# GEOGRAPHY

## STANDARD ELEVEN

The Coordination Committee formed by GR No. Abhyas - 2116/(Pra.Kra.43/16) SD - 4 Dated 25.4.2016 has given approval to prescribe this textbook in its meeting held on 20.6.2019 and it has been decided to implement it from academic year 2019-20.

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# The Constitution of India

## Preamble

WE, THE PEOPLE OF INDIA, having solemnly resolved to constitute India into a SOVEREIGN SOCIALIST SECULAR DEMOCRATIC REPUBLIC and to secure to all its citizens:

JUSTICE, social, economic and political;

LIBERTY of thought, expression, belief, faith and worship;

EQUALITY of status and of opportunity; and to promote among them all

FRATERNITY assuring the dignity of the individual and the unity and integrity of the Nation;

IN OUR CONSTITUENT ASSEMBLY this twenty-sixth day of November, 1949, do HEREBY ADOPT, ENACT AND GIVE TO OURSELVES THIS CONSTITUTION.

## NATIONAL ANTHEM

Jana-gana-mana-adhināyaka jaya hē
Bhārata-bhāgya-vidhātā,

Panjāba-Sindhu-Gujarāta-Marāthā
Drāvida-Utkala-Banga

Vindhya-Himāchala-Yamunā-Gangā
uchchala-jaladhi-taranga

Tava subha nāmē jāgē, tava subha āsisa māgē,
gāhē tava jaya-gāthā,

Jana-gana-mangala-dāyaka jaya hē
Bhārata-bhāgya-vidhātā,

Jaya hē, Jaya hē, Jaya hē,
Jaya jaya jaya, jaya hē.

## PLEDGE

India is my country. All Indians are my brothers and sisters.

I love my country, and I am proud of its rich and varied heritage. I shall always strive to be worthy of it.

I shall give my parents, teachers and all elders respect, and treat everyone with courtesy.

To my country and my people, I pledge my devotion. In their well-being and prosperity alone lies my happiness.

# Preface

Dear Students,

You are welcome to Class XI. You have studied various concepts in Geography under Environmental Studies from Class 3 to Class 5 and in Social Studies from Class 6 to Class 10. Like other subjects, it gives me a great pleasure to present before you a separate textbook of Geography for 100 marks.

Broadly, it is accepted that Geography is the study of structure, processes and interactions between physical and human environment. Hence, the importance of the study of Physical Geography becomes imperative. At the Higher Secondary level, Physical geography has been included in Class XI textbook. We see that various physical factors are distributed in different parts of the earth. We see that this distribution is uneven and full of diversity. We also gain knowledge about specific patterns, describing and analysing them, scientific analysis and projecting about future. We have tried to bring integrity into the chapters by including the recent changes and their importance. It is very important to understand the cause–and-effect relationship when you study the components of the chapter. We have brought changes in Practical Geography according to contemporary times. This will help you get acquainted with the latest technology.

It is said that Geography is the science that lays stress on observation. Observation, cognition, critical thinking, analysis, etc are the skills required in this subject. Use these skills and develop them. Activities which stimulate your thinking power, imaginative power and creativity have been included in the textbook. Various educational tools have been used in the textbook to facilitate understanding of the concepts in the textbook. Through QR codes you can study more relevant information related to the components of the textbook. You can use the websites for this purpose.

You will surely like the textbook which associates with your daily life. Please let us know your views about it.

Best wishes to all of you!

(Dr Sunil Magar)
**Director**
Maharashtra State Bureau of Textbook
Production and Curriculum Research, Pune

**Pune**
**Date :** 20 June 2019
**Indian Solar Year :** 30 Jyaishtha, 1941

# Standard Eleven Geography

## Competencies

- Understanding why landforms on the earth keep changing
- Explaining the effects of Earth movements
- Explaining the specific areas on the global scale where earth movements occur
- Understanding the importance and processes of weathering and its types
- Describing the effects of weathering and erosional processes on the earth's surface
- Explaining the changes occurring on the earth's surface due to geological processes and human interference.
- Identifying the agents responsible for the formation of various landforms
- Explaining the process of landform formation
- Explaining the effect of various factors on processes of landform formation processes
- Identifying the landforms found in their surroundings and explaining their formation
- Understanding the relationship between climate and human life
- Understanding the basis of classification of various climatic regions
- Understanding various climatic regions in the world.
- Describing the co-relation between latitudes and climate.
- Understanding the reasons behind the global climate change
- Examining the role of humans in climate change
- Explaining the effects of global climate change
- Understanding the measures taken by India in facing climate change.
- Understanding the bottom relief of the Indian Ocean
- Examining the economic, political and strategic importance of Indian Ocean
- Examining the importance of Indian Ocean with India's context
- Explaining the importance of oceans in human life
- Understanding that in future we may have to solely depend on oceans
- Explaining the measures of reducing marine pollution
- Understanding the relationship between the species of flora and fauna and the geographical factors
- Estimating the animal and plant life on the basis of the climate of a region
- Understanding the importance of biomes and suggesting measures to conserve them.
- Understanding how disasters can be faced and responded
- Examining the roles of self, communities and administration during natural disasters.
- Understanding the importance of technology in disaster management

## Competencies (Practical)

- Understanding the importance of various isolines and the data they represent.
- Drawing isolines in between the given values
- Interpretation of isolines on the basis of the given data e.g. contours, isotherms, etc.
- Drawing a cross profile with the help of given contours in a toposheet
- Identifying landforms with the help of given contours
- Being able to interpret the toposheets with reference to its components.
- Interpreting the toposheets and drawing conclusions
- Understanding the symbols given on IMD weather maps and the various elements of weather.
- Interpreting the weather maps of various seasons and predicting the weather conditions.
- Geographically locating a place with the help of GPS
- Calculating area of a place with the help of GPS instrument
- Making a map of an area with the help of GPS
- Understanding the importance and applications of GPS in various fields.
- Experiencing various geographical factors in reality

# - For Teachers -

- ✓ To begin with, get familiar with the textbook yourself.
- ✓ Please understand the characteristics of the textbook carefully for the teaching-learning process.
- ✓ Please plan carefully and independently for the activities in each chapter. Please do not teach without planning.
- ✓ Participation of all students is very necessary in the teaching-learning interactions and processes.
- ✓ Please use the geographical teaching aids in the school as required for the appropriate understanding of the subject. It is necessary to use the globe, the maps of the World, India and the State, atlases, etc.
- ✓ The number of periods required for each chapter has been given a thought. Abstract concepts are difficult to follow and therefore you are expected to use the given number of periods fully. Do not finish the chapter in short. This will help the students to assimilate the content without feeling the 'burden of learning'.
- ✓ The chapters in the present book has been prepared for constructivist and activity-based teaching. Please do not teach the lessons in the book by just reading them aloud.
- ✓ Follow the order of the chapters as given in the contents because the concepts have been introduced in a graded manner to facilitate knowledge-building.
- ✓ Please refer to textbooks of earlier classes before teaching this textbook.
- ✓ Like other social sciences, geographical concepts too are not easy to understand. Major concepts of geography have a scientific base and they deal with abstractions. Encourage group work, learning through each other's help, etc. Facilitate peer learning as much as possible by reorganizing the class structure frequently.
- ✓ Do not ask questions on statistical information. Instead, ask questions on their trends or patterns.
- ✓ Do not use the boxes titled 'Do you know?' for evaluation.
- ✓ It is necessary to access supplementary material wherever specific website or use of Internet is indicated. Use QR Code given in the textbook. You as well as the students are expected to use these references. These references will surely help you to go beyond the textbook. Please bear in mind that extra reading is always helpful for understanding any subject in depth.
- ✓ Use thought-provoking, activity-oriented, open-ended, multiple choice questions for evaluation. Some examples are given at the end of the chapters in the 'exercises'. They follow the question paper pattern but not in the obvious sequence.
- ✓ It is compulsory to teach one example in a practical and get another one done from the students.
- ✓ Practical no. 12 to 15 should be carried out according to local conditions/availability.

# CONTENTS





**Front Cover and Back Cover :** A concept drawing of different physical features shown on the Earth's surface.

**Photo credits :** Miss Aalisha Jadhav and https://www.wired.com/story/forget-space-oceans-need-exploring/

# 1. Earth Movements

**Let's recall.**

Observe the following pictures in figure 1.1 and discuss the questions in the class.


**Fig. 1.1**

1) What might be the reasons behind buildings collapsing in photo 1?
2) Which event is depicted in photo 2 ? What impact does it bring about in the surroundings?
3) In photo 3, what could be the reason behind the bend in the rock strata?
4) What could be the reason behind the difference in altitudes of the land and the steepness of the slope in photo 4?
5) Classify the events in the photos into sudden and slow movements.
6) Example of which of these movements is not likely to be found in the mainland of the Indian sub-continent?

## Geographical explanation

Hills, mountains, plateaus, valleys, etc. are the landforms we see on the earth's surface. They have been developed and shaped by the internal and external forces. The internal processes are classified into slow movements and sudden movements.

The earth's surface changes slowly but continuously. These changes occur due to forces such as tension and compression. The internal processes cannot be observed. However, their effects may be seen on the surface. Formation of mountains and distribution of continents are related to slow movements. There are also sudden processes that operate within the crustal part. Their effects can be noticed on the

surface within a few seconds or hours. Earthquake and volcanoes are sudden movements.

### Evidences of Earth Movements :

The landforms are never permanent in nature. They tend to change. There are evidences to indicate that the earth movements have taken place in the past and have affected the surface of the Earth. Some of them are:

a) After the Great Tsunami of 2004, the coast around Sumatra island rose by few centimetres.

b) The formation of three ranges in the Himalayas : the Siwaliks, the Middle Himalayas and the Greater Himalayas.

c) There is a report that says that due to volcanic eruption near Iceland an island appeared above the sea surface in November 1963. This event was witnessed by some sailors who were passing by the area.

d) Some islands such as the Megapode Island were reported to have been lost after the tsunami.

e) To the south east coast of Mumbai, near Mazgaon Dockyard, there are evidences of forest-covered land getting drowned. Even today, trunks of those trees can be found at some depth.

**Do you know?**

The Kachchh earthquake of June 16, 1819 submerged the coastal areas. This inflicted great damage to ships and country –made boats of the fishermen. The fort of Sindree on the sea coast was completely submerged except a single turret which remained above the water level. The land measuring around 1550 sq.km in area was raised upward because of this earthquake. This raised land is known as “Allah’s Bund”.

### Slow Movements :

It is important to understand that in reality, these processes are very complex and interrelated. The Earth’s movements which are the result of internal forces are known as tectonic movements.

Based on the direction of these movements, they are classified as vertical and horizontal movements.

**1) Vertical (Epeirogenic) Movements :** Due to the forces in the interior of the earth and the travel of energy, these movements occur.

Slow movements keep on taking place either towards the centre of the earth or away from it towards the crust. Due to such movements, an extensive portion of the crust is either raised up or it subsides. When a portion of the crust is raised up above sea-level, it leads to the formation of continents. Hence such movements are also called continent-building movements. Such movement can also cause formation of extensive plateaus. Though these movement are slow they influence huge area. These movements are not related to development of tensions or pressure in the earth crust.

**2) Horizontal (Orogenic) Movements :** These movements work in horizontal direction. As per the direction, these movements produce compression or tension in the rock strata. These movements lead to either folds or cracks in the surface of the earth. These movement gives rise to mountains. These movements are also slow movements. But their speed is more than the continental-building movements. And their extent is also lesser. These movements produce either folds or faults. Consequently, either fold mountains or block mountains are formed. They are also called mountain-building processes. These forces are further divided into two types :

a) **Tensional Forces :** When the forces move away from each other and cause stress in the rock strata. See fig 1.2. This process creates ruptures, cracks, fractures and faults in the rock strata. This leads to crustal fracture

and the formation of faults. Rift valleys or block mountains are formed as a result of these forces.

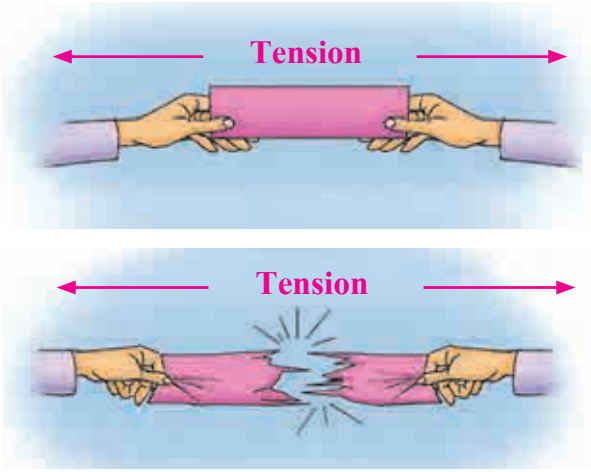


Fig. 1.2 : Tensional Forces

b) **Compressional Forces :** When the forces operate towards each other, they cause compression and hence are called as converging or compressional forces. See fig. 1.3. These movements cause various types of folding. These forces cause pressure on the layer of rocks. These lead to folding and faulting of the surface.

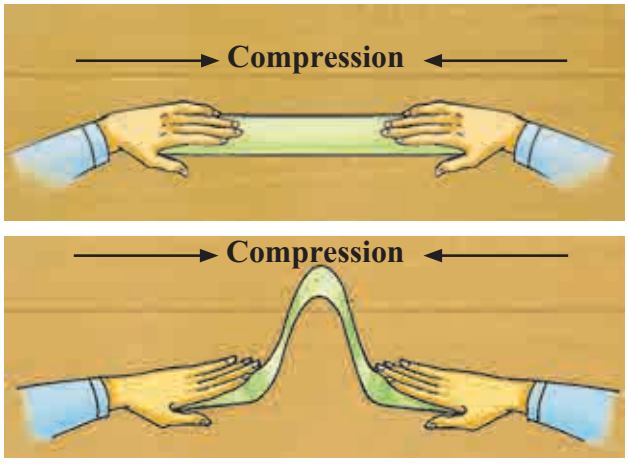


Fig. 1.3 : Compressional forces

**Folding :**

The nature of folding that occurs on the earth's surface depends on many factors. These include the nature of rocks, intensity and duration of force.

Soft and elastic rocks are affected more by these forces. When energy waves move through the layers of rocks on a large scale, folds are formed. Folding results into formation of fold mountains. For example, Himalayas, Alps, Rockies, Andes, etc. Compressional forces push two portions of crustal rocks together and tend to shorten and thicken the crust. The affected rocks react to compressional forces depending on the strength of the rocks and the speed of the forces.

Folding occurs when compressional forces are applied to rocks that are ductile or flexible. Rocks that lie deep within the crust and are therefore under high pressure are generally ductile and particularly susceptible to folding without breaking. As a result rocks deep within the crust typically fold rather than break. Folding is also likely to occur where compressional forces are applied slowly.

**Think about it.**

How will compressional forces affect brittle rocks?

**Parts of fold :** Folds develop in earth's crust. Both sides of a fold are called limbs. The axial plane divides a fold into two parts. The axis may be vertical, inclined or horizontal. A fold has two limbs.

As and when limbs slope downward with central portion getting raised up, it is called anticline. As against this, if limbs slope towards each other and the central part located at lower elevation, it is called synclines. See fig. 1.4.

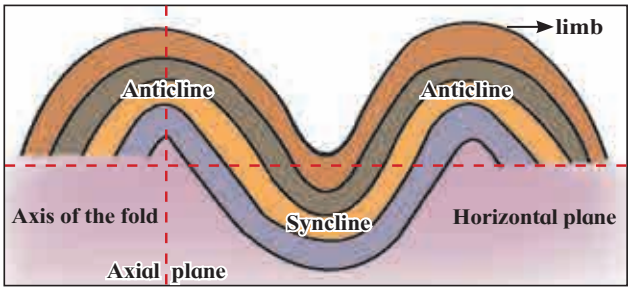


Fig. 1.4 : Parts of fold

**Fold Mountains :** Folding leads to development of fold mountains. e.g. the Himalayas, the Alps, etc.

They are classified as follows depending on their age. i.e.

1) Old fold mountains (over 200 million years of age, e.g. the Aravalis in India (Highest peak-1722m AMSL), the Urals in Russia and the Appalachians in USA.
2) Young fold mountains (10 to 25 million years of age, e.g. the Rockies and the Himalayas). The highest peak Mt. Everest 8848m AMSL.

**Think about it.**

'A mountain never remains a mountain'. Can you relate this idiom with the mountain building process?

## Types of Folds :

**Try this.**

Observe the following diagrams in fig. 1.5. Try to understand the different types of fold shown in the diagram and match it with its characteristics. Write the name of the fold in the space given below.

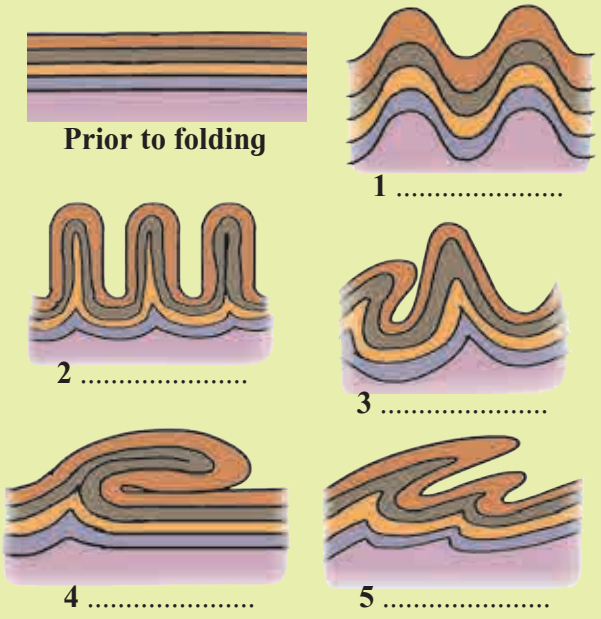


**Fig. 1.5 : Types of folds**

**A) Symmetrical :**

i) The axial plane is vertical.

ii) Limbs are inclined at same angle.

**B) Asymmetrical :**

i) The axial plane is inclined.

ii) The limbs are inclined at different angles.

**C) Overturned :**

i) One limb lies above the other limb.

ii) Limbs slope unequally in the same direction.

**D) Recumbent :**

i) Axial plane is almost horizontal.

ii) One limb lies over the other in horizontal direction.

**E) Isoclinal :**

i) The limbs slope in the same direction with same amount.

ii) The axial plane may be vertical, inclined or horizontal.

iii) Slope of some portion of limbs is near vertical.

## Faulting :

In the earth's crust, the forces operating in opposite direction lead to tension. As a result, rocks develop cracks or fissures. In the regions where cracks developed rocks get displaced such displacement can occur in upward, downward or horizontal direction. Faulting can be classified according to displacement in rocks. Rock layers that are near the Earth's surface and not under high confining pressures are too rigid to bend into folds. If the tectonic force is large enough, these rocks will break rather than bend. Such breaks may also be called fractures, ruptures or faults. Also the rock masses will move relative to each other along the fracture i.e. the zone where they break.

One part of the rock strata moves along the plane of fracture upwards or downward relative to the other parts. The plane of fracture is called fault. Faulting results in the formation of block mountains and rift valleys.

## Types of faults :

**Try this.**

Observe the diagrams in fig. 1.6 and read the explanation regarding the characteristics of various faults given below. Identify the faults and match each of them with their characteristics.

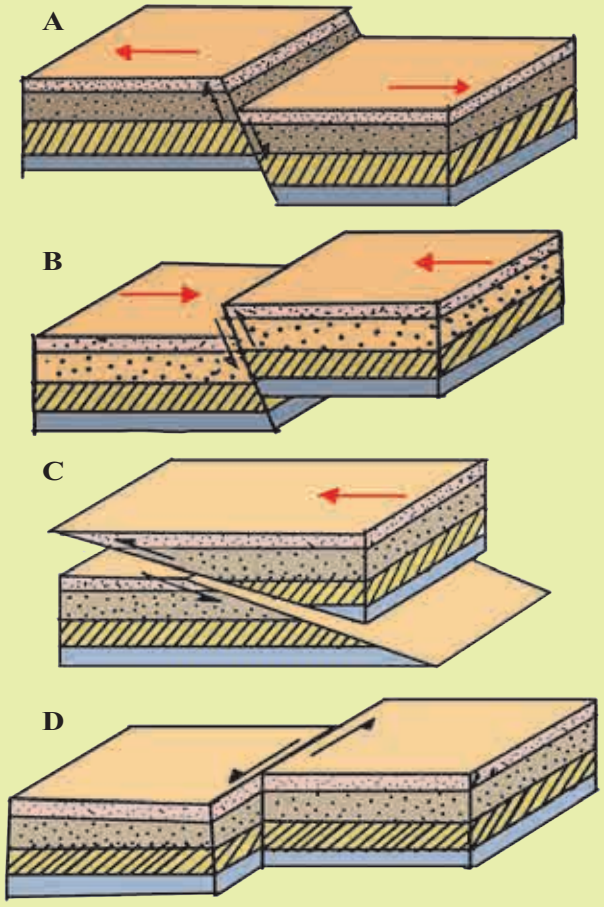


**Fig. 1.6 : Types of faults**

**A) Normal fault :** It results when a portion of land slides down along the fault plane and when the exposed portion of the plane faces the sky.

**B) Reverse fault :** It results when a portion of the land is thrown upward relative to other side of the land. In such situation, the fault plane faces the ground.

**C) Tear fault :** At times, the rock strata on either sides of the fault plane do not have vertical displacement. Instead movement occurs along the plane in horizontal direction.

**D) Thrust fault :** When the portion of the land on one side of the fault plane gets detached and moves over land on the other side. The angle of fault plane is generally low-less than 45°.

**Block Mountain :** Earth movements generate tensional forces that tend to pull the crust apart and faults are developed. If the block enclosed by the faults rises above or the land on either side subsides, the upstanding portion becomes the horst or block mountain. The faulted edges are very steep and the top portion is almost leveled. Generally the block mountain does not have a peak but a flat top. See fig 1.7. For example, the Vosges in France, the Black Forest Mountain in Germany, the Satpuras in Maharashtra and the Meghalaya Plateau in India are examples of block mountains.

