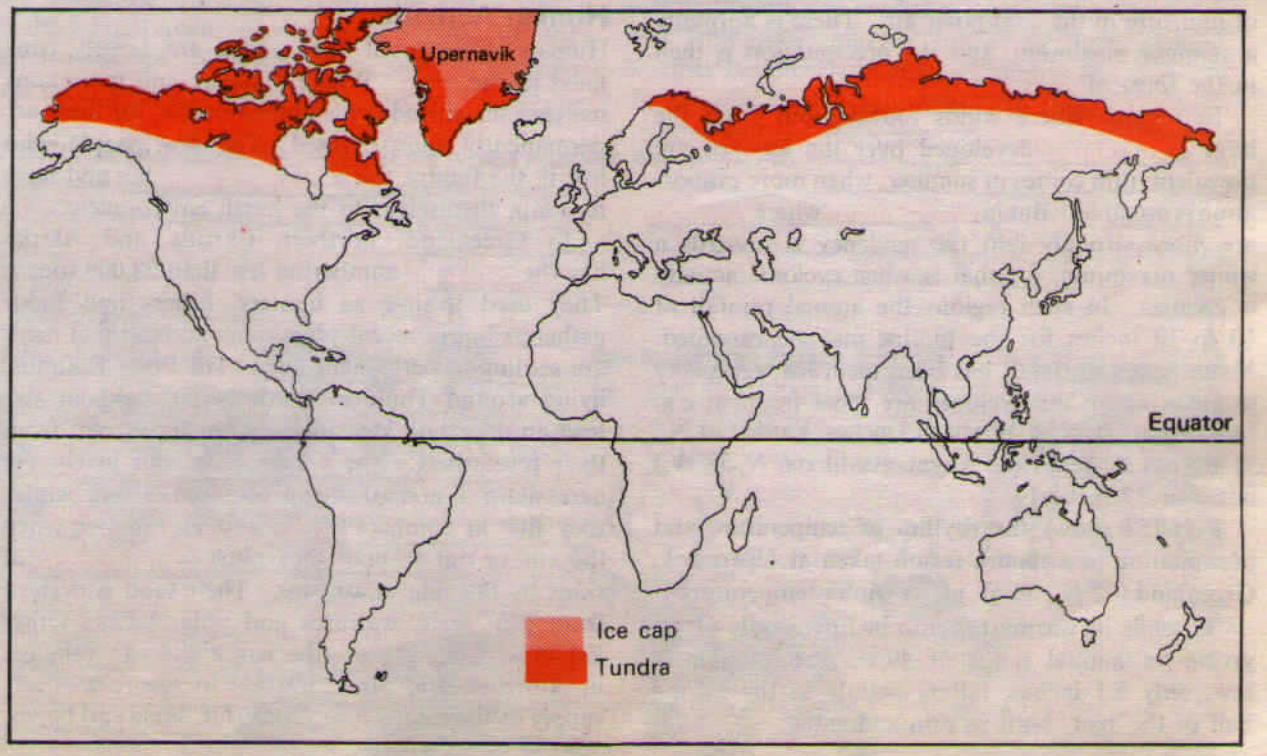
The polar type of climate and vegetation is found mainly north of the Arctic Circle in the northern hemisphere. The ice-caps are confined to Greenland and to the highlands of these high-latitude regions, where the ground is permanently snow-covered. The lowlands, with a few months ice-free, have tundra vegetation. They include the coastal strip of Greenland, the barren grounds of northern Canada and Alaska and the Arctic seaboard of Eurasia. (Fig. 156). In the southern hemisphere, the virtually uninhabited continent of Antarctica is the greatest single stretch of ice-cap where the layers of permanent ice are as thick as 10,000 feet.