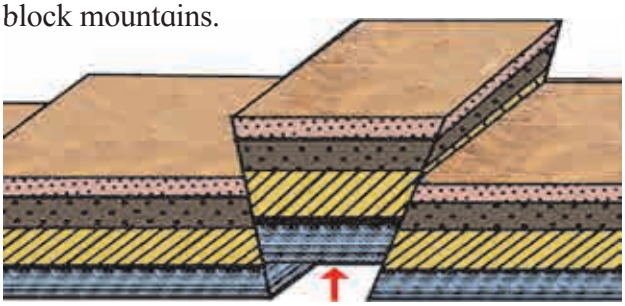

**Fig. 1.7 : Block mountain**

**Rift Valley :** The tension may also cause subsidence in the central portion of the crust between two adjacent faults, forming graben or rift valleys. These have steep walls. Their walls are formed by fault planes. In most of the cases these walls of the rift valley face the sky. The African Rift Valley is an example of this type of landform. In India, valleys of the Narmada and the Tapi are well known examples of rift valley. See fig. 1.8.

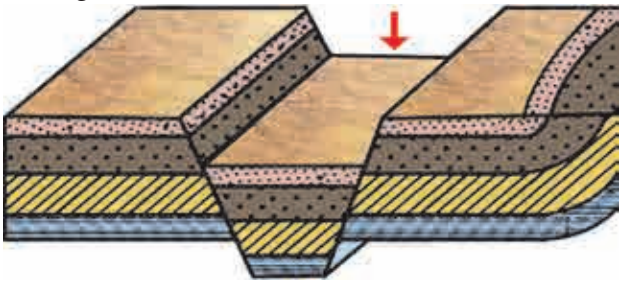

**Fig. 1.8 : Rift valley**

**Think about it.**

1) When can faults form in fold mountains?
2) Can folds form in block mountains? Find the reasons and discuss.

## Sudden Movements :

Beside the folding and faulting movements responsible for the formation of fold mountains and block mountain respectively, there are other movements in the earth's crust. Due to some internal forces at times, movements occur suddenly. Earthquake and volcanic eruptions are the types of these movements which are episodic in nature.

**Let's recall.**

On 19th August, 2018, around 300 people died in Indonesia. Many buildings collapsed. Many roads broke apart. A tsunami was generated.

a) What was the cause behind these events?
b) What actually happened during this natural event?
c) Name the energy waves involved in this natural event.
d) Observe the diagram in figure 1.9 and label the boxes.

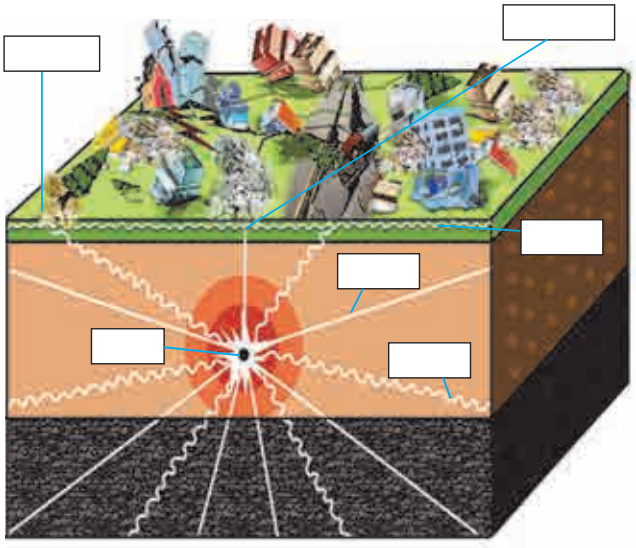

Fig. 1.9 : Earthquake

## Earthquake :

Earthquake refers to shaking of the ground. Movements occurring in the crust of the earth produce a lot of stress in the rock strata. When this stress accumulates beyond a limit, it tends to get released in the crust. Release of stress causes release of energy. Here, release of energy produces energy waves. This makes the earth's crust to shake. This is called an earthquake.

The point where the accumulated stress gets released within the earth crust is called seismic focus. A point directly above it, on the surface, is called an epicentre. The intensity of the shock is maximum at the epicentre and decreases with increasing distance from the epicentre in all directions. The earthquake waves are recorded by an instrument called seismograph.

**Think about it.**

Look at fig. 1.10. During an earthquake, do you think the seismic waves reach entire portion of the earth? Is there any region on the Earth's surface where a given earthquake will not be reported?

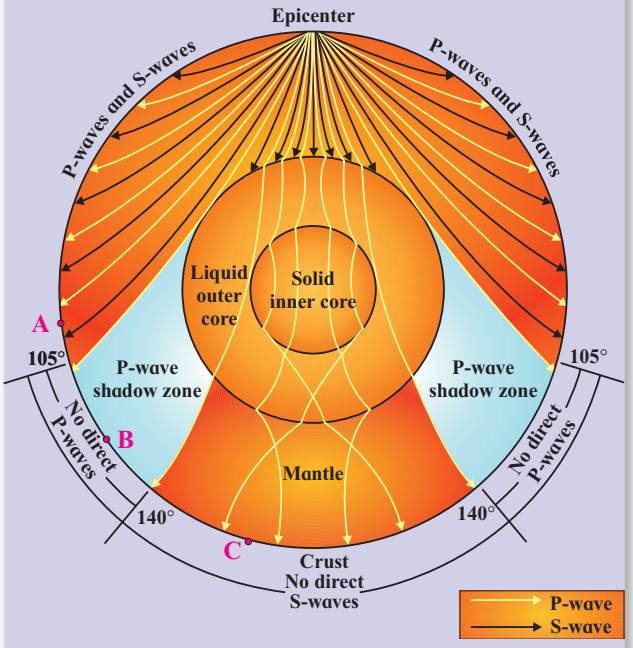


Fig. 1.10 : Shadow zone of an earthquake

**Shadow zone :**

The waves which are caused by the earthquake are called seismic waves. There are three types of waves : P-waves, S-waves and longitudinal waves. P-waves pass through all mediums while S-waves pass only through solid medium. Even though P-waves pass through all mediums, they experience refraction as they pass on one medium to another. Earthquake waves get recorded in seismographs located at far off locations. However, there exist some specific areas where the waves of that earthquake are not reported. Such a zone is called the 'shadow zone'. The study of different events reveals that for each earthquake, there exists an altogether different shadow zone. Figure 1.10 shows the shadow zones of P and S-waves. Generally, seismographs located at any distance within 105° from the epicentre, record the arrival of both P-waves and S-waves. However, the seismographs located beyond 140° from the epicentre; record the arrival of P-waves, but not that of S-waves. Thus, a zone between 105° and 140° from the epicentre is identified as the shadow zone for both the types of waves. The entire zone beyond 105° does not receive S-waves. The shadow zone of S-waves is much larger than that of the P-waves. The shadow zone of P-waves appears as a band around the earth between 105° and 140° away from the epicentre. The shadow zone of S-waves is larger in extent. You can draw the shadow zone for any earthquake provided you know the location of the epicentre.

**Think about it.**

Why has a shadow zone for L-waves not been shown in fig. 1.10?

**Can you tell ?**

In fig. 1.10 A, B, C are three points on the earth's surface. Analyse their locations with respect to epicentre and shadow zones.

**Do you know ?**

Isoseismal line is an imaginary line, drawn on the map, connecting the places of uniform intensity of earthquake.

**Always remember**

While the Mercalli scale describes the intensity of an earthquake based on its observed effects, the Richter scale describes the earthquake's magnitude by measuring the seismic waves that are caused by the earthquake. The two scales have different applications and measurement techniques. The energy released in an earthquake of a magnitude 5 is 32 times more than that of magnitude 4.

| Scale | Mercalli Scale | Richter Scale |
|---|---|---|
| What does it measure? | The intensity of earthquake | The energy released during an earthquake |
| Measuring Tool | Observation | Seismograph |
| Quanti-fication | Quantified from observation of the effects on earth's surface, humans, objects and man-made structures | Logarithmic scale obtained by calculating logarithm of the amplitude of waves. |
| Unit | I (not felt) to XII (total destruction) | From < 2.0 to 10.0+ (never recorded). 3.0 earthquake releases 32 times more energy than a 2.0 earthquake. |

## Give it a try.

**How to locate epicentre of a given earthquake?**

Take the given hypothetical data in the table. The data shows the time of arrival of P-waves and S-waves at 3 seismograph stations. Assume the scale of the map as 1 cm : 18 km. See fig. 1.11.

| Recording Station | P-wave arrival time ( IST) | S-wave arrival time |
|---|---|---|
| Jalana | 11: 06: 06 | 11: 06: 19 |
| Washim | 11: 06: 46 | 11: 07: 03 |
| Aurangabad | 11: 07: 06 | 11: 07: 24 |

**Procedure :**

1) Compute the time difference between the arrival of P-waves and S-waves for each station; this is called time lag. (It shows the distance of the seismograph from the focus. *Thumb rule: For every second of time lag, the earthquake is approximately 8 km away.*)
2) Using the rule above, convert the time lag into distance (seconds of time lag × 8) for each station.
3) Convert this distance into centimetres as per the scale of the map.
4) On a map, locate the seismograph stations.
5) Draw circles, taking the seismograph stations as the centre, with the radius equal to the distance you have calculated in the previous step.
6) These arcs of circles will intersect one another at a point. This point is the location of the epicentre.

In normal practice, an epicentre is located using computer models. The procedure outlined here is a much simplified version of what is normally done, although the principle is the same.

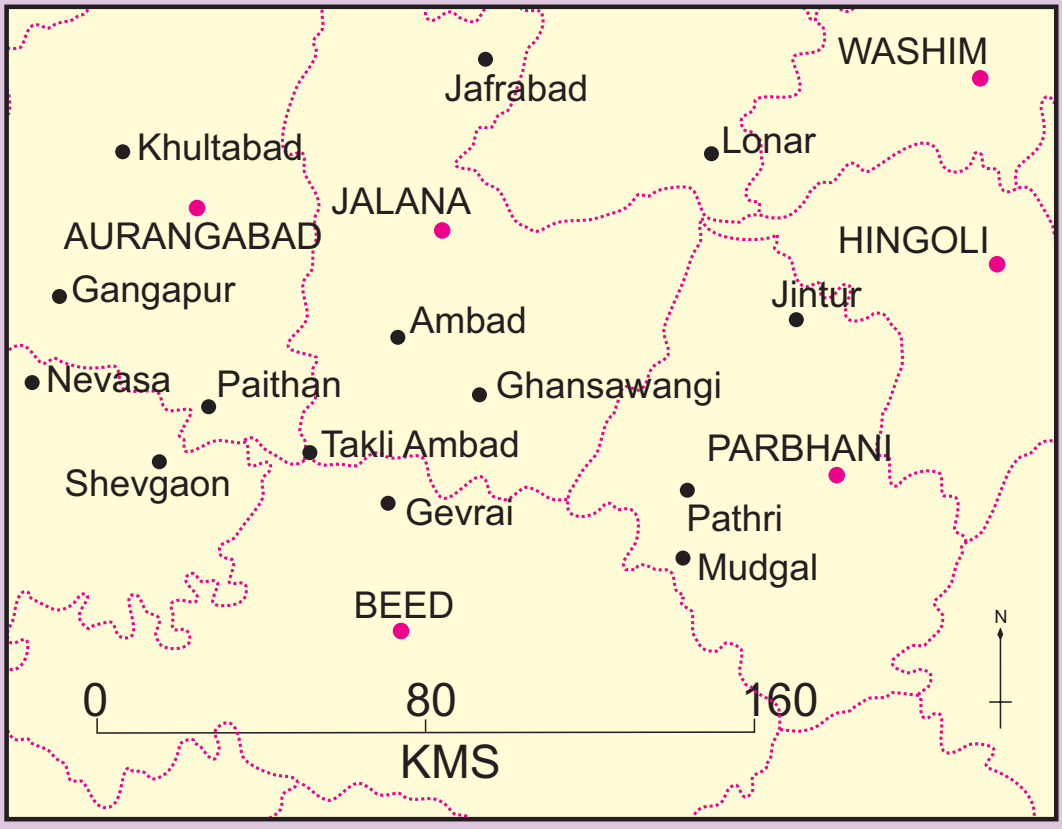


Fig. 1.11

**Causes of Earthquakes :** Now you know that earthquakes are caused mainly due to the release of stress within the crust. Following are some of the causes of an earthquake.

1) **Volcanicity :** Some, but not all, earthquakes are associated with volcanic eruptions. Such earthquakes are generally shallow and their effect is seen mostly in the areas close to eruption site. e.g. A volcanic earthquake in the Cascades near Mount St. Helens was of magnitude 5.5 in 1981.

2) **Tectonic Movements :** The earth's crust consists of several large and small unstable tectonic plates. They float on denser portion of the upper mantle zone. Due to their movements, the earthquake generally occurs along their margins (divergent and convergent). Refer to the map in fig. 1.21. The earthquakes which generally occur in Indonesia, California (North America), Chile (South America), Uttar Kashi and Assam in India are examples of such earthquakes.

3) **Anthropogenic causes :** In recent years, earthquakes have occurred due to an atomic explosion, large construction activity, drilling, blasting, and large scale mining in different parts of the world may also lead to earthquakes. However, their effects are highly localized.

**Earthquake Zones in India :**

On the basis of the intensity of damage risk, India is classified into five risk zones. Use the given weblink http://www.bmtpc.org/DataFiles/CMS/file/map%20of%20india/eq-india.pdf and complete the table accordingly.

**Seismic Zones in India**

| Zone | Degree of Risk | States/UTs |
|---|---|---|
| I | Least | |
| II | Low | |
| III | Moderate | |
| IV | High | |
| V | Very High | |

**Volcanoes :**

Volcano is an opening in the earth's surface through which gases, molten lava and solid material are ejected from the upper mantle portion on to the surface of the earth.

On the basis of origin of eruption, volcanoes can be classified into two types. i.e. 1) Eruption through cones, 2) Eruption through fissures. (fig 1.12 and 1.13)

**Fig. 1.12 : Central or Conical Volcano**

**Fig. 1.13 : Fissure type volcano**

Volcanoes may also be classified on the basis of periodicity and continuance of the eruption activity, like active volcanoes, dormant volcanoes and extinct or dead volcanoes.

**Find out !**

Find out examples of active, dormant and extinct volcanoes.

## Volcanic Materials :

Read the following passage about the Krakatoa volcanic eruption and answer the following questions.

- Make a list of materials that came out during eruption.
- Classify them into liquid, solid and gaseous forms.

*There is an island known as Krakatoa between the islands of Java and Sumatra in Indonesia. There were frequent volcanic eruptions here. From May 1883, massive explosions began. The eruption that took place at about 10 in the morning on 28 August 1883 was the largest ever recorded explosion. As a result of this explosion, the entire island disappeared. During this eruption, rock particles and dust thrown up in the atmosphere was about 25 $km^3$. The column of this dust-ash rose as high as 80 km. The discharge of Krakatoa threw into the air nearly 21 $km^3$ of rock fragments, and large quantities of ash fell over an area of some 800,000 $km^2$. Near the volcano, masses of floating pumice, were so thick that ships had to halt. The surrounding region was plunged into darkness for two and a half days because of ash in the air. For some years after this, cloud kept moving round the earth. About 36,000 people died in these eruptions and the tsunami waves created by it.*

*In 1927, volcanic eruptions began at the same place and a new island rose in place of the Krakatoa island that had vanished. It was named 'Anak Krakatoa' or 'Child Krakatoa'. The volcano here constantly emits ash and steam. This new island has now become a laboratory for geologists and biologists.*

There are mainly three types of material which come out in volcanic eruptions, namely, liquid, solid and gaseous forms.

### Geographical explanation

1) **Liquid material :** It is the molten rock material. When the molten rock material is below the earth surface it is called 'magma'. When it appears on the surface it is called 'lava'. On the basis of percentage of silica it is classified into two types

**a) Acidic Lava :** It contains higher percentage of silica. It has got high melting point. It is thick, fluid and moves slowly.

**b) Basic Lava :** It contains less percentage of silica. It has low melting point. Its more fluid and can flow over longer distances.

2) **Solid material :** It consists of dust particles and rock fragments. When the material is very fine it is called volcanic dust. The small sized solid particles are called ash. The solid angular fragments are known as breccias. Sometime, the lava material thrown into the air solidifies into small fragments before falling on the earth surface; it is called volcanic bombs.

3) **Gaseous Material :** At the time of volcanic eruption, a dark cloud of smoke can be seen over the crater. On the basis of shape, cloud is called cauliflower cloud. Various inflammable gases are found in these clouds. These gases produce flames.

## Volcanic Landforms :

A number of landforms are formed due to cooling and solidification of magma. Some important landforms are given below.

1) **Lava Domes :** Domes are developed when magma comes out and solidifies around its mouth. The shape of the dome depends upon fluidity of lava. High dome with steep slopes are developed by acidic lava. Due to basic lava, broad-based low domes are developed. See fig. 1.14.

Fig. 1.14 : Lava Domes

2) **Lava Plateaus :** Due to spread of lava in huge quantity from fissure volcano, it covers large areas and plateaus are formed. The Deccan Trap in India has developed from volcanic eruptions millions of years ago. See fig. 1.15.

Fig. 1.15 : Lava Plateaus

3) **Caldera :** At times, the eruption of a volcano brings about large quantity of material and relieves lot of pressure. After the eruption, a large and deep depression remains in that area. This large depression is called caldera. These can be around 10 km wide and hundreds of metres deep. They may later turn into lakes. Smaller calderas are known as craters. See fig. 1.16.

Fig. 1.16 : Caldera

4) **Crater lake :** When the funnel shaped crater of an extinct volcano is filled with rain water, its forms a crater lake. See fig. 1.17.

Fig. 1.17 : Crater lake

5) **Volcanic plug :** It is formed, when the lava solidifies in the volcanic neck.

Fig. 1.18 : Volcanic plug

6) **Cinder Cone :** Solid material is ejected in large quantity. This material consists of ash, cinder and breccias. Cinders are half burnt pieces of solid material. The solid material is deposited around the mouth until a conical hill with steep slopes is formed. For example cone of Mt. Nuovo in Italy. See fig. 1.19.

Fig. 1.19 : Cinder Cone

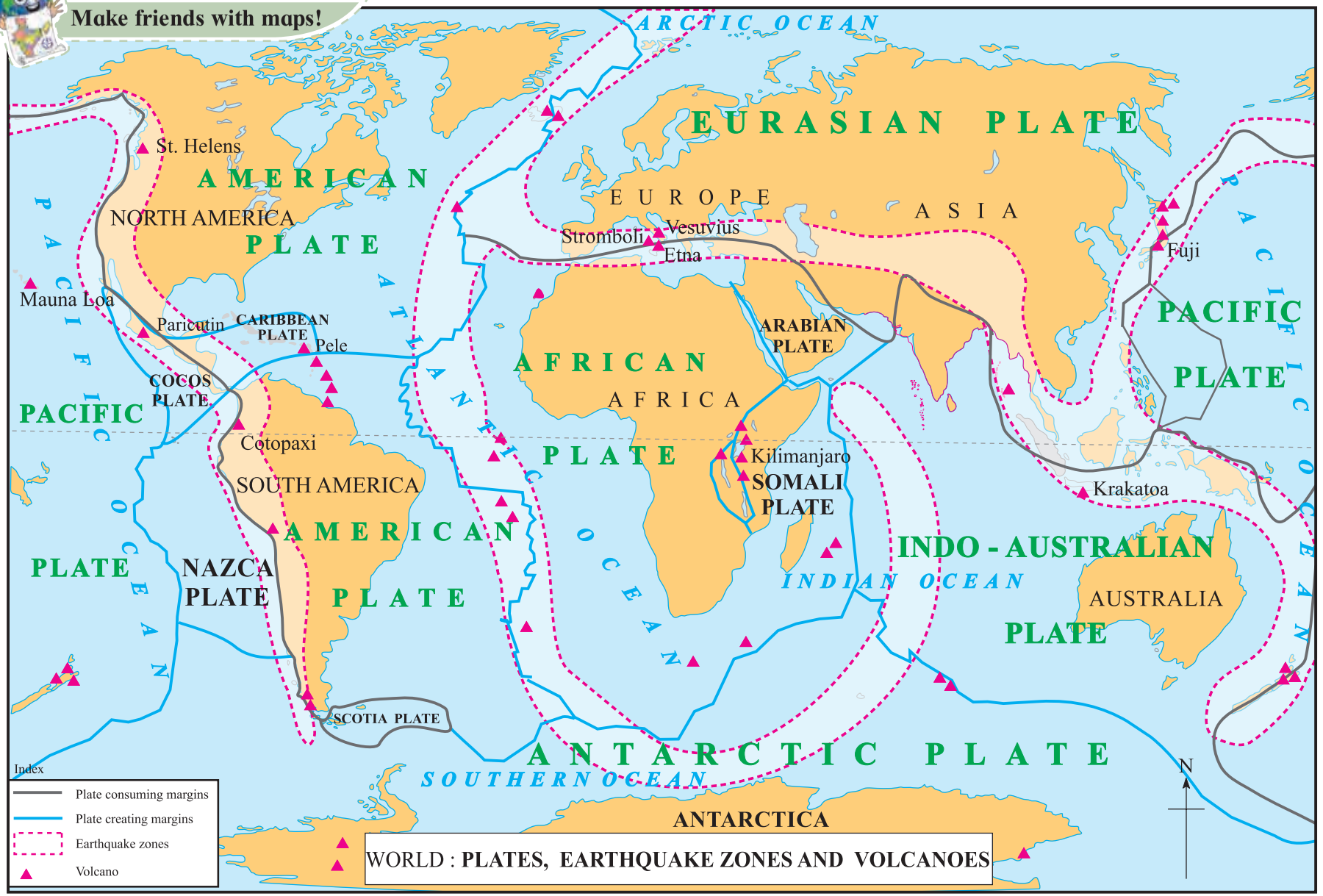


Fig. 1.20




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7) **Composite Cone :** Composite cones are built up of alternate layers of lava and cinder. This cone is composed of two materials and therefore it is called a composite cone. It is symmetrical in shape. e.g. Mt. St. Helens, USA. See fig. 1.21.

**Fig. 1.21 : Composite Cone**

**Distribution of Earthquakes and Volcanoes :**

There are three major belts or zones of earthquake and volcanoes on the earth. Look at the map given in fig. 1.20.

1) **Circum-Pacific Belt :** This belt is also called as "Ring of Fire". It includes the volcanoes of Eastern and Western coastal areas of the Pacific Ocean. Most of high volcanic cones and volcanic mountains are seen in this belt. Cotopaxi is the highest volcanic mountain of world found in this belt. Fujiyama (Japan), Mt. St. Helens (Washington, USA), Pinatubo and Mayon (Philippines) are other significant volcanoes.

2) **Mid-Atlantic Belt :** This belt covers the volcanoes mainly along the Mid-Atlantic ridge. The most active volcanic area is Iceland which is found on Mid-Atlantic ridge.

3) **Mid-continental Belt :** This belt includes the volcanoes of Alpine mountain chains, the Mediterranean Sea and volcanoes of fault zone of eastern Africa. The famous volcanoes are Stromboli and Etna.

## Exercise

**Q. 1) Complete the chain :**

| A | B | C |
|---|---|---|
| 1) Widespread volcanic eruption | 1) Zone V | 1) I to XII |
| 2) Andaman and Nicobar Islands | 2) Fissure eruption | 2) Block Mountain |
| 3) Mercalli scale | 3) Intensity | 3) Very high seismic vulnerability |
| 4) Slow movements | 4) Faulting | 4) Solid |
| 5) Phillippines | 5) Volcanic bombs | 5) Deccan Trap |
| 6) Volcanic material | 6) Circum Pacific belt | 6) Mayon |

**Q. 2) Identify the correct correlation :**

A : Assertion; R : Reasoning

1) A : Faulting leads to development of fold mountains.

R : Faulting occurs when tensional forces move away from each other.

1) Only A is correct

2) Only R is correct

3) Both A and R are correct and R is the correct explanation of A.

4) Both A and R are correct but R is not the correct explanation of A.

2) A : Intensity of an earthquake is a measurement of the energy released during an earthquake.

R : Mercallis scale is used to measure intensity of an earthquake.

1) Only A is correct
2) Only R is correct
3) Both A and R are correct and R is the correct explanation of A.
4) Both A and R are correct but R is not the correct explanation of A.

3) A : South-East Asia, Japan and islands in the Pacific Ocean are most vulnerable to earthquakes and volcanic eruption.

R : They are located in 'Ring of Fire'.

1) Only A is correct
2) Only R is correct
3) Both A and R are correct and R is the correct explanation of A.
4) Both A and R are correct but R is not the correct explanation of A.

**Q. 3) Identify the correct group :**

| | | | |
|---|---|---|---|
| **A)** | 1) Symmetrical fold | **B)** | 1) Black Forest |
| | 2) Isoclinal fold | | 2) Vosges |
| | 3) Overturned fold | | 3) Himalayas |
| | 4) Recumbent fault | | 4) Satpuras |
| **C)** | 1) Narmada Valley | **D)** | 1) Caldera |
| | 2) African Valley | | 2) Crater lake |
| | 3) Tapi Valley | | 3) Cinder Cone |
| | 4) Rhine Valley | | 4) Lava plateau |

**Q. 4) Give geographical reasons :**

1) Extinct conical volcanoes often form crater lakes.
2) People living in the Himalayas are more vulnerable to earthquakes.
3) L-waves do not have a shadow zone.
4) Soft rocks form folds while hard rocks form faults.
5) Folds depend on the strength of rocks and intensity of forces.

**Q. 5) Answer in detail :**

1) Explain different types of faults.
2) Explain with examples, different types of landforms produced by volcanic eruption.
3) Explain the concept of shadow zone.
4) Write a note on volcanic materials.

**Q. 6) Differentiate between :**

1) Folding and faulting
2) Normal fault and Reverse fault
3) Syncline and Anticline
4) Asymmetrical fold and Symmetrical fold
5) Mercalli scale and Richter scale
6) Slow movements and sudden movements

**Q. 7) Draw diagrams for :**

1) Types of folds
2) Types of faults
3) Shadow zone
4) Volcanic landforms

***

# 2. Weathering and Mass Wasting

**Let's recall.**

Study the diagram given in figure 2.1 and answer the following questions :

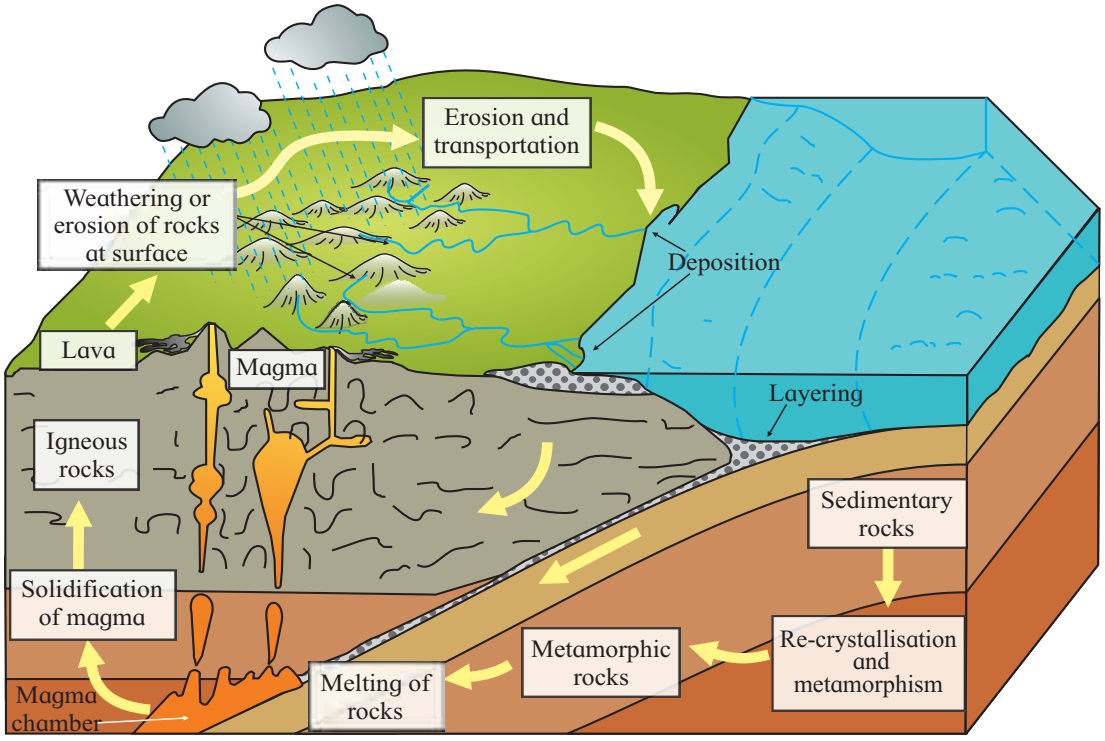



**Fig. 2.1 : Rock cycle**

1) Identify the types of rocks shown in the diagram.
2) Arrange the rocks according to their chronology of origin.
3) Explain how sedimentary rocks are formed.
4) Think of all the factors which may break the rocks into smaller pieces.
5) Which type of rock will break easily as compared to others? Why?

## Geographical explanation

Igneous, sedimentary and metamorphic rocks are the three types of rocks found on the Earth. Igneous rocks are formed from lava which has come from eruptions on the Earth's surface. Igneous rocks are, therefore, the first rocks formed on the Earth's surface. As we have seen in fig. 2.1, when rocks break into smaller pieces, they are carried away from one place to another. In these sediments, organic materials also gets mixed. When layers of sediments deposit on each other, immense pressure acts on them. As a result and also because of the cementing material, sedimentary rocks are formed. Metamorphic rocks are formed when igneous and sedimentary rocks are subjected to immense heat and pressure.

How can rocks break? Rocks which are exposed are affected by the climate of that region. Rock can break because of water, pressure, heat, etc. in various different ways. Those rocks which have joints or layers break

easily than rocks which are homogeneous. Generally, sedimentary rocks break easily than igneous rocks.

### Weathering :

When rocks break, the grains in the rocks get disintegrated. This means, they get weakened and over a period of time, they get eroded and break. Weathering is the physical or chemical breakdown due to weather conditions. It occurs mainly through the action of water and temperature on rocks and the reaction of rocks to these processes. As very little or no motion of materials takes place in weathering, it is called in-situ process. Weathering often results in rounding and smoothening of sharp edges of rocks.

**Types of weathering :** The rocks are weathered physically or chemically. So, basically, there are two types of weathering: physical and chemical. Factors such as water, heat and pressure which affect weathering can cause both the types of weathering chemical and physical. Effect of such factors can be varying on different rocks in different climates.

Let us have a look at these factors that affect weathering :

1) **Water :** Water is a very common factor which plays an important role in weathering. The availability of water largely depends on the climate of the place. It enters the small pores, cracks and fissures inside the rocks.

In areas, where diurnal range of temperature is high, water inside the cracks freezes during nights. During daytime, it again becomes water. When water freezes, its volume increases. It starts exerting pressure on the walls of the rock and widens the cracks. Eventually, the rocks break down. This process is called freeze-and-thaw weathering. See fig. 2.2. It is particularly effective in high altitudes in mid and low latitudes, high-latitudes as well as mountainous regions. The sedimentary rocks such as sandstone, grit and conglomerate get easily disintegrated due to water.

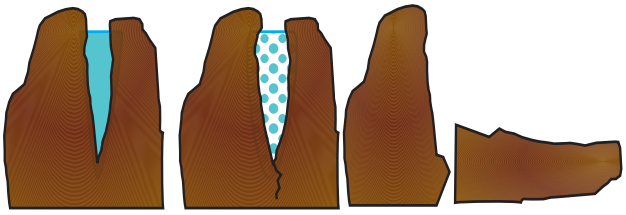


**Fig. 2.2 : Freeze and thaw weathering**

Water also breaks down the rocks chemically. This can happen in two ways. The water molecules react with minerals present in the rocks. This process is called hydrolysis. If the rock is made up of those minerals which react easily with water, the compounds of those elements will form and break the rock. This process can happen with those igneous rocks which have silicate minerals. The resultant compounds will break the rock by changing the chemical composition of the minerals in the rock after hydrolysis. For physical and chemical weathering to happen, the water present as moisture in the soil or air is also enough to cause weathering.

Another way by which water can cause chemical weathering is by solution . When some minerals in the rock react with water in the rock or moisture in the air and get dissolved, the process is called solution. They form acids, get leached from the main rock and lead to decomposition of the rock. Minerals like calcium, magnesium, nitrates, etc. dissolve in water. For example, the calcium present in the limestone reacts with the water and air to form carbonic acid. The minerals dissolve in water and get carried away in the water.

A) **Oxygen :** Oxygen in the air and water reacts with certain elements in the minerals inside the rock. In this process, the minerals

in the rock react with the oxygen in the air or water. Metals, particularly iron and aluminum, commonly oxidize forming iron or aluminum oxides. Compared to the original rock, these oxides are less hard, larger in volume and have a distinct color. See fig. 2.3. Generally, the iron oxides are red in colour and aluminum oxides are yellow. When oxidation happens on steel or iron objects we call it rust.

**Fig. 2.3 : Oxidation**

**B) Carbon Dioxide :** This process involves reaction of carbon dioxide with the minerals in the soil. The decomposition of dead matter in the soil produces $CO_2$. This $CO_2$ and the $CO_2$ in the air reacts with minerals in the rock. Minerals such as feldspar and carbonates decompose when this happens. This is particularly true for sedimentary rocks such as limestone. In humid climates, water adds to the weathering process. In arid climates, the absence of water in the region leads carbonate rocks to form cliffs that are resistant. Often, carbonation and solution occur simultaneously. During carbonation, the calcium and carbonate in limestone detach from each other, thereby decomposing the limestone.

**C) Salt :** Though salt is a chemical compound, it can also carry out physical weathering. The salts of calcium, sodium, magnesium, potassium etc. present in the rocks have a tendency to expand due to their thermal properties. This leads to crystallization of salts and individual grains split from the main rocks which fall off at the end. Such a type of weathering is, especially, very dominant in areas with alternative dry and wet periods and in coastal areas. It leads to formation of honeycomb structures. See fig. 2.4. e.g. Hareshwar in Raigad district. These structures are examples of the combined effect of physical and chemical weathering by water.

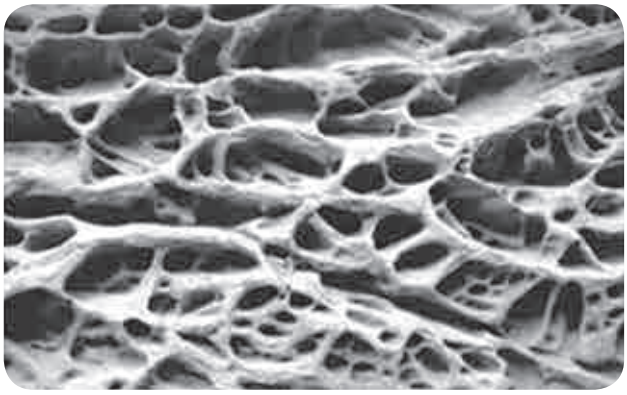


**Fig. 2.4 : Honeycomb weathering**

**Think about it.**

In which regions will freeze-thaw weathering not be effective?

**2) Heat :** In areas where water availability is rare, weathering process is mainly induced by temperature. Hot deserts are the areas of high diurnal range of temperatures. As the temperature increases with the rising sun, the rock gets heated. The minerals in the rock react differently to temperature increase. Therefore, the rock as a whole does not expand but different minerals expand separately. This leads to the development of stresses within the rock. This molecular stress becomes the prime factor in disintegration of the rock. This differential thermal expansion and contraction contributes to granular disintegration. It means the breaking free of individual mineral grains from a rock. See fig. 2.5.

Fig. 2.5 : Granular Weathering

In a similar process, the rocks break away due to heat. This is called shattering. In hot deserts, this shattering produces a sound similar to firing of pistols. This breaking of the rock is very intense and hence such a sound is produced. See fig. 2.6.

Fig. 2.6 : Shattering

In rocks such as granite which have joints, heat can cause weathering by breaking the rocks along the joints into blocks. This type of weathering is called block disintegration. See fig. 2.7. It is particularly effective in areas where diurnal range of temperature is high. The repeated expansion and contraction of minerals in the rocks produces stress along the joints. The joints then widen, deepen and finally break down the rock, block by block.

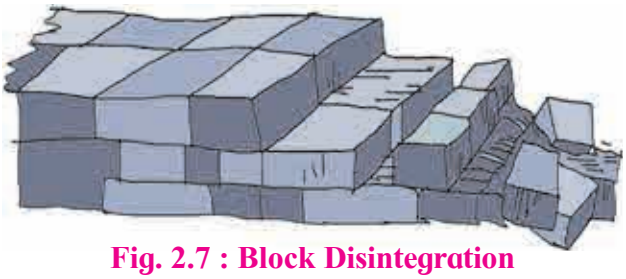


Fig. 2.7 : Block Disintegration

Though heat may not directly cause chemical weathering, it certainly speeds up chemical weathering. It can become more effective with increase in heat.

3) **Pressure :** Because of the overlying rocks, the rocks beneath the surface experience a lot of pressure. When the underlying rocks get exposed to the surface, they are now subjected to low pressure than before because the overlying rocks have been removed. As a result of the pressure differences, at depth (high) and surface (low), the outer part (a few centimetres to metres) of the rock mass expands outward. This expansion causes the outer layer to separate from the lower layer. This type of weathering is called dislodgement which happens due to pressure release or unloading. It is common in igneous rocks, particularly granite, where rock forming material is homogeneous. The successive removal of these outer layers of the rocks is called exfoliation. See fig. 2.8.

In areas where coarse grained igneous rocks like granite are found, the cracks in the outer surface form a dome–shape. In Deccan Plateau areas such as Karnataka, Andhra Pradesh, Telangana and Odisha, one comes across such domes.

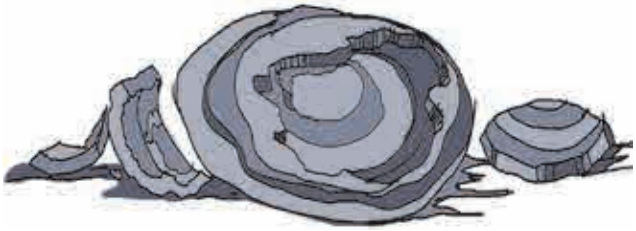


Fig. 2.8 : Exfoliation

**Use your brain power!**

Can animals and plants also influence weathering? Will that be physical or chemical weathering? Which type of weathering does stone quarrying cause?

## Geographical explanation

**Biological Weathering :** It is the disintegration of rocks as a result of the action by living organisms. Roots of trees and other plants can wear away rocks as they penetrate into the soil. The roots get bigger, they exert pressure on rocks and makes the cracks wider and deeper. Eventually, the plants break the rocks apart. Some plants also grow within the fissures in the rocks which lead to widening of the fissures and then eventual disintegration. See fig. 2.9 A.

Microscopic organisms such as algae, moss, lichens and bacteria can grow on the surface of the rocks and produce chemicals that have the potential of breaking down the outer layer of the rock. They eat away the surface of the rocks. These microscopic organisms also bring about moist chemical micro-environments which encourage the chemical and physical breakdown of the rock surfaces. The amount of biological activity depends upon how much life is in that area. Burrowing animals can speed up the development of fissures. See fig. 2.9 B.

Fig. 2.9 : A) Biological Weathering

Fig. 2.9 : B) Biological Weathering

**Think about it.**

Besides climatic factors, rock type and structure, can you think of some more factors that affect weathering?

**Do you know?**

Air pollution contributes to the accelerating weathering rates. Burning coal, natural gas, and petroleum releases chemicals such as nitrogen oxide and sulfur dioxide into the atmosphere. When these chemicals combine with heat and moisture, they change into acids. They then fall back to earth as acid rain. Extensive damage has already occurred in some regions to historically important structures made of limestone and marble. There is a growing concern about world's monuments and sculptures. The Parthenon in Greece, the Taj Mahal in India and the Great Sphinx in Egypt are getting damaged.

**Anthropogenic Weathering :** Man being a biological agent affects weathering. With economic and technological development, man has become the most powerful weathering and erosion agent. Mining, blasting of hills and ridges for road and dam construction,

quarrying for industrial and building materials, etc. results in a fast rate of disintegration of rocks. This may be accomplished by natural weathering processes in thousands to millions of years. Man accelerates the rate of weathering on hill slopes through activities like deforestation.

**Different rates of weathering :**

**Try this.**

Take the following three materials : • Two pieces of chalk. • Two glass test tubes. • Two wax candles.

On a sunny day, keep one chalk and one test tube in the sun. Make sure they will not be disturbed there. Light one of the candles. See what happens. Take two vessels and fill them with water. Put a chalk and a candle in water. Observe what happens. After you keep the materials in the sun for around 6 hours, observe what happens. Pour some cold water on the heated glass test tube. Now answer the following questions :

1) What happened to the chalk kept in the Sun?
2) What happened to the glass test tube when cold water was poured over it?
3) What happened to the chalk kept in the water?
4) What happened to the candle kept in the water?
5) What happened to the candle when you lighted it?

## Geographical explanation

You saw three examples of materials reacting differently to different conditions. Chalk dissolved in water but nothing happened to it when kept in the sun. Similarly, heated test tube cracked when cold water was put on it. Also, wax melted when candle was lighted but nothing happened to it when kept in water. In nature, similarly, rocks react differently to the physical conditions. Different amount and degree of temperatures and rainfalls affect both physical and chemical weathering. Thus, there is a direct impact of climate on weathering.

In almost all environments, physical and chemical weathering processes work together but usually one of them dominates. Chemical weathering is effective and rapid in humid climates.

From the above explanation can you conclude and complete the table below using the words : intense, moderate, slight and very slight or no weathering.

**Rate of Physical Weathering :**

| | High rainfall | Moderate rainfall | Low rainfall |
|---|---|---|---|
| High temperature | | | |
| Moderate temperature | | | |
| Low temperature | | | |

**Rate of Chemical Weathering :**

| | High rainfall | Moderate rainfall | Low rainfall |
|---|---|---|---|
| High temperature | | | |
| Moderate temperature | | | |
| Low temperature | | | |

**Use your brain power !**

A region is having an annual mean temperature of 5° C and an annual rainfall of 1000 mm. Can you comment upon the weathering and the type with the help of following questions? Discuss in class.

1) Which type of weathering will be dominant here?
2) Where will such a region be found?

**Can you tell ?**

See the diagram in fig 2.10 and answer the following questions :

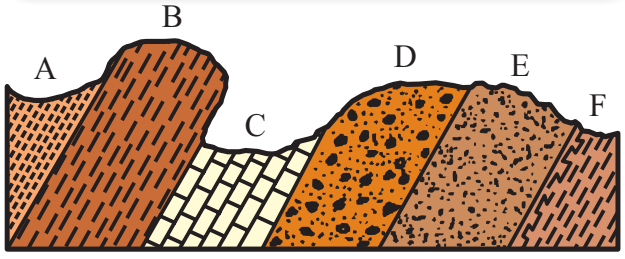



**Fig. 2.10**

1) Which rock layer has experienced the most weathering?
2) Which rock layer has experienced the least weathering?
3) What could be the reason behind difference in weathering?

**Geographical explanation**

Some rocks are more resistant while others are less resistant to weathering process. Some rocks react differently to different types of weathering. For example, quartzite, a metamorphic rock, is harder than even steel. It does not easily react chemically but is easily fractured by physical weathering. Under arid conditions, limestone does not easily weather away but it does so easily in humid regions. Granite resist weathering in arid and semi arid regions but the minerals inside it are prone to chemical weathering easily. Rocks having vertical strata are easily loosened and broken down due to temperature changes, frost action, water and wind actions. On the other hand, the rocks having horizontal beds are more compact and are less affected by the mechanisms of disintegration and decomposition.

Additionally, the rock structure also influences weathering. If the rocks have lots of fractures or joints in them, they will be more susceptible to weathering. Larger the grains of the rock, faster will it get weathered. This is because there will be lot of space in the rock for water to enter.

**Importance of weathering :**

Weathering prepares the way for formation of soils and various landforms that we see on the earth. Weathering is the first step as it gives materials to be eroded by agents of erosion, transported from one place to another and deposited to form landforms such as deltas, beaches, plains, etc.

Weathering helps in the enrichment and concentration of ores. In regions of high rainfall, the leaching process removes bases from parent rocks. As a result, iron or aluminium gets concentrated in upper layers. e. g., laterite or bauxite.

**Mass wasting :**

**Can you tell ?**

The satellite images given in fig. 2.11 A and B belong to the same location but different timeline. Study the images and answer the following questions.

1) Compare the images and tell what differences do you find in these images.
2) In 2019 what does the patch of land going from north-west to south-east signify? Why was it not there in 2011 image?
3) To what extent is the climate of the place responsible for this disaster?
4) Which other factors are responsible for the disaster?