## Climate

**Temperature.** The polar climate is characterized by a very low mean annual temperature and its warmest month in June seldom rises to more than 50°F. In mid-winter (January) temperatures are as low as −35°F. and much colder in the interior. Normally not more than four months have temperatures above freezing-point! Winters are long and very severe; summers are cool and brief. Within the Arctic and Antarctic Circles, there are weeks of continuous darkness. At the North Pole, there are six months without light in winter. Despite the long duration of sunshine in summer, when the sun does not set, temperatures remain low because the sun is low in the sky and much of the warmth of its faint rays is either reflected by the ground snow, or used up in melting the ice. It has little power left to raise the air temperature. Water in the soil is frozen to great depths and the summer heat can only thaw the upper six inches of the soil. The ground remains solidly frozen for all but four months, inaccessible to plants. Frost occurs at any time and blizzards, reaching a velocity of 130 miles an hour are not infrequent. They can be very hazardous for the polar inhabitants. In coastal districts, where warmer water meets cold land thick fogs may develop. They last for days, and in many instances it is not possible to see for more than a few feet.

**Precipitation.** Precipitation is mainly in the form of snow, falling in winter and being drifted about

Fig. 156 Ice Cap and Tundra



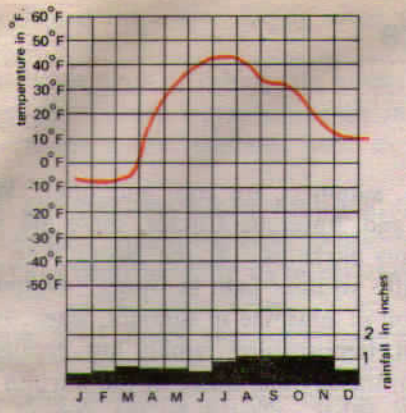



Fig. 157 Tundra type

| Upernavik | J | F | M | A | M | J | J | A | S | O | N | D | Range/Total |
|---|---|---|---|---|---|---|---|---|---|---|---|---|---|
| Temperature | -8 | -8 | -6 | 25 | 35 | 41 | 41 | 34 | 34 | 25 | 14 | 1 | 49°F |
| Precipitation | .4 | .5 | .7 | .7 | .6 | .5 | .8 | 1.1 | 1.1 | 1.1 | 1.1 | .5 | 9.1 ins. |

Fig. 157 Tundra Climate

**Place: Upernavik, Greenland (72°N., 56°W.)**
**Altitude: 65 feet**
**Total Annual precipitation: 9.1 inches**
**Annual temperature range: 49°F. (-8° -41°F.)**

during blizzards. Snowfall varies with locality; it may fall either as ice crystals or large, amalgamated snow flakes. As it takes 10–12 inches of snow to make 1 inch of rain, precipitation in polar regions can be expected to be light, not more than 12 inches in a year. Convectional rainfall is generally absent because of the low rate of evaporation and the lack of moisture in the cold polar air. There is normally a summer maximum, and the precipitation is then in the form of rain or sleet.

In regions where winds blowing out from the large anticyclones developed over the ice-caps are prevalent, rain comes in summer, when more evaporation is possible. But in coastal areas, where cyclones are more strongly felt, the tendency is towards a winter maximum, for that is when cyclonic activity is greatest. In such regions the annual rainfall of 10 to 12 inches for the tundra may be exceeded. Much heavier rainfall has been recorded, especially in areas where the cyclones are most frequent e.g. Jan Mayen (71°N., 8°W.) has 15 inches, Vardo (70°N., 31°E.) has 26 inches and Angmagssalik (66°N, 38°W.) has over 37 inches!

Fig. 157 shows the rhythm of temperature and precipitation of a tundra region taken at Upernavik, Greenland (72°N., 56°W.). Its winter temperature is -8°F. while its warmest month in July is only 41°F., giving an annual range of 49°F. Precipitation is low, only 9.1 inches, falling mainly in the second half of the year, both as rain and snow.

## Tundra vegetation

In such an adverse environment as the tundra, few plants survive. The greatest inhibiting factor is the region's deficiency in heat. With a growing season of less than three months and the warmest month not exceeding 50°F. (the tree-survival line), there are no trees in the tundra. Such an environment can support only the lowest form of vegetation, mosses, lichens and sedges. Drainage in the tundra is usually poor as the sub-soil is permanently frozen. Ponds and marshes and waterlogged areas are found in hollows.