**Geographical explanation**

The satellite images show village Malin, Ambegaon Taluka, near Pune. On 30th July 2014, mud came down the slope from the top of the hill. Many villagers lost their lives. The incident happend after heavy rainfall in the area. The sweeping portion from north -west to south-east is visible in the second image. This happened because the village is located at the foot of a hill. Thus, relief and

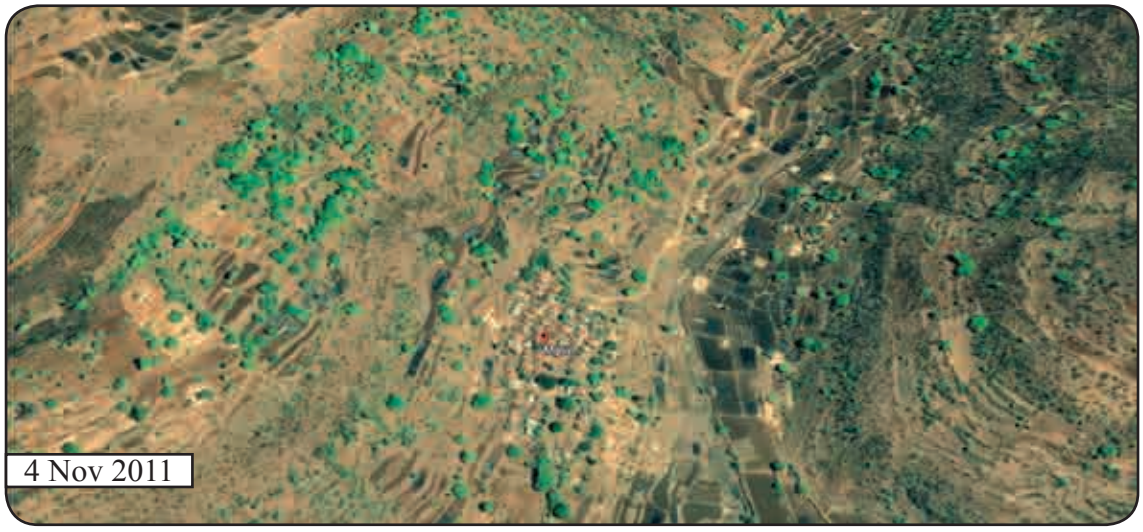



Fig. 2.11 : A)


Fig. 2.11 : B)

slope were responsible for the mudslide. Heavy rainfall and absence of vegetation aggravated the situation.

Mass movements or mass wasting is the down-slope movement of loose mixture of soil, land and rock particles by the force of gravity. In mass movements, the materials come down the slope without the aid of a transporting medium like running water, ice or wind. Mass movements occur continuously on all slopes. Some act very slowly other very suddenly, often with disastrous results.

Let us look at the factors responsible for their movement :

a) **Relief and slope :** There should be considerable elevation in an area for down slope movement to occur. Such movements will not occur in plain areas. Hilly, mountainous and plateau areas are more vulnerable to such movements. The steeper the slope, higher are the chances of occurrence of mass movements. Gentle slopes will have slow movements while steep slopes will have rapid movements.

b) **Gravity :** Gravity is the main force responsible for mass movements. It is a force that acts everywhere on the Earth's surface, pulling everything down.

c) **Water :** Although water is not always directly involved as transporting medium

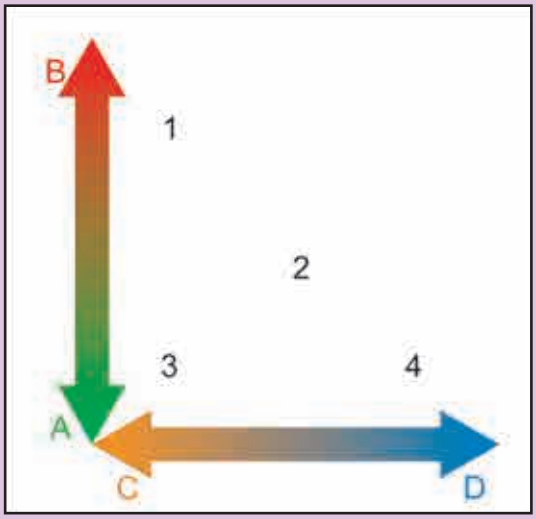
in mass movement process, it plays an important role.

Addition of water from rainfall or snowfall or melting of snow makes the material on the slope heavier. Water can seep into the soil and rock and increase their weight. Water can reduce the friction along a sliding surface. All these factors increase the chances of materials coming down the slope.

**d) Weak material and structures :** Some rocks are weaker than others. Rocks which have joints break easily. In particular, rocks contains calcium or clay minerals tend to have a low strength. Such areas will be more susceptible to mass wasting.

**Give it a try.**

Study the following schematic diagram. It shows the relationship between speed of material and moisture content. Read the index, and answer the following questions :




A) Fast B) Slow C) Dry D) Wet

1) Creep 2) Slide 3) Fall 4) Flow

**Questions:**

1) What will happen when the weather conditions are dry?
2) When will a flow occur?
3) When will a creep occur?

Now can you enumerate the factors which affect mass wasting?

## Geographical explanation

Mass movements can be divided into four main classes. The classification is based on how quickly the rock and weathered material moves and how much water there is :

1) Fall or topple happens when rocks have a free fall and land at the bottom of a slope.
2) Flows are a mixture of water, rock and weathered material. They move very quickly. Large flows can bury entire villages, smaller flows can block roads.
3) A slide happens when a section of soil or rock suddenly gives way and moves down a slope. The material moves as a single mass along a slippery zone.
4) Creep is a very slow mass movement that goes on for years or even centuries.

If the friction on a rock is stronger than gravity for a particular slope, the rock material is likely to stay. But if gravity is stronger, movement will occur in the direction of slope.

Another factor that determines mass wasting is the material of the slope. Mass wasting is effective on slopes that are made up of clay and shale. The shape and composition of individual clay particles can absorb water and prevent water from percolating through the ground. A layer of clay on a slope can prevent water from filtering through the slope. Instead, the water stays near the surface and saturates the ground. This can cause the surface layers to lose friction and slide.

A third factor that influences mass movement is the load or weight on that slope. Construction activities on slopes and heavy rainfall can add weight to the material on the slope. There are several other ways friction can

be reduced along a slope e.g. wildfires, removal of vegetation, or adding too much water. Due to this, materials will move down the slope.

A region's climate can also determine the likelihood of mass movement. Humid climates tend to have slides.

The amount of water in the soil is a major factor in the stability of a slope. A little water can actually prevent slopes from sliding. But too much water lubricates the individual grains of weathered material decreasing friction between each grain. So the possibility of mass wasting increases. The increase of water within the soils can come from over irrigation, pipe leaks, or prolonged wet spells. In many mountainous regions, melting of snow increases the water content within the soil.

Vegetation plays a big role in stabilizing slopes. The strong root systems of trees and other plants help hold the soil in place. When these trees are removed, the soil becomes weak. This is why deforested areas are likely to be sites of mass wasting.

**Think a little**

Think of the reason why landslides should be more frequent in foothill zone of the Himalayas and Western Ghat region. Why do landslides not occur in Marathwada in Maharashtra or Maidan area in Karnataka?

## Types of Mass Wasting :

**Try this.**

Different types of materials flow down the slope. Types of mass wasting depend on their speed. Observe the pictures given in figure 2.12. Match the explanation given below with the diagrams. Identify them as slow or rapid movements.

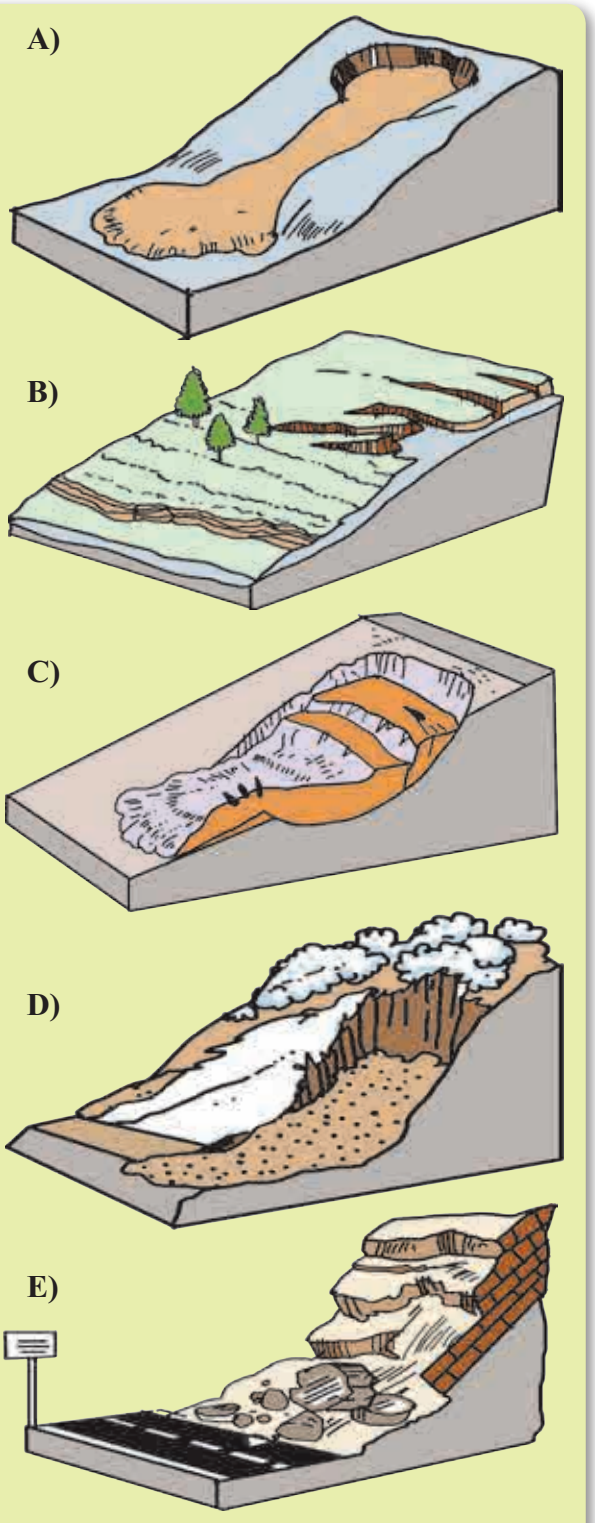



**Fig. 2.12 : Types of mass Wasting**

1) **Creep :** i) Slowest moving, ii) Down slope movement of soil tops of the hills, iii) Occur along tops and basal portions of hills.
2) **Rock fall :** i) Rapid fall of rock material down a cliff face, ii) Occurs mainly in rocky areas.

3) **Earth flow :** i) Rapid or slow, ii) Water saturates the soil, iii) Typically occurs on hillsides in humid regions.

4) **Solifluction :** Solifluction is the name for the slow downhill creep of soil in periglacial or alpine regions. It occurs slowly and is measured in millimetres or centimetres per year. As permafrost is impermeable to water, soil overlying it may become oversaturated and slide slope down under the pull of gravity.

5) **Land slide :** i) Occurs on moderately steep slopes, ii) Movement of rock, earth or debris down a section of land as a single unit.

**Think about it.**

Can tectonic forces be responsible for mass movements?

**Give it a try.**

On the basis of the given points, differentiate between weathering and erosion.

| | Weathering | Erosion |
|---|---|---|
| Definition | | |
| Causes/Agents | | |
| Effect/Results | | |
| Examples | | |

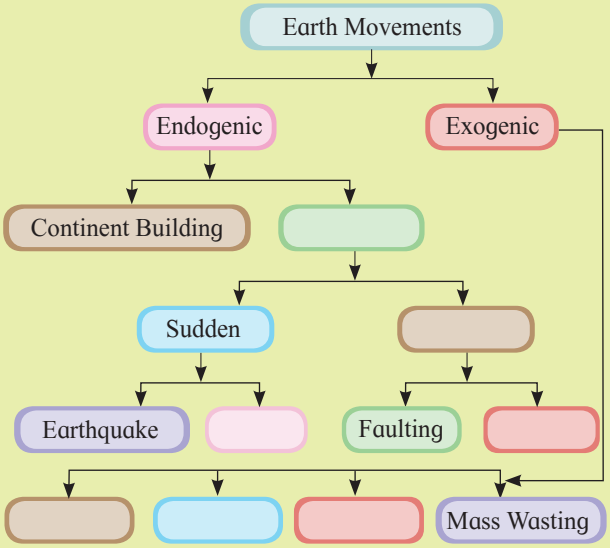
**Erosion :** It is one of the denudational processes. It involves segregation of rock particles from rock mass through the action of friction. Erosion involves the application of kinetic energy to the surface along which material moves. It is the wind (air), streams (water) and glacier (ice) that move under the influence of gravity or effect of pressure differences from one place to another. These are therefore called the 'agents of erosion. We will study about them in detail in the next chapter.

**Think about it.**

There is a shift of materials in mass movements as well as in transportation from one place to the other. So, why can't both not be treated as one and the same?

**Try this.**

Complete the following flowchart.




## Exercise

**Q. 1) Complete the chain :**

| Rock type | Name of the rock | Dominant type of weathering |
|---|---|---|
| 1) Igneous | 1) Dolomite | 1) Physical Weathering |
| 2) Sedimentary | 2) Slate | 2) Chemical Weathering |
| 3) Metamorphic | 3) Basalt | |
| | 4) Limestone | |
| | 5) Granite | |

**Q. 2) Identify the correct correlation :**

A : Assertion; R : Reasoning

1) A : In areas of high rainfall, slides are very common.

R : Types of mass wasting movements are dependent on a region's climate.

1) Only A is correct
2) Only R is correct
3) Both A and R are correct and R is the correct explanation of A.
4) Both A and R are correct but R is not the correct explanation of A.

2) A : Gravity is a major factor in mass wasting.

R : Gravity pulls all things down to the earth's surface.

1) Only A is correct
2) Only R is correct
3) Both A and R are correct and R is the correct explanation of A.
4) Both A and R are correct but R is not the correct explanation of A.

3) A : Freeze and thaw weathering is common in desert areas.

R : Water gets into cracks and breaks the rocks.

1) Only A is correct
2) Only R is correct
3) Both A and R are correct and R is the correct explanation of A.
4) Both A and R are correct but R is not the correct explanation of A.

4) A : Surface water helps solifluction

R : Water table is responsible for the same.

1) Only A is correct
2) Only R is correct
3) Both A and R are correct and R is the correct explanation of A.
4) Both A and R are correct but R is not the correct explanation of A.

**Q. 3) Identify the correct group :**

**A)** 1) Oxidation
2) Carbonation
3) Freeze-thaw weathering
4) Shattering

**B)** 1) Solution
2) Salt Weathering
3) Oxidation
4) Carbonation

**C)** 1) Fall
2) Creep
3) Slide
4) Flow

**D)** 1) Pressure
2) Temperature
3) Slope
4) Rainfall

**Q. 4) Give geographical reasons :**

1) Temperature is the main factor behind granular weathering.
2) Human is an agent of weathering.
3) Slope is a major factor in mass wasting.
4) Oxidation changes the size and colour of the rocks.
5) Effect of mass movement will be greater along the western slope of the Sahyadris than the eastern slope.

**Q. 5) Write short notes on :**

1) Gravity and Solifluction
2) Role of water in mass wasting
3) Exfoliation
4) Weathering and homogeneity in rocks
5) Carbonation

**Q. 6) Draw neat and labelled diagrams for :**

1) Freeze and thaw weathering
2) Block disintegration
3) Biological weathering

**Q. 7) Answer in detail :**

1) Explain with examples the process of weathering happening in Konkan.
2) Explain the correlation between Himalayas and mass movements. Give examples wherever necessary.

***

# 3. Agents of Erosion

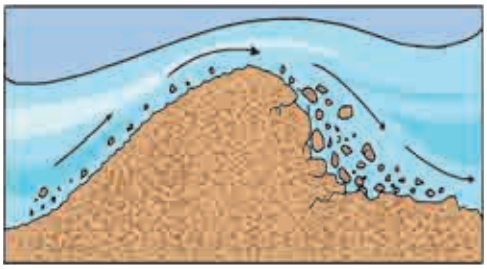
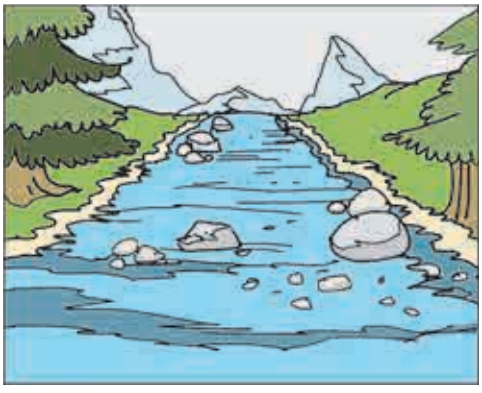
## Can you tell ?

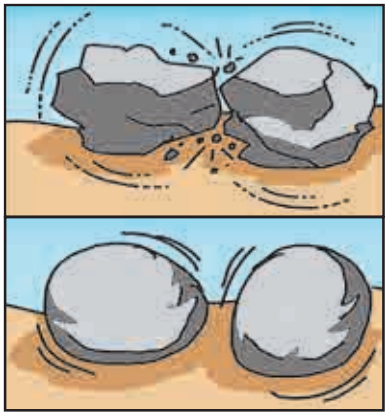
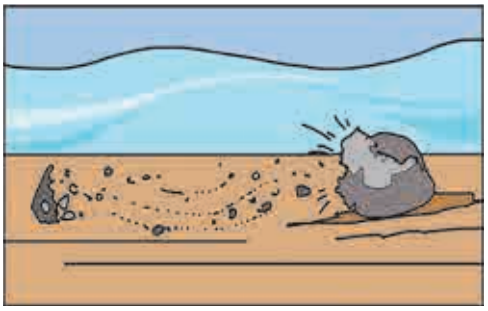
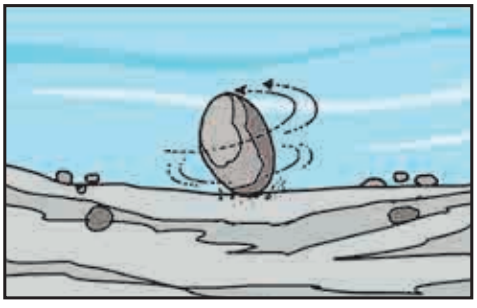
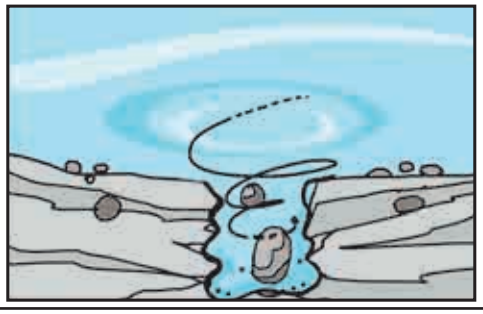
The names of many places may have some relation with the landforms located there. The names of few of them are given below as example. You are expected to find out the particular landforms to which they are associated. Find about them and try to locate them on a map using an atlas. Make a list of similar examples from India. Discuss your findings in the class.