In the more sheltered spots, stunted birches, dwarf willows and undersized alders struggle for a meagre existence. Climatic conditions along the coastal lowlands are a little more favourable. Here are found some hardy grasses and the *reindeer moss* which provide the only pasturage for the herbivorous animals like reindeer. In the brief summer, when the snows melt and the days are warmer and longer, berry-bearing bushes and Arctic flowers bloom. Though short-lived, they brighten the monotonous tundra landscape into 'Arctic prairies'. In the summer, the tundra is full of activities. Birds migrate north to prey on the numerous insects which emerge when the snow thaws. Mammals like the wolves, foxes, musk-ox, Arctic hare and lemmings also live in tundra regions.

## Human Activities

Human activities of the tundra are largely confined to the coast. Where plateaux and mountains increase the altitude, it is uninhabitable, for these are permanently snow-covered. The few people who live in the tundra live a semi-nomadic life and have to adapt themselves to the harsh environment.

In Greenland, northern Canada and Alaska live the Eskimos, numbering less than 28,000 today. They used to live as hunters, fishers and food-gatherers but in recent years more and more of them are settling in permanent huts. The Polar Eskimos, living around Thule in north-west Greenland still lead an uncertain life, not very much different from their forefathers. The seasonal changes in climate necessitate a nomadic way of life. During winter they live in compact igloos and in summer when they move out to hunt they pitch portable tents of skins by the side of streams. Their food is derived from fish, seals, walruses and polar bears. Other Eskimos hunt caribou (the name given to reindeer in America) and other animals to secure a steady supply of their daily meat, milk, fat, skins and bones.

In the last fifty years through their contact with the Europeans, the way of life of the Eskimos has undergone tremendous changes. Coastal villages have permanent wooden houses complete with modern facilities; speed-boats are replacing frail *kayaks*. Deadly rifles instead of traditional harpoons are used to track down animals and seals. Fur-bearing animals are being reared on a commercial scale and fishing, too, is being commercialized. In some more accessible parts of Canada and Alaska, schools have been established and the Eskimo children are being taught the skills which will allow them to fit into the modern way of life.

In the Eurasian tundra are other nomadic tribes such as the Lapps of northern Finland and Scandinavia, the Samoyeds of Siberia (from the Ural Mountains and the Yenisey basin), the Yakuts from the Lena basin, and the Koryaks and Chuckchi of north-eastern Asia. They wander with their herds of reindeer across the Eurasian tundra where there are pastures. Many of them have taken to a more settled life. In the U.S.S.R. large farms have been established for raising reindeer and for breeding fur-bearing animals.

## The Importance and Recent Development of the Arctic Region

The Arctic region, once regarded as completely useless, is now of some economic importance. Apart from the efforts of the various governments in assisting the advancement of the Arctic inhabitants the Eskimos, Lapps, Samoyeds etc., new settlements have sprung up because of the discovery of minerals. Gold is mined in Alaska, nickel near Petsamo, U.S.S.R., petroleum in the Kenai Peninsula, Alaska, and copper at the Rankin Inlet, Canada. Coal has been mined in Spitsbergen for a long time and also in Alaska. With the declining reserves of iron ore around Lake Superior, the Great Lakes industrial concerns are using more and more iron from large iron ore deposits in Labrador. New railway lines have been constructed to bring the ores to the St. Lawrence River for subsequent shipment to the major industrial districts. Rich deposits of iron ores at Kiruna and Gallivare in Sweden have made it possible for Sweden to enjoy a prosperous export trade in iron and steel and other metallurgical products.

With the establishment of ports on the Arctic seaboard of Eurasia, it is now possible to ship timber and fur from Siberia. Though the ports, such as Igarka at the mouth of the Yenisey, are not ice-free, modern ice-breakers keep the passage open most of the time. On the Arctic lowlands where the growing season is lengthened by warm currents or higher temperatures, experiments have been carried out to devise varieties of hardy cereals for local needs. It may not be long before the tundra is brought under greater agricultural, especially pastoral, use. The healthy air and its preservative qualities (it is practically germ-free) are factors worth consideration for future colonization. Scientists, meteorologists and explorers have lived in the Arctic and Antarctica, making studies of their geology, weather conditions, plant and animal life, that will be of great significance in years to come.