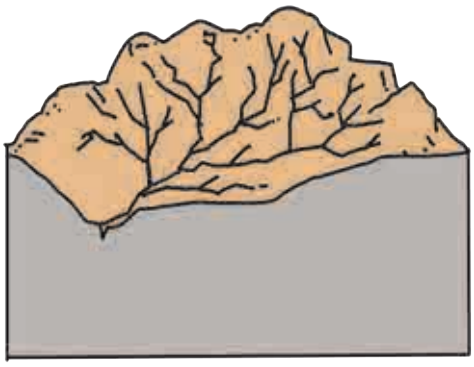
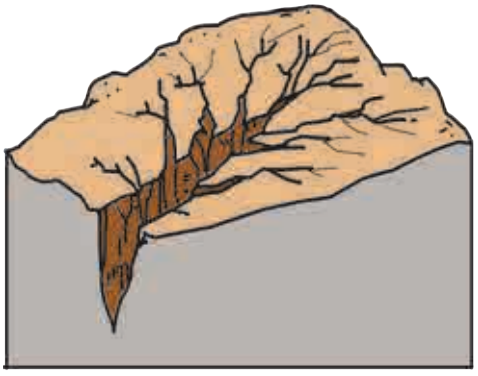
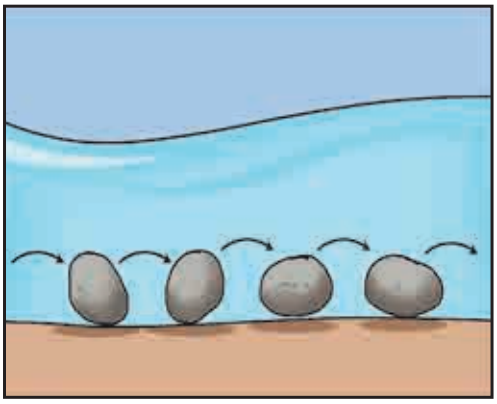
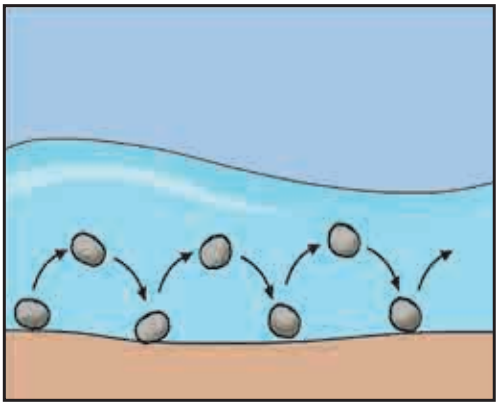
| Name of the place | Landform associated with the name | Location |
|---|---|---|
| Revdanda | Sand bar | Raigad, Maharashtra |
| Ganpati Pule | Beach | Ratnagiri, Maharashtra |
| Pravara Sangam | Confluence of rivers | Ahmadnagar, Maharashtra |

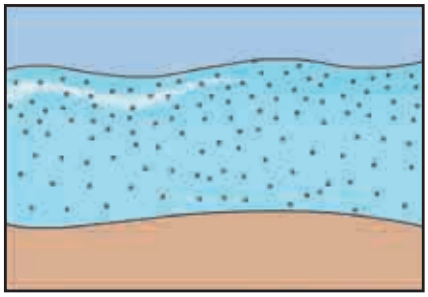
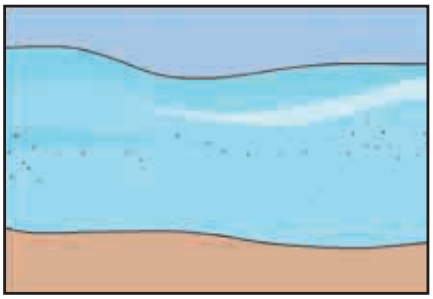
## Geographical explanation

You have seen how landforms may be used to name places or villages. Landforms have been formed due to certain processes. Agents work upon them. Landforms develop over a long period. You have already learnt about the agents of erosion: running water (river), sea waves, wind, underground water and glaciers. They are the medium. These agents detach or separate, pick up, move, and eventually lay down broken rock particles. These agents of erosion cause various processes when they pick up, move and deposit these rock particles. These processes lead to erosional and depositional landforms. Some processes are common across all agents but some are specific to a particular agent. Try to understand these processes with the help of the table given below. The adjacent diagrams will help you to visualize how the process operates.

| Sr. No. | Processes of Erosion | Agent | Diagram |
|---|---|---|---|
| 1. | Plucking is the process by which moving ice exerts pressure on majority portion of rocks on bed or along the bank. This causes uprooting of rock portion which is getting exposed to the flow. This uprooting of particles is called plucking. The eroded bedrock will have a rugged surface. | Glacier |  |
| 2. | Abrasion involves the scratching and polishing of the surface or bedrock by the particles which are moving onto it. Just as sandpaper is used for smoothening, the rock particles involved in abrasion rub against and wear away the surface. The eroded bedrock or surface will have a smooth side. Abrasion increases as velocity increases. | Wind, glacier, sea waves |  |

| Sr. No. | Processes of Erosion | Agent | Diagram |
|---|---|---|---|
| 3. | Attrition is when rocks and pebbles bump into each other and break up into smaller fragments. During transit, materials reduce in size. Rock particles become more rounded. | Wind , Waves, river |  |
| The difference between abrasion and attrition is that abrasion affects the surface along which the material moves and attrition relates to the material that moves. | | | |
| 4. | Solution - Solution is when certain types of rocks get eroded as a result of acids in the sea or river water. When minerals in rocks like chalk and limestone are dissolved in water, they are carried in the water. The load is not visible. In particular, limestone, dolomite and sandstone coasts are very susceptible to this type of erosion. | Underground water, river, sea waves |  |
| 5. | Deflation – The particles which are loosened on the surface are blown away by the wind. This action is more intense where vegetation is absent. After removal, the portion from where sand is blown off appears as a depression. These are called deflation hollows. | Wind |  |
| 6. | Drilling - Bedload moves along the running water. As and when this flow encounters an obstacle due to relief on the bed or joints in the bed, the flow tends to develop a circular pattern. This circular system becomes stable, though the water continues to flow in downstream direction. This leads to development of a whirl. The trapped sediments also follow the similar circular motion. The continuous action of these trapped sediments and the whirl deepens the bed of the river at a given point. Eventually, it develops into a larger depression assuming a shape of a pot. | River |   |

| Sr. No. | Processes of Erosion | Agent | Diagram /Figure |
|---|---|---|---|
| 7. | Down cutting, also called downward erosion is a process of hydraulic action that deepens the channel of a stream or valley by removing material from the stream's bed or the valley's floor. | River, glacier |  |
| 8. | Head ward erosion is the backward erosion by river in the source region. Gravel or soil in the source region may collapse due to steep slope. This is carried away by the stream. This causes the river to move backward. Such erosion takes place in the opposite direction of the flow of the river. | River, glacier | |
| 9. | Lateral erosion is the erosion that occurs on the sides of valleys of a river or glacier. The valley side slopes are eroded by the tributary streams. As and when, rate of downcutting decreases, the effect of lateral erosion becomes evident. This process is also called valley widening. In the valley floor region too lateral erosion occurs that mainly leads to widening of flood plains. | River, glacier, sea waves |  |
| **Sr. No.** | **Processes of Transportation** | **Agent** | **Diagram /Figure** |
| 10. | Traction – The material acquired by the agents is transported by rolling, pushing and dragging along the surface. The material consists of boulders and big rocks. | All except groundwater |  |
| 11. | Saltation – Often, rock materials move forward by leaps and bounds through this process. Saltation is when material such as pebbles and gravel and coarse sand that is too heavy to be carried in suspension is bounced along the surface by the force of the water or wind. | River, wind and sea waves |  |

| Sr. No. | Processes of Transportation | Agent | Diagram /Figure |
|---|---|---|---|
| 12. | Suspension - Fine light material is carried along with wateror air in the upper layer. They are very small in size. For a long distance, they do not come to rest. | River, wind, sea waves |  |
| 13. | Solution – The material is carried in water in a dissolved state. In areas where limestone or similar soluble rock is present, the amount of dissolved load in water is greater. | River, sea waves, groundwater |  |
| 14. | The process of deposition takes place due to certain factors in the course followed by the agent. The velocity at which the agent is moving has a great impact on deposition. If the stream or wind slows down, the carrying capacity will decrease and the particle sizes carried and deposited will also decrease. If a stream flows faster, say, during floods or when the river is in the mountains, then the carrying power of the stream will increase and the sizes of particles deposited will increase as well. If there is a change in the slope of the land, or change in direction of flow, deposition may occur there. Winds change their directions. When the slope is almost absent like in plain regions, the rivers are unable to carry sediments further and start depositing. Smaller particles settle more slowly than the larger particles, due to gravity. The smaller particles tend to stay in suspension for longer periods of time. Smaller particles are carried away till the end by river or wind. And their deposition occurs in the later stage. An obstacle like tree or mountain or similar structure may come in between. The agents may slow down because of obstacles. Deposition may take place at such a point. | | |

Understanding these processes will help you see how the action of different agents of erosion leads to landform formation. These landforms are a sum result of erosional, transportation and depositional processes. These processes act together or may also act singularly at different locations. Based on the effect of each of them, landforms produced by different agents can be classified as erosional and depositional landforms.

### Let's recall.

You have already learnt about various landforms formed by the agents of erosion in Class IX. Identify the landforms given in class IX textbook from page no. 30 to 38. Identify the agent which is responsible for their formation. Also, state whether they are erosional or depositional landforms. Complete the table accordingly in your notebook.

| Sr. No. | Page No. | Name of the landform | Agent | Erosional / Depositional |
|---|---|---|---|---|
| 1 | 30 | | | |
| 2 | 31 | | | |
| 3 | | | | |
| 4 | | | | |

## Geographical explanation

You must have realized that not all agents of erosion are present everywhere. In arid regions, wind is the dominant agent while river is the most common of all. Karst topography occurs only where there are dolomite or calcium rocks. There are many factors which control the formation of landforms. They are climate, type of rocks, intensity of erosion, slope of the land and obstacles. These factors affect the processes of erosion and deposition and the processes discussed above. For example, the wind starts depositing when it is not able to carry the heavy load of the sediments. Thus, the process of forming depositional landforms begins. Rivers start depositing when their speed reduces.

Though all agents of erosion are not present everywhere, process of erosion and deposition occurs everywhere. Common processes lead to different landforms through different agents. Flood plains are formed due to deposition by rivers while drumlins are formed by deposition by glaciers.

### Agents of erosion and landforms :

Let's understand how each and every agent works to form various landforms.

### Work of river :

**Think about it.**

Have you ever been to a river and seen its bed? Discuss in the class about your observations about the river, its banks, its bed and its velocity.

## Geographical explanation

A river, which is flowing water, erodes rock materials, transports them to newer places and deposits them. In this process, it creates many landforms. Picking up pieces of rock and moving them require the river to have kinetic energy. When it has more kinetic energy, it can pick up and move more particles.

As soon as a stream begins from its origin, it starts erosion. In mountainous areas, river flows at a higher speed. Here, the bed gets more eroded than its banks. Gorges are formed with steep banks and a narow bed. For example, the gorges of river Ulhas and river Narmada. Deeper gorges are called canyons.

**Find out !**

Find out famous examples of gorges and canyons.

Over a period of time, river starts consuming its energy in transporting the material. Consequntly, the bed is less eroded. However the erosion along the banks and the slope of the valley increases. Hence, the valley with almost vertical sides becomes wider resembling the letter 'V'. These valleys are called 'V' shaped valleys.

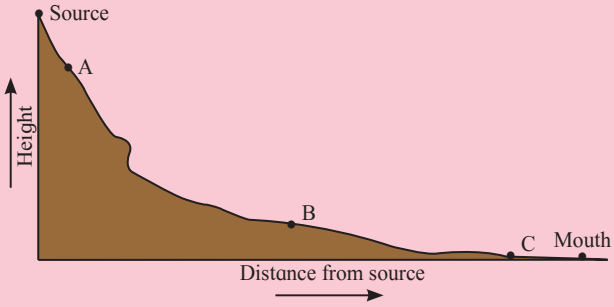
Some times, water flowing over a hilly region comes down a cliff, waterfalls commonly get formed at such locations. When a river runs over alternating layers of hard and soft rock, rapids and waterfalls are formed. Jog falls on the Sharavati river, Chuliya falls on river Chambal and Venna falls in Mahabaleshwar are some well known examples. At the base of the waterfall, plunge pools can form because of constant gush of water on the rock below.

Potholes generally originate in special circumstances, such as below waterfalls or where rocks are structurally weak. Swirling whirlpool motions of the river water causes stones at the bottom to grind the bedrock and enlarge the potholes by drilling while finer sediments are carried away in the current. Potholes may range from a few centimetres to many meters in diameter

and depth. Large potholes can be seen in the beds of river Kukadi at Nighoj in Ahmadnagar district and river Indrayani at Bhegadewadi in Pune district. In river beds, gravels and pebbles are often rounded. This happens because the rock materials carried in the flow tumble and bounce against one another. This process called attrition makes the load fine-grained.

### Can you tell?

Look at the figure below and answer the questions :




1) What features are formed in the upper course of the river? What processes will play an important role?
2) Can you mark the location where a waterfall may formed?
3) Why is there a change in slope from A to B? How will it influence the flow of the river?
4) Which human activities can be conducted in the region around A and B?
5) In which area will the process of deposition overtake erosion?
6) Alluvial fans and deltas are both features formed due to deposition but at different locations. Identify their regions of formation and reason behind their different locations.

When the river enters the plains, there is a change in the slope. The river's velocity is reduced abruptly. As a result, it may deposit some material at the foothills. This leads to formation of alluvial fans. Coarse sediments like boulders and cobbles are deposited towards the apex.

As river enters the plains, the river now uses much of its available energy for transporting the heavy load. The speed of erosion is reduced. Erosion on the outer bank and deposition on the inner bank of the channel leads to formation of serpentine bends called meanders. During floods, streams seek a shorter and straight path and may not meander. This isolates a meander bend from the new flow channel of the river. If the cut-off meander remains filled with water, it forms an oxbow lake.

Flooding in this course increases the erosional work of rivers in the area of the gently sloping plain leading to formation of extensive plains called floodplains. The richness of the soil, formed by material brought by the rivers (alluvium) is beneficial for agriculture to thrive here. During floods, these floodplains become inundated with sediment-filled water that deposits sediments on the sides of the river. This leads to formation of natural levees on the sides of the river banks.

Minimum gradient and close proximity to the sea makes erosion impossible in this region. Heavy load and reduced velocity make the river break into various channels. They are called distributaries of a river because the load gets distributed. Here the river deposits the sediments within its channel as a result flow gets separated. Islands are formed. This takes a some what triangular shape. This distinct landform is called a delta. See fig. 3.1. Deltas can only form at those river mouths where the sediment supply is high. It can be formed where the sea is not very deep. Therefore, some rivers may not form delta because they do not have huge load of sediments. Instead they may form estuaries at the sea.

Fig. 3.1 : Work of river

## Work of sea waves :

**Can you tell ?**

Look at fig. 3.2 A and identify the landforms at A, B, C, D, E, F and G.

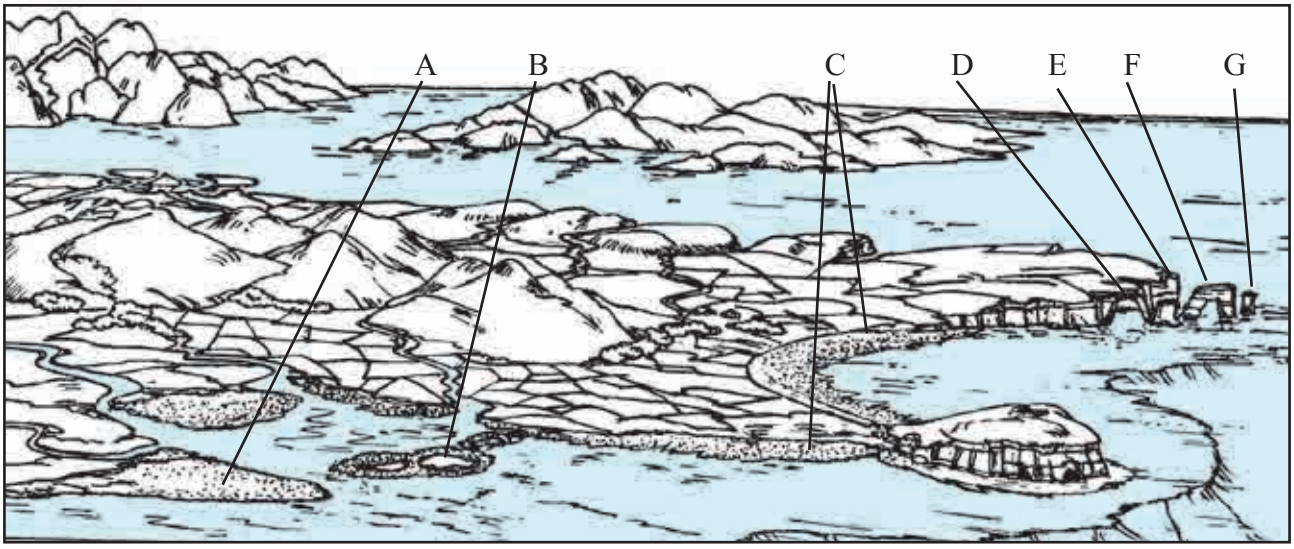



**Fig. 3.2 : A) Work of sea waves**

### Geographical explanation

Like running water sea waves too erode rocks. Abrasion is the most effective form of erosion by waves. Waves also erode rock material chemically through solution. Salt weathering is particularly significant in coastal areas.

If a steep coastal slopes continues deep beneath the water, the impact of waves may break the rocks. Sea cliffs are carved where waves strike directly against rocks. The softer rock along the coastline gets eroded first. Sometimes, waves can erode the softer part and make it hollow enough to be called a cave.

A sea arch forms when waves erode a layer of soft rock underneath a layer of hard rock. If a sea arch collapses, it creates a sea stack, which looks like a large rock in the middle of water. Sea arches also result where two caves meet from each side of a headland.

Surfaces at the base of the cliffs are called wave-cut platforms. Extensive platforms are developed where the rocks are least resistant to wave erosion. This happens due to abrasion. They are visible at lower water levels, such as at low tide. They are also proof of cliff recession.

The most common landform of coastal deposition is the beach. The part of land projecting into the sea is called headland. The coast between two adjacent headlands is concave in shape. The eroded particles are brought by the waves and deposited in this portion. Besides, the rivers and other agents of erosion bring large amounts of sediment from the land. Moreover, as these areas are shallow, the velocity of waves decreases. As a result, all these different types of sediments get deposited in this area along the sea. Predominantly, fine sand gets settled along the coast between the headlands. Such sandy deposits along the coast. are called beaches. Along the coastal areas in Maharashtra, long beaches have developed at Diveagar, Guhagar, Hareshwar, etc. The Marina beach at Chennai is the longest beach in India. See fig. 3.2 B.

Sand also gets deposited along the sides of the headlands. Such deposition extends parallel to the coast from one headland to the another. Over a period of time, these deposits extend over long distances and develop into a bund or bar that protrudes into the water at some distance away from the beach. These are called sand bars. Along the coast in Maharashtra, we can find sand bars at Shrivardhan and Revdanda. The sand bars offer the first protection against storm or tsunami by absorbing most of their destructive force. Between these sand bars and the land, a part of the sea gets enclosed. The water in this enclosed sea is brackish. This brackish water is called a lagoon. Large waves do not get generated in these lagoons as they get separated from the sea. These lagoons are like salt-water lakes. The Chilka Lake in Orissa and the Vembanad lake in Kerala are examples of lagoons. The Chillka Lake in Orissa becomes a fresh water lagoon during monsoons.

Sometimes, such sand bars are not separated from the mainland and extend into the sea. They are known as sand spits. Sand bars and sand spits may get separated from the land.

### Uniqueness of coastal areas :

Compare to the other agents of erosion, the work of sea waves goes on ceaselessly. Therefore, its effect becomes apparent within a short period of time. Erosion in some part and deposition in the adjoining part keeps on taking place constantly. The beaches and bars which are normally the products of deposition, are also subject to erosion. Coastal regions are always vulnerable to the risk of getting submerged due to increase in sea level. Coastal regions are also the regions of high population density. Therefore, the coastal zone management warrants serious attention.

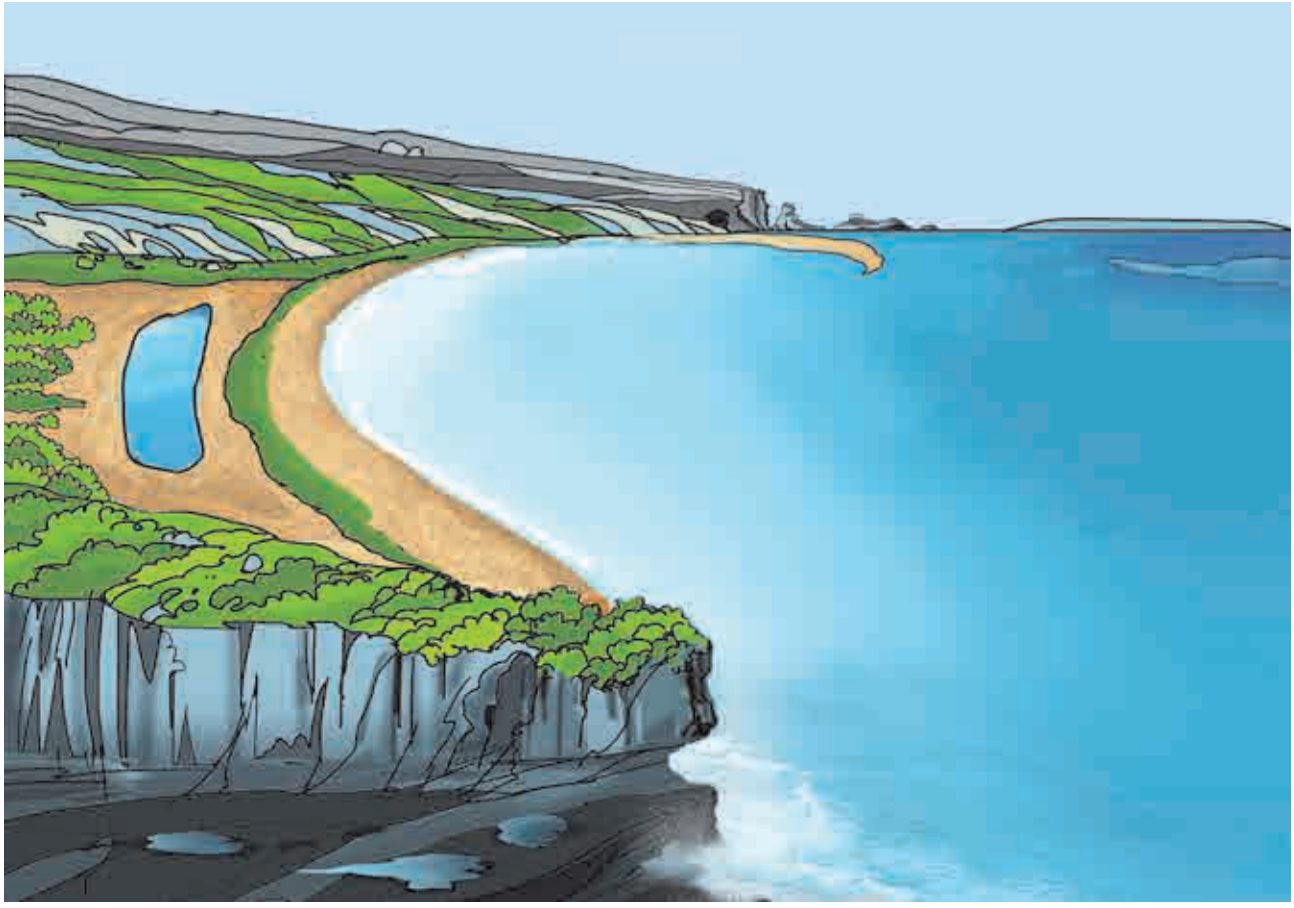


**Fig. 3.2 : B) Work of sea waves**

## Work of winds :

### Geographical explanation

On a global level, wind is less effective as an agent of erosion than running water, waves, groundwater or glacier. But, wind is a significant agent in the deserts. Following conditions are necessary for wind to become effective :

a) Aridity : In such areas, rate of evaporation is greater than rate of precipitation.
b) Sparse vegetation cover or absence of trees
c) Presence of dry loose materials at the surface
d) A wind velocity high enough to pick up and move sediments

Strong winds blow frequently in arid regions. These movements of the wind pick up loose surface materials and transport them with wind currents. Deflation occurs when wind blowing fast enough in swirling motion over an area of loose sediment. It is able to pick up and remove small fragments of rock. This erosion can produce shallow depressions, which can vary in diameter from a few centimetres to a few kilometres are called deflation hollows. The Qattar depression in Egypt is formed in this way. It is around 300 km long and 135 km wide. Its depression is 133 m below sea level.

Where the land surface is exposed, wind can polish the rock surface through abrasion. Abrasion carves the windward side of rock into smooth sloping surface. These rocks are called ventifacts. See fig. 3.3 A.

Fig. 3.3 : A) Ventifacts

Abrasion also contributes to formation of mushroom rocks. The high rising rocks in the path of the wind are attacked by the sand that moves with the wind. Winds and the particles they carry attack the base of an individual rock. The larger top part is not eroded as much as the basal part. The particles at medium height are smaller but their velocities are high. Hence, their impact is more. As a result, the portion of rock at medium height is eroded more and the rock as a whole gets the shape of a mushroom. See fig. 3.3 B.

Fig. 3.3 : B) Mushroom Rock

In areas where hard and soft rocks are found, the softer rocks get more eroded faster. The eroded portion of softer rocks appear like elongated ridges and harder rocks appear as elevated portions. A yardang is the remaining part of a ridge where rocks have been eroded. See fig. 3.3 C.

Fig. 3.3 : C) Yardang

Attrition reduces the size of the particles as they dash against each other mutual bouncing.

Transportation is carried out by winds where large-sized particles at lower heights and finer particles at moderate heights through traction and saltation, respectively. All materials transported by the wind are deposited. Coarser, material is often deposited in the shape of hills, called sand dunes. Fine-grained sediment such as silt, can be transported in suspension over long distances from its source area. These deposits are called loess.

**Types of Sand dunes :** Sand dunes are classified according to their shape and wind direction

**a)** Barchans are crescent-shaped dunes. They form where supply of sand is minimum. Due to an obstacle in the path of the wind or due to the lowering of its velocity, the sand moving with it gets fropped at some places. The barchan slope that faces the wind is gentle whereas the opposite slope is steep. Such hills can be seen in large numbers in the Great Indian Desert in Rajasthan.

**b)** Longitudinal dunes are long dunes deposited in the direction of the wind. They appear parallel to the wind direction. They do not migrate like the barchans but extend in the wind direction. They are also called seif dunes. They are sometimes hundreds of kilometres long. Such dunes can bee seen in Rub-al-Khali desert in Saudi Arabia.

Loess deposits form loess plains varying in thickness from few centimeters or less to more than 100 meters. They are formed far away from deserts when winds carry suspended particles for hundreds or thousands of kilometres. In northern China, the loess is 30 to 90m thick. It is formed by the winds coming from the Gobi Desert. They are fertile plains. See fig. 3.3 D.

**Fig. 3.3 : D) Work of wind**

**Work of groundwater :**

Study fig. 3.4 A. given above and answer the following questions.

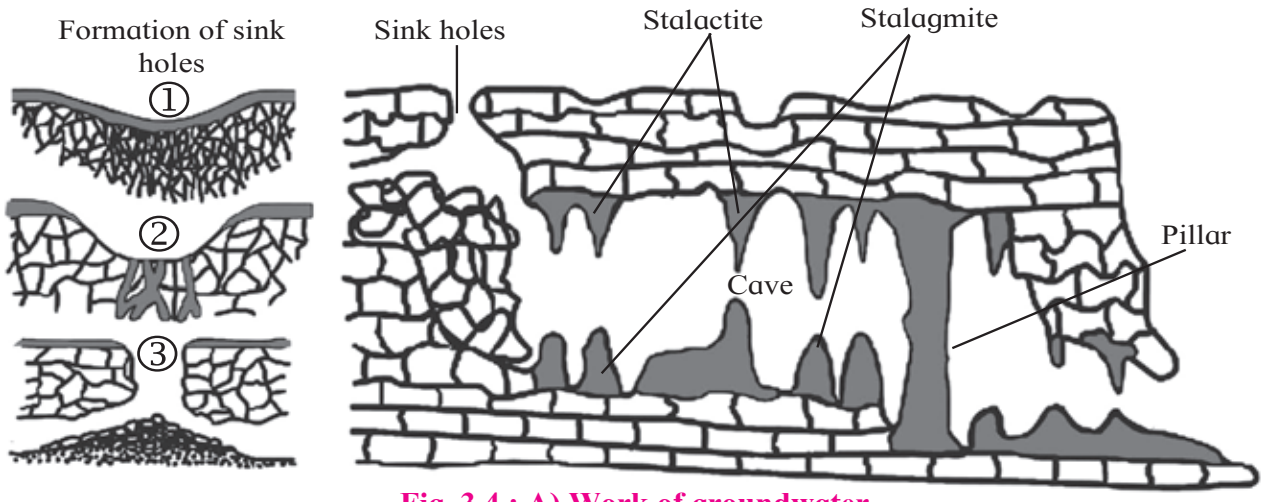



**Fig. 3.4 : A) Work of groundwater**

1) Which rocks are mainly found here?
2) Identify the spot where stream disappears.
3) Which major erosional process works in this area?
4) Identify the landforms formed by deposition.
5) Why do depositional landforms not form on the surface in areas of Karst terrain?

## Geographical explanation

Like water flowing at the surface, water beneath Earth's surface moves, carries other substances, influences the form and appearance of the landscape.

Water from precipitation, or melt-water soaks into the ground. In areas, where the bedrock is soluble in water, like limestone, water below the surface is an important agent in shaping the landform features. Sub-surface water dissolves, removes, transports and deposits materials. Through the chemical removal of rock materials, underground water is an effective agent especially where limestone is present.

The most common soluble rock is limestone, a sedimentary rock composed of calcium carbonate (CaCo3). Landform features created by sub-surface water are found in many parts of the world. The region around Mediterranean sea has large scale limestone features. These have majorly developed on the Karst Plateau along Croatia's Dalmatian Coast. Landforms developed by underground water anywhere in the world are therefore called Karst landforms. Other examples outside Europe are found in Mexico, USA, Caribbean Islands and southern China. In India, they are found in isolated parts in Meghalaya, Bora caves in Andhra Pradesh, Kanhur Plateau in Maharashtra, some parts of Madhya Pradesh and Chhattisgarh.

Karst topography needs three important factors to develop :

i) **Carbon dioxide :** Warmer humid climate have greater amount of vegetation, which supplies $CO_2$ to sub-surface water. $CO_2$ is necessary for the acidity of water which makes dissolving easier.

ii) **Active movement of underground water :** Water saturated with dissolved $CO_2$ should have easy movement. The greater the permeability of the rock, the faster ground water will flows.

iii) **Joints :** Fracture patterns and joints in the rocks in an area encourage passage for water.

**Erosional and depositional landforms :** Infiltration of water into the sub-surface tends to be concentrated where joints and fractures exist in the rocks. This is the reason why the groundwater forms landforms below the surface. In areas of land with water-soluble rocks, such as gypsum and limestone, the acidic water dissolves the rock. Such cracks enlarge with time. They eventually become larger and then due to continuous solution, develop into roughly circular surface depressions called sinkholes. The surface streams which sink disappear underground through sinkholes. The surface streams which sink disappear underground through sinkholes. Sudden collapse of sinkholes could be a significant natural hazard.

In some areas, groundwater dissolves rock,leaving network of passageways. Sometimes, the water that moves down through sinkholes, strikes a compact and impermeable rock layer. Instead of penetrating further, it starts getting stored and flows parallel to the surface. Minerals like calcium carbonate present in the rock there, get dissolved in this water. Over a period of time this process gives rise to caves. Some are large enough and may extend to few kilometres. For example, one of the caves in Meghalaya in India is 23 km long.

The dripping water leaves behind a deposit of calcium carbonate. Water dries in these caves from the ceiling. Water saturated with calcium carbonate dripping onto the floor of a cave builds up similar but more massive structures. The structures growing from the ceiling are called stalactites. Those growing from the ground of the cave are called stalagmites. Stalactites and stalagmites often continue to grow and may meet to form columns or pillars. When the dripping water contacts the cave air, it releases $CO_2$ to the air. This is the reverse of carbonation process causing the water to precipitate calcium carbonate. See fig. 3.4 B.

**Fig. 3.4 : B) Work of groundwater**

**Work of glacier :**

See fig. 3.5 A, B, C. Answer the following questions.

1) What differences do you find in the three figures?
2) Identify the landforms formed due to erosion by glaciers.
3) Where can U–shape valley be formed?
4) In which region will deposition start?
5) Identify the landforms formed by deposition by glaciers.

## Geographical explanation

Glaciers are important agents of erosion in high altitudes beyond the snowline and in polar areas. In areas with high latitude and high altitudes, precipitation is always in the form of snowfall. As a result, layers of snow accumulate and convert into ice. Due to tremendous pressure of ice, layers of ice start moving down slope very slowly. Such a flow of ice is called glacier. As glacier is in solid state, its velocity is very low. Like other agents of erosion, glaciers too parry out erosion, transportation and deposition. Glaciers remove rock particles from the surface on which they flow by plucking and by abrasion. Abrasion and plucking at the base of a glacier lead to formation of Roche moutonnees They are bedrock hills that are smoothly rounded on the upper side by abrasion and plucking on the lower side.

Ice movement, accompanied by weathering and mass wasting, steepens the wall at the head of the glacier. It deepens into armchair-shaped depression called cirque. Often two or more cirques develop side-by side. This leaves the area between any two of them into a narrow wall. This is called arête. Where three or more cirques are formed, the headward erosion of the glacier erodes the summit. This leads to formation of a characteristic peak which is called a horn. The Matterhorn in the Swiss Alps is an example. As the glaciers move ahead, they erode the sides as well as the bottom of the valleys they flow through (lateral and vertical erosion) equally.

This makes the valley broad at the bottom. This is called a U-shaped valley. You can see the difference in the landform before glaciation sets in. The presence of glaciers (moving ice) changes the landscape. See fig. 3.5 A, B, C.

Like rivers, glaciers too have tributaries. These tributaries also form U-shaped valleys. But, the rate of erosion is different because of difference in sizes of glaciers. The main valley gets eroded faster and becomes deeper than the tributary glacial valleys. These appear to be hanging, when seen from the main valley. They are therefore called hanging valleys. At the confluence of hanging valleys and main valley snow falls in blocks. At these locations, waterfalls form after the glacier disappears.

1) **Drumlin :** Coarse material that moves with glacier gets deposited at different places in the form of heaps. They appear to have egg like shape. Such heaps are called drumlins. At times, large number of drumlins get deposited in an area. If you see this from a higher elevation, it appears like a basket of eggs.
2) **Eskers :** When the coarse material, moving with the glaciers is deposited in linear and zigzag manner it is called an esker.
3) **Erratic rock :** In the areas under the influence of glaciers generally at high latitudes, huge rock pieces are found to have been deposited in the area where the local rocks are of different formation. Such rock appear as erratic ones to the area in which they are deposited. These can be considered as guest rocks.

Glaciers generally deposit load of sediments along the side and front of the ice. These deposits are called moraines. The moraines deposited at the sides of the wall are called lateral moraines. At the toe or foot of the glacier, sediment is deposited in a jumbled heap of all grain sizes forming a curved depositional ridge called end moraines. End moraines, that mark the farthest advance of a glacier are called terminal moraines. Where two tributary glaciers join together, their lateral moraines merge underneath to form medial moraines.

**Use your brain power!**

In which diagram of the three will you find end moraines? See fig. 3.5 A, B, C.

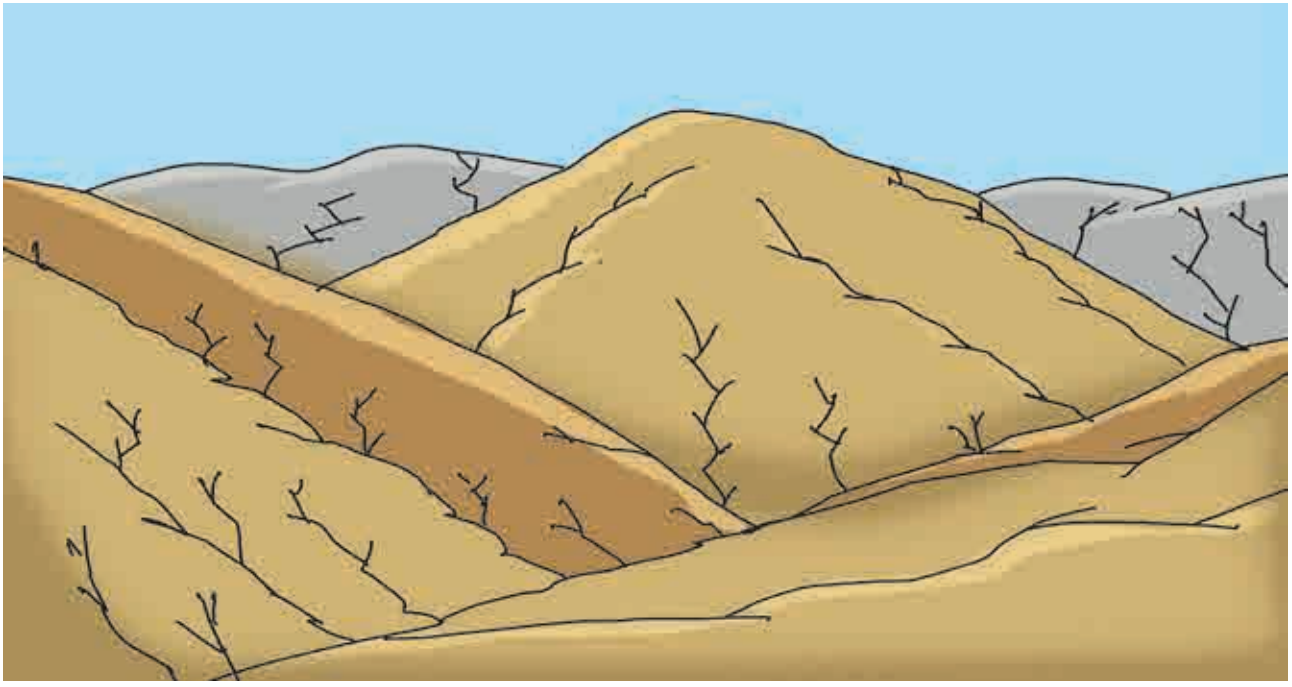


**Fig. 3.5 : A) Pre-glaciation**

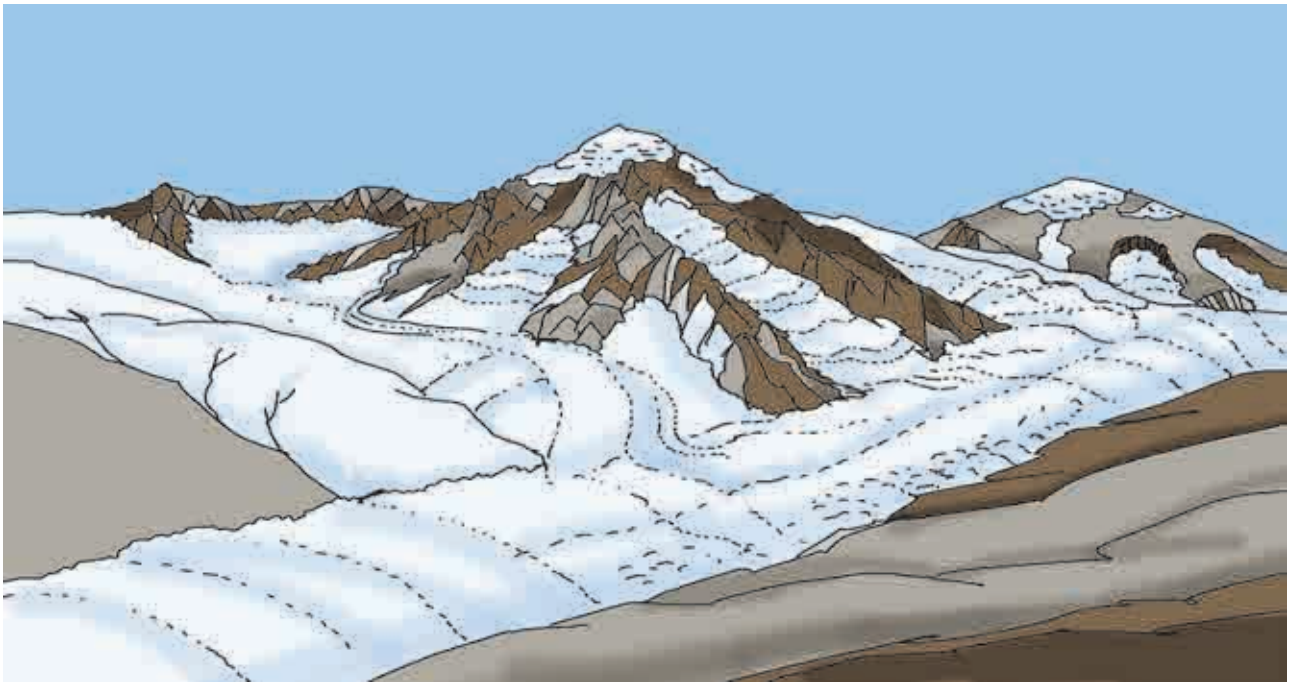


**Fig. 3.5 : B) During glaciation**

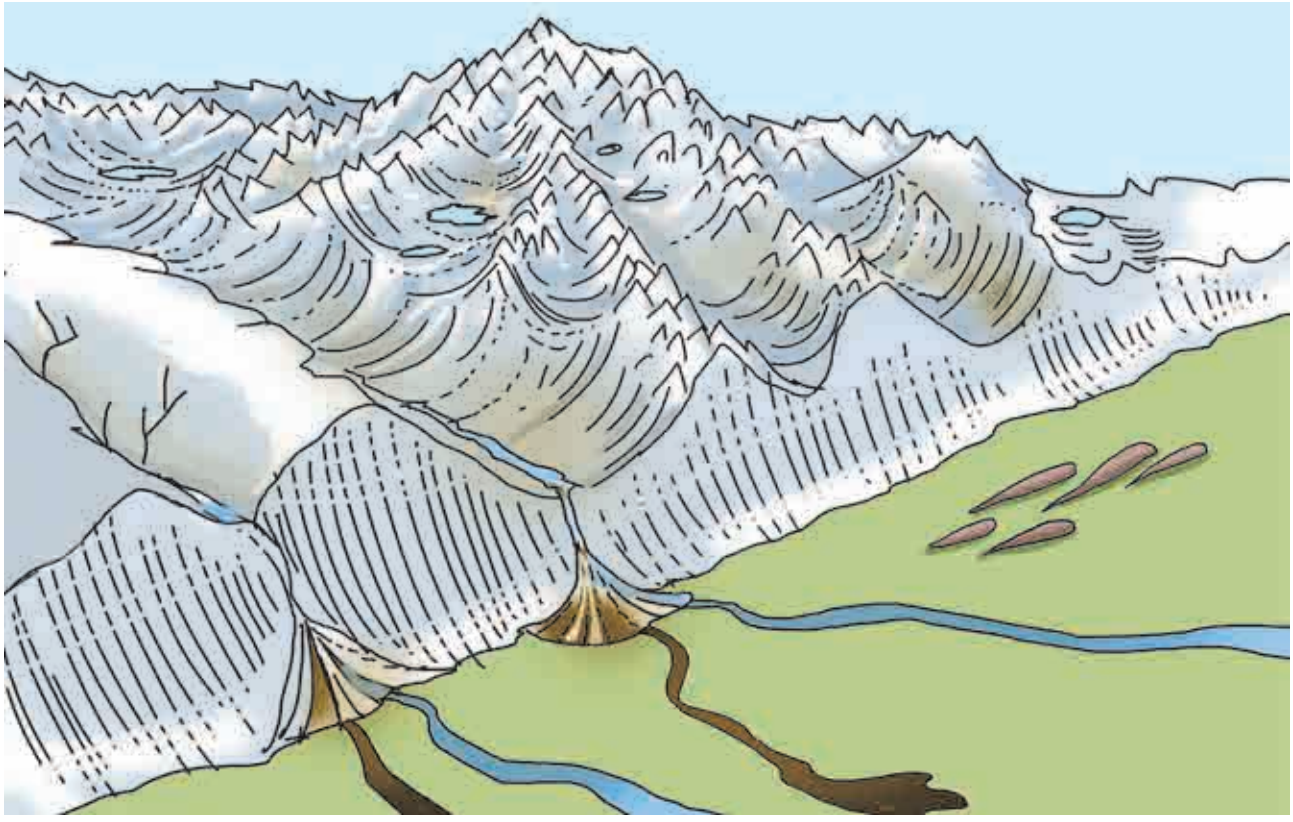


**Fig. 3.5 : C) Post glaciation**

## Exercise

**Q. 1) Complete the table :**

| Agents | Erosional landforms | Depositional landforms |
|---|---|---|
| 1) River | | |
| 2) Wind | | |
| 3) Sea waves | | |
| 4) Groundwater | | |
| 5) Glacier | | |

**Q. 2) Choose the correct option by identifying the correct correlation in the sentences :**

1) Water or snow enters the cracks in the rocks and makes it weak. When the glacier passes on these rocks, it pulls the rocks at the bottom along with it. This process is called

a) Plucking b) Abrasion

c) Attrition d) Transportation

2) Sometimes, the river starts erosion upstream. This happens when the head stream gets a lot of water in the early stages of river's flow.

a) Downcutting b) Headward erosion

c) Lateral erosion d) Vertical erosion

3) Soft rock erodes beneath the hard rock due to sea waves. This results into landforms

which further develop as sea arches. The landform is

a) Sea cave b) sea stack

c) sea cliff d) wave cut platform

4) This landform develops due to depositional work of wind. The windward slope of this landform is gentle.

a) Loess plains b) barchans

c) Seif d) Sand hills

5) River, glacier, wind, sea waves and groundwater are the agents of erosion. Following work in the correct order is responsible to form various landforms.

a) Disintegration, picking up, transportation, weathering

b) picking up, disintegration, deposition, weathering

c) deposition, transportation, picking up, disintegration

d) disintegration, picking up, transportation, deposition

**Q. 3) Give geographical reasons :**

1) The Eastern coast of India have deltas formed by the rivers but the Western coast has estuaries.

2) There is direct relationship between the velocity of the agents and the process of deposition.

3) Compared to all the agents, sea waves work ceaselessly.

4) One finds many sheep rocks, horns, arêtes and hanging valleys in the Himalayas.

5) Karst landforms are seen concealed under the surface of the earth.

6) Snowline decides the limit of glacier work as an agent of erosion.

**Q. 4) Write short notes on :**

1) Attrition

2) The work of rivers in hilly areas and human activities

3) Conditions necessary for work of wind.

**Q. 5) Distinguish between :**

1) Attrition and Abrasion

2) U shaped valley and V shaped valley

3) Stalactite and stalagmite

4) Tributaries and distributaries

**Q. 6) Answer in detail :**

1) Explain the landforms formed by different agents through the process of abrasion.

2) Explain how the depositional work done by river Ganga has been beneficial to human activities.

3) Which agents of erosion can you see on the cover page of the textbook? Which landforms can you see there? Write the process of formation of any one.