The borderlands between the Taiga and the tundra *Elizabeth Meyer*

## QUESTIONS AND EXERCISES

1. Draw separate sketch maps to show the area covered by each of the following:
   (a) tundra in Eurasia
   (b) savanna in South America
   (c) hot desert in Australia
   (d) equatorial forest in Africa

   For any *three* of them describe their characteristic features of natural vegetation and for any one of them explain how the features are related to the climate of the area.

2. Statistics of rainfall and temperature for three towns are given below. For any *two* of them.
   (a) State their season of maximum rainfall
   (b) Name the type of climate
   (c) Suggest a possible location of the town
   (d) Describe their climatic rhythm.

| Town A | Altitude: 207 feet | | | | | | | | | | | | Range/ Total |
|---|---|---|---|---|---|---|---|---|---|---|---|---|---|
| | J | F | M | A | M | J | J | A | S | O | N | D | |
| Temp. °F. | 47 | 49 | 51 | 57 | 64 | 71 | 76 | 76 | 70 | 62 | 53 | 46 | 30 |
| Rainfall in ins. | 3.2 | 2.7 | 2.9 | 2.6 | 2.2 | 1.6 | 0.7 | 1.0 | 2.5 | 5.0 | 4.4 | 3.9 | 32.7 |
| Town B | Altitude: 65 feet | | | | | | | | | | | | |
| Temp °F. | –8 | –9 | –6 | 25 | 35 | 41 | 41 | 34 | 34 | 25 | 14 | 10 | 49 |
| Rainfall in ins. | 0.4 | 0.5 | 0.7 | 0.6 | 0.6 | 0.5 | 0.9 | 0.1 | 1.1 | 1.1 | 1.1 | 0.5 | 9 1 |
| Town C | Altitude: 9,350 feet | | | | | | | | | | | | |
| Temp. °F. | 55 | 55 | 55 | 55 | 55 | 55 | 55 | 55 | 55 | 55 | 55 | 54 | 1.0 |
| Rainfall in ins. | 3.2 | 3.9 | 4.8 | 7.0 | 4.6 | 1.5 | 1.1 | 2.2 | 2.6 | 3.9 | 4.0 | 3.6 | 42.3 |

3. The following are representative of plants found in different climatic zones:
   spruce, olive, teak, reindeer moss, date, oak, eucalyptus and bamboo.

   For any *six* of them
   (a) Name the type of climate in which each of them thrives.
   (b) State the sort of natural vegetation with which they are associated.
   (c) Describe very briefly the role each of them plays in the economy of a named country in which they are found in abundance.

4. Explain briefly any *four* of the following terms connected with the Arctic climate and the tundra vegetation:
   blizzards, permafrost, midnight sun, ice-cap, snow-blindness, kayaks, international deep-freeze.

5. Make a comparative study of the Polar Eskimos of Greenland and the Orang Asli (e.g. Senois) under the following headings.
   (a) How they obtain their food.
   (b) How they shelter themselves.
   (c) What significant changes have taken place in their environment and their way of life.

## SELECTED QUESTIONS FROM CAMBRIDGE OVERSEAS SCHOOL CERTIFICATE PAPERS

1. (a) With the aid of sketch maps to show *one* major region where each type is found, describe the main features of vegetation of tropical grassland (savanna) and coniferous forest.
   (b) For *either* tropical grassland (savanna) *or* coniferous forest, show how the main features of the vegetation are influenced by climate. (1966)
2. Answer *either* (a) *or* (b).
   (a) With the help of examples, show how the present distribution of tropical forests has been influenced by:
      i. climate.
      ii. the work of man.
   (b) i. Why is the coniferous forest only found in some parts of the world?
      ii. Name *four* types of coniferous trees.
      iii. What are the chief uses of the timber obtained from coniferous forests? (1965)
3. With the aid of separate sketch maps, locate examples *two* of the following:
      i. A region of savanna.
      ii. A region of coniferous forest.
      iii. A region of tropical desert scrubland.