**Q. 7) Draw neat and labelled diagrams for :**

1) Deflation

2) Wave-cut platform

3) Mushroom rocks

***

# 4. Climatic Regions

**Use your brain power!**

Have you ever thought why there is difference in the skin colour of various peoples in the world? Why all the people in the world do not eat same food? Why there is a variety in clothing pattern and types too? Even our houses are different. How come flora and fauna are restricted to particular region? Why different fruits are found in different places?

## Geographical explanation

As you know, there are five spheres namely atmosphere, lithosphere, hydrosphere, biosphere and magnetosphere. You have studied about them in earlier classes. Out of these, atmosphere is the one which is actually related with climate and weather. The climate of any region is decided by detailed study and observation for longer period of time such as 30 years. These observations give us an idea about the trends in the weather and its elements. Multiple occurrences of any phenomena of weather with consistency help us to decide the climate of the region. The climate of a place is responsible for the variety in so many factors including our food, our occupations, our houses, our clothes and many activities.

**Can you tell?**

Make a list of the human activities you think that are not influenced by climatic elements. Let us see how far you can proceed.

## Geographical explanation

Climate directly or indirectly influence not only our physiology but all human activities. Climate has enormous influence on the pedological processes. Climate and soils in a region determine the land cover condition of the region. Its effect on the vegetal growth in the region is obvious. Agriculture, that determines the food habits of the population in a region, is greatly influenced by the climate.

### Classification of Climate and identifying Climatic Regions (Natural Regions) :

During the second half of the 19th century and early 20th century, when geographers debated the concept of region and regionalization, climate got primacy over any other criteria for defining the macro regions of the world. There have been many attempts to define macro-regions of the world on the basis of climatic conditions. We will divide these regions on the basis of latitudinal locations. Let us look at each region in detail. Refer to the given map in fig. 4.1 simultaneously. Locate the places on the map. You are advised to use an atlas too.

**Find out !**

Use Internet or reference books to find out about the attempts at classification of climates.

**Do you know?**

Why do we call the Climatic Regions also as "Natural Regions"?

A natural region is a basic geographic unit. Usually it is a region which is distinguished by its common natural features of geography, geology, and climate. From the ecological point of view, the naturally occurring flora and fauna of the region are likely to be influenced by its geographical and geological factors, such as soil and water availability, in a significant manner. Thus most natural regions are homogeneous ecosystems.

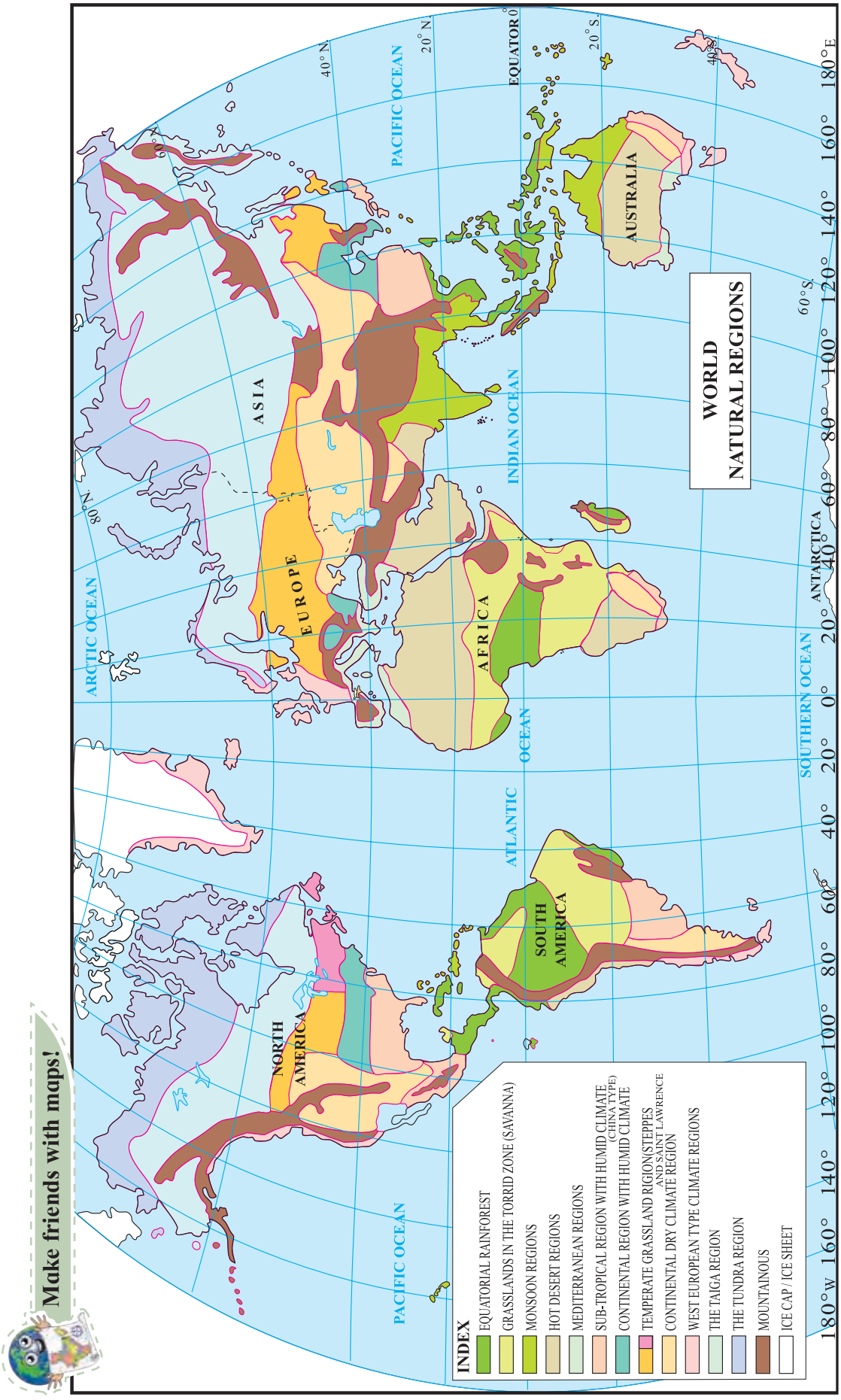



Fig. 4.1

Make friends with maps!

## A) Low-latitude regions : 1) Equatorial Rainforests

### Can you tell?

Read the graphs fig. 4.2 a) and b) and answer the following questions. Locate the places on the map:

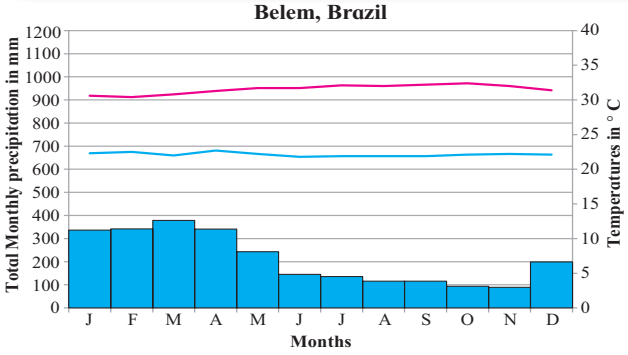



Fig. 4.2 (a)

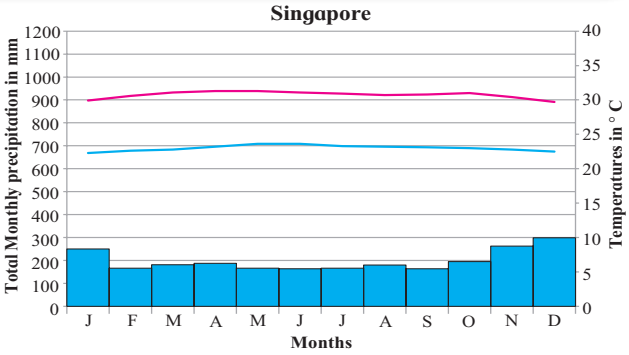



Fig. 4.2 (b)

1) In which months there is no rainfall?
2) In which month is the temperature highest?
3) In which month is the temperature lowest?
4) What could be the factors which influence the climate of these places?
5) Write a concluding statement about the climate of both the places based on the questions above.

### Geographical explanation

Temperatures are almost the same throughout the year in this region. As this region is located within 5° to 10° of the equator, the noon rays of the Sun are always close to being directly overhead. Days and nights are almost of equal length and amount of insolation remains nearly constant throughout the year. In other words, the concept of summer and winter as being hot and cold seasons do not exist in these parts. The ITCZ (Inter-Tropical Convergence Zone) is an area of low pressure in equatorial regions. This is where the northeast and southeast Trade winds converge. They move north or south with the apparent movement of the Sun. Heavy precipitation is associated with warm, humid air of the doldrums, the unstable conditions along the ITCZ and the low pressure areas. Due to convectional currents, moist air rises, condenses and results in heavy rain almost daily. Although no season can be called dry, during some months it may rain only for 15 or 20 days.

| Geographical distribution | Climatic Characteristics | Related features |
|---|---|---|
| • 0° to 10° in both the hemispheres. • Amazon Basin, Congo basin, east coast of Central America, Madagascar, Malaysia, Indonesia, Philippines and Papua New Guinea | • Constant high temperatures, average around 27° C; • Heavy convectional precipitation 2500 to 3000 mm evenly distributed over the year, heavy; • High amount of cloud cover and humidity | • Rainforests, dense three layered vegetation, huge tall hardwood trees, climbing and jumping animals, reptiles, large biodiversity • Iron rich soils, chemical weathering effective than physical • Tribes inhabit the dense forests |

### Use your brain power!

1) What would be the annual range of temperature in this region?
2) Where is this type of climate found in India?

## A) Low-latitude regions : 2) Tropical Monsoon Climate

### Can you tell ?

Read the graphs fig. 4.3 a) and b) and answer the following questions. Locate the places on the map:

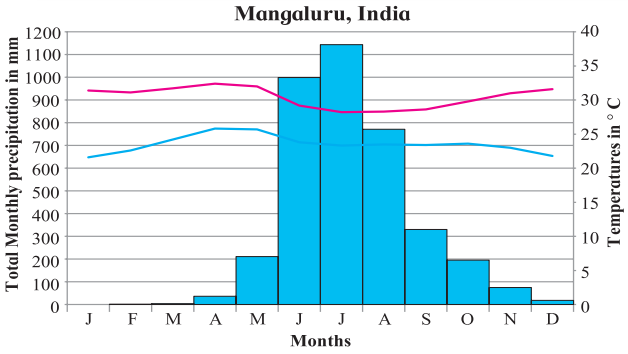



Fig. 4.3 (a)

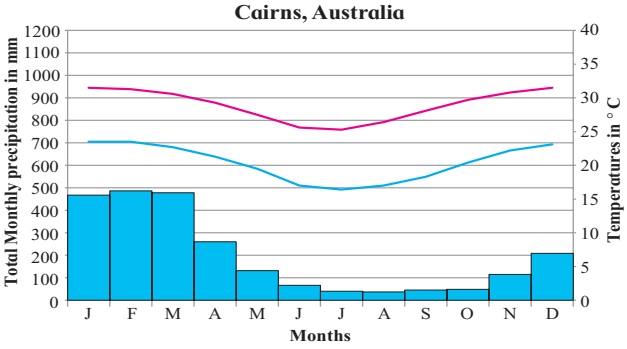



Fig. 4.3 (b)

1) Name the months of highest and lowest rainfall. What is difference between the values of rainfall?
2) Name the months of the highest and the lowest temperatures.
3) Are the months of rainfall same in both the places? If not, why?
4) What could be the factors which influence the climate of these places?
5) What difference do you find in the graphs in fig. 4.2 and these?
6) Write a concluding statement about the climate of both the places.

### Geographical explanation

The climate here has distinct seasons. It has a short dry season unlike the rainforests. The annual range of temperature is higher than that of the rainforest. This type of climate occurs due to seasonal winds called the monsoon. The differential heating and cooling of land and water creates low pressure on the land while the sea experiences high pressure. This is strongly related to shifting of the ITCZ. During the summer the ITCZ moves north to the latitudes of 20°-25°. Several months later, the moisture laden summer monsoon is replaced by dry north-east monsoon. By this time, the ITCZ has shifted to the southern hemisphere. In northern hemisphere, the winds move from sea to land bringing moisture along with them in summers. In southern hemisphere same conditions prevail when there are winters in the northern hemisphere. In summers, their direction is south-westerly while in winters, it is north-easterly.

| Geographical distribution | Climatic Characteristics | Related features |
|---|---|---|
| • Within 10° to 30° N and S in coastal areas of SW India and SE Asia, SW Africa, NE and SE Brazil, northern parts of Australia, parts of Japan | • Summer temperature around 27° to 32° C, winter temperature 15° to 24° C • Rainfall, 250 to 2500 mm one or more month with less than 6cm of rainfall, excessively wet during rainy season, orographic rainfall (India) • High annual range of temperature, • Summer onshore and winter offshore wind movement related to shifting ITCZ and changing pressures over large landmasses | • Spectrum of biodiversity narrows down as compared to tropical rainforest, ranges from jungle to thorn forest in drier boundaries • Large hooved leaf eaters and large carnivores like tigers • Iron rich soils in high rainfall zones • Paddy rice agriculture |

### Use your brain power !

1) Comment upon the type of weathering which will occur in this region.

## A) Low-latitude regions : 3) Tropical Savannah type of climate

### Can you tell ?

Read the graphs fig. 4.4 a) and b) and answer the following questions. Locate the places on the map:

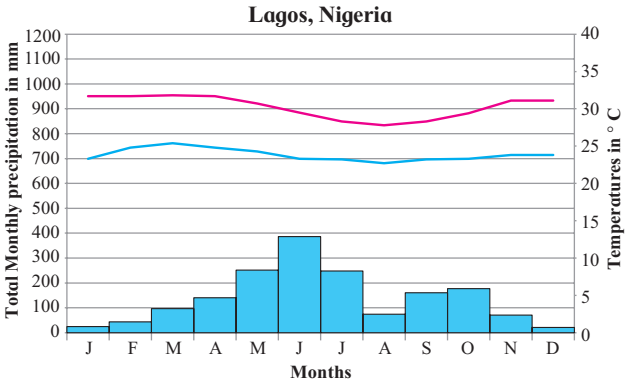



Fig. 4.4 (a)

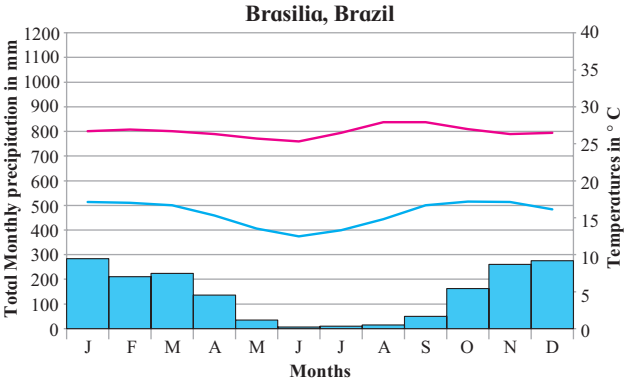



Fig. 4.4 (b)

1) In which months is there no rainfall?
2) In which month is the temperature highest?
3) In which month is the temperature lowest?
4) Are the months of rainfall same in both the places? If not, why?
5) What could be the factors which influence the climate of these places?
6) What difference do you find in the previous and these graphs?
7) Write a concluding statement about the climate of both the places.

### Geographical explanation

The Sun's rays at noon are never far from overhead, the insolation is maximum and temperatures are constantly high here. As the latitudinal wind and pressure belts shift with the direct angle of the Sun, these regions are under the influence of ITCZ for part of the year and sub-tropical highs for the other part. If you see the map, you will find these areas are peripheral to the rainforests. See table for details.

| Geographical distribution | Climatic Characteristics | Related features |
|---|---|---|
| • Between 10 to 20° latitudes N and S<br>• In India parts of the peninsular plateau and rain-shadow zone in Maharashtra, Telangana and Karnataka; parts of Mizoram<br>• Borders around Congo, south-central Africa, llanos of Venezuela, Campos of Brazil etc. | • Distinct wet summers and dry winters, summer temperatures around 35°C, winter temperatures around 24°C<br>• Rainfall averaging 250-1000 mm, Alternating ITCZ and subtropical highs and Easterlies | • Tall and thick grass (Elephant grass), with scattered drought-resistant trees, broad towards the apex, scrub,<br>• Grazing more common, large herbivores, carnivores and scavengers<br>• Herding and animal husbandry occupations |

### Use your brain power !

1) Which agricultural crops are produced here?
2) Why are longitudes not given in geographical distribution?

## A) Low-latitude regions : 4) Tropical Deserts or Arid type of climate

### Can you tell ?

Read the graphs fig. 4.5 a) and b) and answer the following questions. Locate the places on the map:

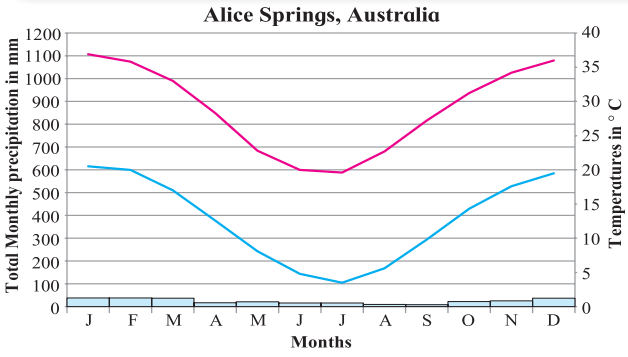



Fig. 4.5 (a)

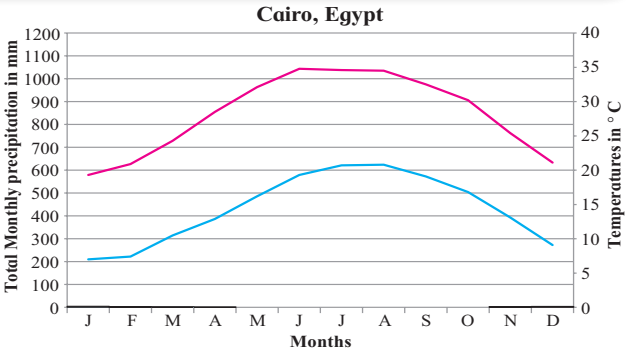



Fig. 4.5 (b)

1) Name the months of highest and lowest rainfall. What is the difference between the values of rainfall?
2) Name the months of highest and lowest temperatures.
3) Are the months of rainfall same in both the places? If not, why?
4) What could be the factors which influence the climate of this places?
5) What difference do you find in the previous and these graphs?
6) Write a concluding statement about the climate of both the places.

### Geographical explanation

The concentration of deserts near both the tropics is because of the sub tropical high pressure belts. This makes the air here dry. Location in the interior of the continents far from oceanic moisture can also lead to formation of deserts. The vast cold deserts of Asia and Great Basin of western USA are examples. Location on the leeward side of the high mountains giving little or no access to moisture-laden winds can also cause deserts. Patagonia Desert of Argentina and arid lands of China are formed due to such rain-shadow conditions. The presence of off-shore cold water due to cold currents can cause deserts near the coast. The Benguela current has given rise to the Kalahari Desert and Humboldt to the Atacama Desert. Winds which pass over these cold waters reach the land with low temperatures. They become warm, as they pass over the land, become dry and make them arid.

| Geographical distribution | Climatic Characteristics | Related features |
|---|---|---|
| • Usually between 20° to 30° latitudes in both hemispheres; Western coasts of all continents, large parts of Gujarat, Rajasthan and south west Haryana, Iran, interior parts of Asia, coastal Chile, Peru, south-west Africa, interior Mexico, Baja California, North Africa, Namibia and parts of US. | • Summer temperatures around 30° to 45° C, winter temperature around 20° to 25° C, highest diurnal range, highest day-time temperatures • Precipitation less than 200 mm • Low or no humidity • Windy conditions, descending, diverging circulation of subtropical highs • Continental location, rain-shadow conditions | • Xerophytic vegetation • Usually small, nocturnal burrowing animals • Badaun (Sahara), Bushmen (Kalahari), Aborigines (Australia) • Saline soils • Agriculture practised near oases |

### Use your brain power !

1) Comment upon the rate of weathering in this climate.

## B) Mid-latitude regions : 1) Mediterranean Climate:

### Can you tell ?

Read the graphs fig. 4.6 a) and b) and answer the following questions. Locate the places on the map:

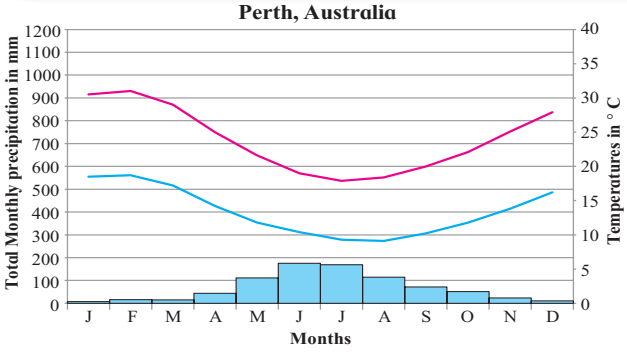



Fig. 4.6 (a)

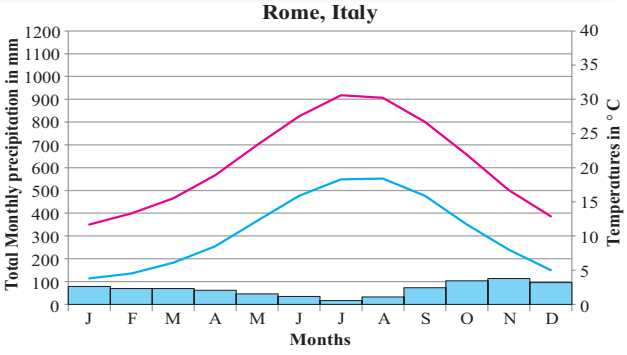



Fig. 4.6 (b)

1) Name the months of highest rainfall.
2) Name the months of lowest temperatures.
3) Are the answers to 1 and 2 same?
4) Are the months of rainfall same in both the places? If not, why?
5) What could be the factors which influence the climate of this places?
6) What difference do you find in the previous and these graphs?
7) Write a concluding statement about the climate of both the places.