For each of the *two* you have chosen, describe the chief features of the vegetation and show how they are related to the geographical characteristics of the region. (1962)

4. With the aid of sketch maps locate examples of *two* of the following:
   (a) An evergreen forest in a hot region.
   (b) A deciduous temperate forest.
   (c) A region of tundra.

For each *one* you choose, describe the chief features of the vegetation and show how these are related to the climate of the area. (1961)

5. (a) Draw a sketch map of *one* major land area, which extends in latitude from the equator to at least 35° North or 35° South. On the sketch map, mark distinctively and name *three* major areas of different natural vegetation.
   (b) Describe the important features of the natural vegetation in the areas marked on the sketch map. (1960)

6. Mean Monthly Rainfall in Inches

| Town | Lat. | Long. | J | F | M | A | M | J | J | A | S | O | N | D | Total |
|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|
| **Darwin** | 12°S. | 131°E. | 15.2 | 12.3 | 10.0 | 3.8 | 0.6 | 0.1 | 0.0 | 0.2 | 0.5 | 2.0 | 4.7 | 9.4 | 58.7 |
| **Adelaide** | 35°S. | 138°E. | 0.8 | 0.7 | 1.0 | 1.8 | 2.7 | 3.0 | 2.6 | 2.6 | 2.1 | 1.7 | 1.1 | 1.0 | 21.1 |
| **Alice Springs** | 23°S. | 133°E. | 1.7 | 1.3 | 1.1 | 0.4 | 0.6 | 0.5 | 0.3 | 0.3 | 0.3 | 0.3 | 1.2 | 1.5 | 9.9 |

For each town:
   (a) Describe briefly the main features of its rainfall.
   (b) Suggest reasons for the amount and distribution of the rainfall. (1967)

7. Records of temperature and rainfall for *three* towns are given below. For each:
   (a) write a description of the temperature and rainfall.
   (b) name the type of climate, give reasons for your answer.
   (c) locate *one* area in the world where this type of climate occurs. (1963)

A. (Altitude 9,350 ft.)

| | J | F | M | A | M | J | J | A | S | O | N | D |
|---|---|---|---|---|---|---|---|---|---|---|---|---|
| Temp. (°F.) | 55 | 55 | 55 | 55 | 55 | 55 | 55 | 55 | 55 | 55 | 54 | 55 |
| Rainfall (in.) | 3.2 | 3.9 | 4.8 | 7.0 | 4.6 | 1.5 | 1.1 | 2.2 | 2.6 | 3.9 | 4.0 | 3.6 |

B. (Altitude 30 ft.)

| | | | | | | | | | | | | |
|---|---|---|---|---|---|---|---|---|---|---|---|---|
| Temp. (°F.) | 44 | 44 | 45 | 48 | 52 | 57 | 59 | 59 | 57 | 52 | 48 | 46 |
| Rainfall (in.) | 5.5 | 5.2 | 4.5 | 3.7 | 3.2 | 3.2 | 3.8 | 4.8 | 4.1 | 5.6 | 5.5 | 6.6 |

C. (Altitude 30 ft.)

| | | | | | | | | | | | | |
|---|---|---|---|---|---|---|---|---|---|---|---|---|
| Temp. (°F.) | 78 | 79 | 81 | 84 | 88 | 92 | 95 | 94 | 92 | 89 | 86 | 81 |
| Rainfall (in.) | 1.5 | 0.6 | 0.6 | 0.8 | 0.0 | 0.0 | 0.0 | 0.0 | 0.0 | 0.3 | 0.7 | 1.4 |

8. The following are brief descriptions of *three* different types of climate:
   i. A very large temperature range, with light summer rainfall.
   ii. Mild winters, hot summers, with heavy summer rainfall.
   iii. High uniform temperatures with heavy rain all the year.

For any *two* of them:
   (a) Name the type of climate
   (b) Give a fuller description of the climate and the factors which give rise to it. (1962)

9. Write an explanatory account of the climate of *two* of the following areas:
   (a) the coastlands of northern Australia.
   (b) the Prairies of Canada.
   (c) the coastal area of Norway.
   (d) Peninsular Italy. (1961)