### Geographical explanation

In Mediterranean regions, the summers are long, warm and dry whereas winters are mild and wet. They are different from low-latitudinal climates in that the latter have high temperatures throughout the year while the former have a moderate climate. Rainfall in winter is a characteristic of this region. Subtropical high pressure in summer and westerly wind movement in winter dominate this climate.

| Geographical distribution | Climatic Characteristics | Related features |
|---|---|---|
| • Western coastal location between 30° to 40° N and S • Central California, borders of Mediterranean Sea, Cape Town (South Africa), Southern and SW Australia, central part of Chile | • Mild, moist winters, temperature around 10° to 14° C, warm, dry summers, temperature around 21° to 27° C quite sunny, high summer diurnal temperature range • 500 to 1000 mm winter rainfall • Foggy coasts • Alternation between subtropical highs in summer and Westerlies in winter. | • Typically scrub, but also forests, leaves are evergreen, hard, thick, leathery, and usually small • coniferous vegetation in higher altitudes, grass in areas of low rainfall • Winter-sown grains, olives, grapes, vegetables, citrus fruits, animal husbandry • Favorable climate leads to development of tourism and cinema industrie (particularly California) |

### Use your brain power !

1) Why do people in Europe use olive oil for cooking?

## B) Mid-latitude regions : 2) China type climate or humid sub tropical climate

### Can you tell ?

Read the graphs fig. 4.7 a) and b) and answer the following questions. Locate the places on the map:

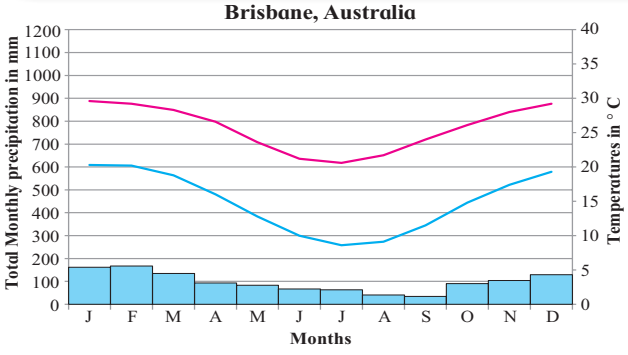



Fig. 4.7 (a)

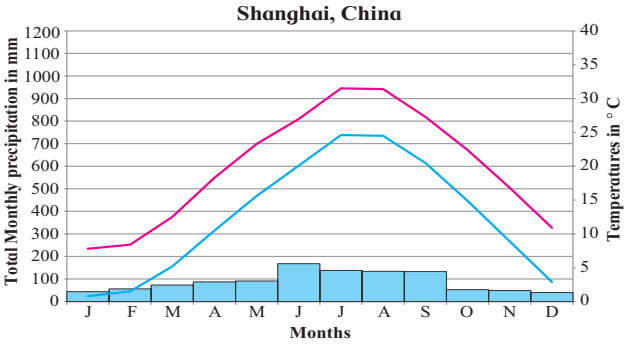



Fig. 4.7 (b)

1) Name the months of highest and lowest rainfall.
2) Name the months of highest and lowest temperatures. Relate them with rainfall months.
3) Are the months of rainfall same in both the places? If not, why?
4) What could be the factors which influence the climate of this places?
5) What difference do you find in the previous and these graphs?
6) Write a concluding statement about the climate of both the places.

### Geographical explanation

The major difference between Mediterranean and China type is that the Mediterranean is found on the western margins of the continents while China type is found in eastern parts almost in the same latitudes. You will find that rainfall is occurring throughout the year. Both the regions receive winter moisture from cyclonic storms but in summers, China type receives rainfall from convectional showers. They are subject to tropical storms.

| Geographical distribution | Climatic Characteristics | Related features |
|---|---|---|
| • East coast location between 20° and 40° N and S<br>• SE USA, SE South America, coastal SE South Africa, eastern Australia, eastern Asia from through South China to southern Japan, Easter island in Chile | • Warmest months above 10° C, coldest between 0° C and 18° C<br>• High humidity, hot summers like tropics<br>• Frost in winter<br>• Generally year round precipitation between 600 to 2500 mm decreasing inland<br>• Humid onshore air movement in summer, cyclonic storms in winter | • Mixed forests, some grasslands, pines in higher altitudes.<br>• Rice, wheat, corn, cotton, tobacco, sugarcane, citrus fruits. |

### Use your brain power !

1) What factors make this region agriculturally productive?

## B) Mid-latitude regions : 3) Marine West European type climate

### Can you tell ?

Read the graphs fig. 4.8 a) and b) and answer the following questions. Locate the places on the map:

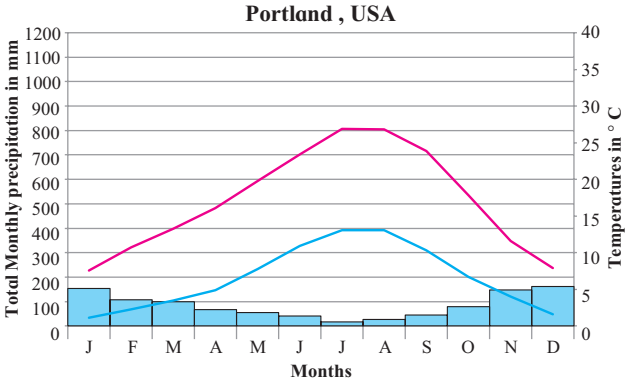



Fig. 4.8 (a)

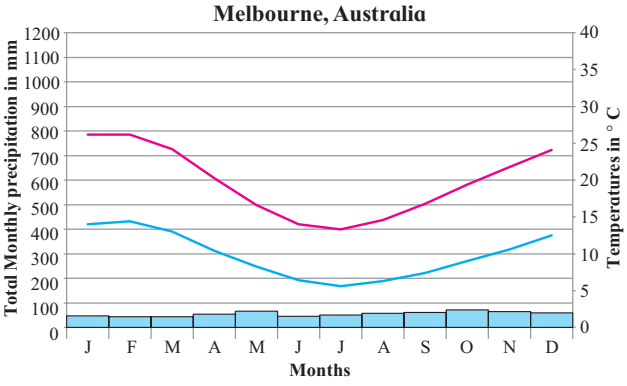



Fig. 4.8 (b)

1) In which months do you find temperature is the lowest?
2) In which months is the precipitation the lowest?
3) What are the highest values of precipitation?
4) Name the months with no precipitation at all.
5) Write a concluding paragraph about this climatic regions.

### Geographical explanation

Considering the latitudes, proximity to the sea and prevailing onshore winds make this climate temperate. Annual temperature ranges are relatively small. Winters are mild because of warm ocean currents. For example, the North Atlantic drifts brings warm tropical waters to the European Coastal area.

| Geographical distribution | Climatic Characteristics | Related features |
|---|---|---|
| • Located in western parts of continents from 45° to 65° N and S. Western coastal USA and Canada, southern Alaska, southern Chile, SE Australia, New Zealand and Western Europe | • Mild to cool summer, temperatures around 20° C<br>• Winter temperature around 5° C<br>• Precipitation year round around 500 to 2500 mm<br>• Heavy cloud cover, high humidity<br>• Drizzle, fog, frost<br>• West coast location under the influence of Westerlies, effect of warm ocean currents in coastal areas. | • Year round short green grass, trees shed leaves during winter, coniferous forest<br>• Wheat, rye, pasture and grazing animals<br>• Coastal fisheries |

### Use your brain power !

1) Why does Chile recur frequently in examples of geographical distribution.
2) Why has fishing developed here?

## C) High latitudinal regions : 1) Taiga or Sub-Arctic

### Can you tell ?

Read the graphs fig. 4.9 a) and b) and answer the following questions. Locate the places on the map:

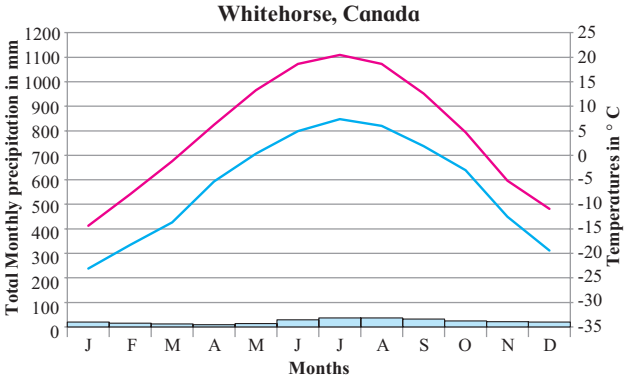



Fig. 4.9 (a)

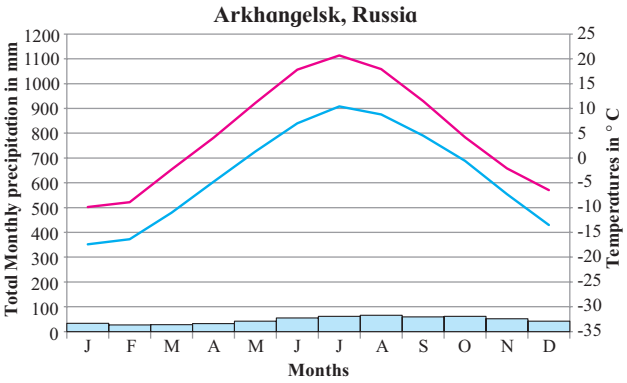



Fig. 4.9 (b)

1) Note the values of the axes. How different are these graphs from the earlier ones?
2) Note the highest and the lowest temperatures and their months
3) Note the highest and the lowest rainfall and their months.
4) Why dose not a place from Southern Hemisphere appear here?
5) What factors are responsible for this climate?

### Geographical explanation

Latitudinal location plays a great role in the climate. The low temperatures reduce the moisture holding capacity of the air leading to low rainfall. If the locations are away from seas, they are again deprived of moisture. In Southern Hemisphere, few settlements exist and there is no permanent human settlement beyond this region.

| Geographical distribution | Climatic Characteristics | Related features |
|---|---|---|
| • High-mid latitudes (55° to 65°) • Northern North America from Newfoundland to Alaska, northern Eurasia from Scandinavia through most of Siberia to the Bering Sea and Sea of Okhotsk | • Brief cool summers, temperature around 15° to 20° C, bitterly cold winters, temperature less than 0° C<br>• Year round precipitation around 300 to 500 mm in summers, snowfall in winter<br>• Heavy cloud cover, high humidity, drizzle, fog, frost, cold winters poleward<br>• Westerlies in summer, strong polar anticyclone in winter (Asia)<br>• Continental location | • Northern coniferous forest (Taiga), soft and light wood<br>• Strongly acidic soils, poor drainage<br>• Short growing season, experimental vegetables and root crops<br>• Animals with fur<br>• Hunting and lumbering |

### Use your brain power !

1) What would be the annual range of temperature in this climate? What could be the occupational activities carried out by humans here?
2) What type of weathering will be prominent here?

## C) High-latitude regions : 2) Tundra climate

### Can you tell ?

Read the graphs fig. 4.10 a) and b) and answer the following questions. Locate the places on the map:

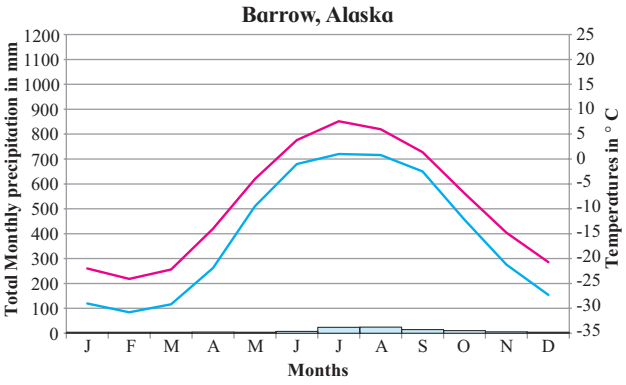



Fig. 4.10 (a)

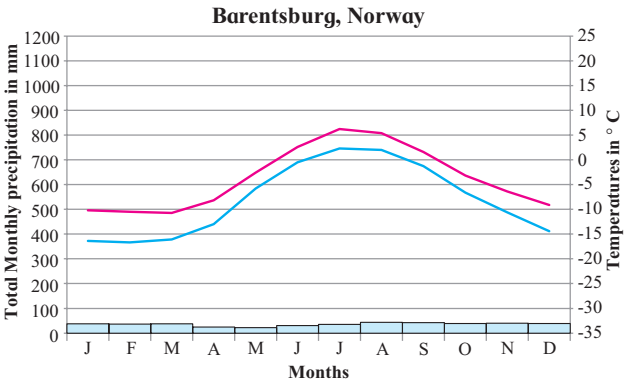



Fig. 4.10 (b)

1) Why is it that both the graphs are from the Northern Hemisphere?
2) Which are the warmest and the coolest months?
3) What is the annual range of temperature?
4) Why does not the duration of day (sometimes more than 24 hours) influence its temperatures or precipitation?

### Geographical explanation

When you compare the graphs, you see that the tundra climate is closer to the poles than the Taiga. The temperature ranges in Tundra are large but not larger than the Taiga. Also, you might have noticed that the winter temperatures are not as severe as the Taiga. How is this possible when the tundra is closer to the poles? This is because if you refer to the map and see the location, the Tundra is closer to the sea while Taiga is away from any ocean body. The temperatures are influenced by the maritime location. Though this region experiences daylight for almost 6 months, the day temperatures are not very high. This is because the sun's rays are oblique and little insolation is received.

| Geographical distribution | Climatic Characteristics | Related features |
|---|---|---|
| • 65° to 90° N, Arctic Ocean borderlands of North America, Greenland and Eurasia, Antarctic, Peninsula, some polar islands | • Summer temperatures around 10° C, winter temperature around -20° to -30° C<br>• Low evaporation<br>• Precipitation around 300 to 500 mm in the form of snow.<br>• Coastal fog, strong winds<br>• Proximity to coasts<br>• Polar anti-cyclones (high pressure belts), near to permafrost | • Tundra vegetation, swamps during melting<br>• Mineral and oil resources<br>• Animal with fur polar bear, seal, walrus<br>• Hunting and fishing<br>• Inuits |

### Use your brain power !

1) What kinds of mass movement may happen here?

## C) High-latitude regions : 3) Ice sheet

### Can you tell ?

Read the graphs fig. 4.11 a) and b) and answer the following questions. Locate the places on the map:

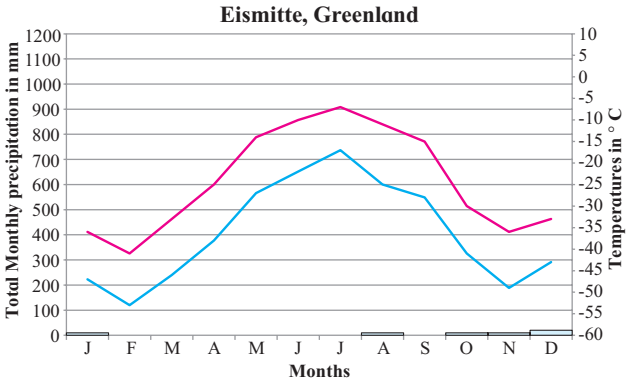



Fig. 4.11 (a)

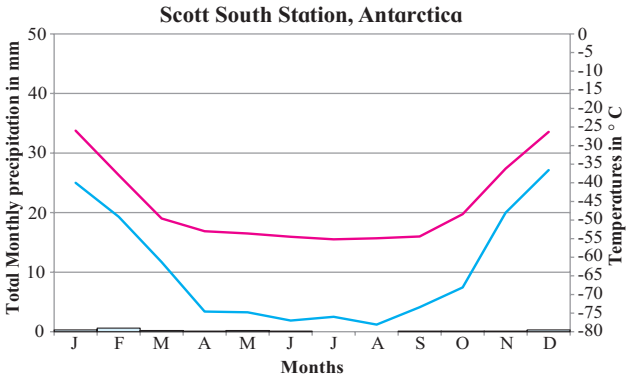



Fig. 4.11 (b)

1) Which are the warmest and the coolest months ?
2) Name the months of highest and lowest rainfall.
3) In what way do you find similarities of this climate with other climate types of high latitudes?
4) What factors influence this type of climate?

### Geographical explanation

The ice cap climate occurs over interior Greenland and Antarctica. It covers the area around the Poles in both the hemispheres. This climate is the most severe climate on the earth. As you can see from the graphs, all average monthly temperatures are below zero. The reason for low temperatures is the minimal insolation received in these regions. There is little or no insolation received during half the year. Also, insolation is received at oblique angles and the perpetual snow cover reflects back the heat received. . Polar anti-cyclone winds limit the precipitation. No vegetation can thrive in this climate. Even in summer, the temperature is below freezing point. This area receives very little precipitation.

| Geographical distribution | Climatic Characteristics | Related features |
|---|---|---|
| • Near the poles in both the hemispheres<br>• Antarctica; interior Greenland; permanently frozen portions of the Arctic Ocean and associated islands | • Warmest month below 0° C<br>• Precipitation exceeds evaporation<br>• All months average below freezing; world's coldest temperature;<br>• Extremely meagre precipitation in the form of snow<br>• Year-round influence of the polar anticyclone; ice cover | • Ice and snow-covered surface; no vegetation<br>• No exposed soils<br>• Only sea life or aquatic birds<br>• scientific exploration |

### Use your brain power !

1) What kind of activities will bring people from other regions to this climate?
2) What could be the occupations followed here?

## D) High-altitude regions : 1) Highland or Mountain type

### Can you tell ?

Read the graphs fig. 4.12 a) and b) and answer the following questions. Locate the places on the map:

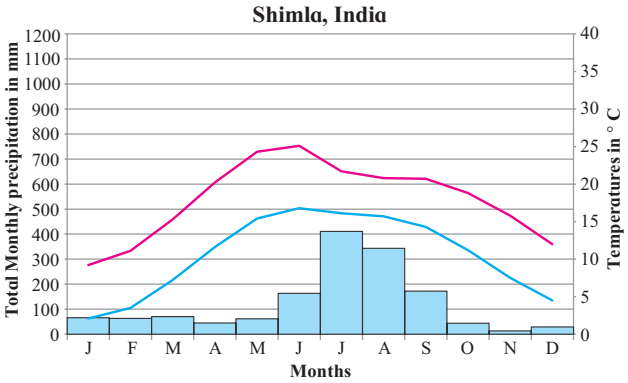



Fig. 4.12 (a)

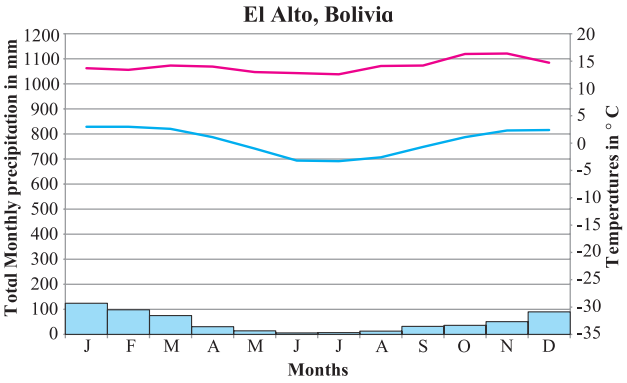



Fig. 4.12 (b)

1) Which are the warmest and the coolest months ?
2) Name the months of highest and lowest precipitation.
3) In what way do you find similarities of this climate with other climate types of high latitudes?
4) Why are the axes showing temperatures different in both the graphs?
5) What factors influence this type of climate?

### Geographical explanation

Highland climates are governed by topography. In high mountains, large changes in mean temperatures occur over short distances. Types of precipitation, its amount and intensity also vary across highlands. Temperature decreases with increasing altitude. A vertical zone of climatic types with increasing elevation in the mountain environment is found.

| Geographical distribution | Climatic Characteristics | Related features |
|---|---|---|
| • Distributed widely over Earth particularly concentrated in higher reaches of mountains in Asia, central Europe, western North and South America. | • Climate depends on altitude, location on leeward or windward side, orographic rainfall, snowfall in higher reaches | • Coniferous in higher reaches, tropical decidous to evergreen, in lower reaches, laterite soils, grazing and pastures, terrace cultivation, tourism |

### Use your brain power !

1) What type of human activities will develop in this region?
2) In what ways might high latitudes be different from high altitudes?

## Exercise

**Q. 1) Write the names of climatic regions according to the factors that dominate their characteristics :**

| Latitudinal location | Winds and wind systems | Proximity to sea | Continental location | Altitude |
|---|---|---|---|---|
| | | | | |
| | | | | |
| | | | | |

**Q. 2) Choose the correct alternative :**

1) Monsoon region

a)
- annual average temperature around 27° C
- >2500 mm annual precipitation
- Indonesia
- Hard-wood evergreen trees

b)
- Average temperature in Summers around 35° C
- < 2500 mm annual rainfall
- South East Asia
- Hard wood deciduous trees

c)
- Temperatures in summer around 35° C
- 1000 mm annual rainfall
- Continental part of Indian peninsula
- Tall and thick grass

d)
- Average temperatures in summer around 27° C
- 1000 mm rainfall in winter
- South Africa
- Hard–wooded, waxy, evergreen forests

2) The region with high diurnal range of temperature :

a) Tropical rainforests

b) Tropical grasslands

c) Tropical desert regions

d) Tropical Monsoon regions

3) Lumbering flourished as an occupation from the Newfoundland to Alaska in North America because :

a) Tundra Climatic Region

b) Taiga Climatic Region

c) West European Climatic Region

d) China-type climatic region

4) The main reason behind the months of precipitation in the graphs of Monsoon climatic regions being different is :

a) ITCZ b) orographic rainfall

c) hemispheres are different

d) apparent movement of the sun

**Q. 3) Give geographical reasons :**

1) In Monsoon climate region, rainfall occurs in specific season.

2) Taiga region is not found in Southern Hemisphere.

3) The diurnal range of temperature is more in desert areas.

4) There is no concept of season in equatorial regions.

5) The Savannah region is prone to droughts

6) Though Mussoorie and Dehradun are located on the same latitude , why is their climate different?

**Q. 4) Differentiate between :**

1) Rainforests and Savannah Climatic Regions

2) Taiga and Tundra regions

3) Monsoon and Mediterranean Regions

**Q. 5) Answer in detail :**

1) Explain, with examples, the effect of latitude on a place's climate.

2) Explain, with examples, how winds affect the climate of a place.

3) Russia is larger than Chile in area but does not experience climatic diversity as Chile. Explain.

4) Explain the factors affecting climate of a place giving examples.

**Q. 6) On a world map, show the following areas :**

1) Savannah climatic region in Africa

2) Highland climatic region in India

3) Chile and Russia

4) Ice cap climatic region

5) Desert climatic region

***

# 5. Global Climate Change

## Can you tell?

The graph in fig. 5.1. shows the difference between the global average temperature of the twentieth century and global monthly temperatures from 1985 to 2015. Answer the questions given below :

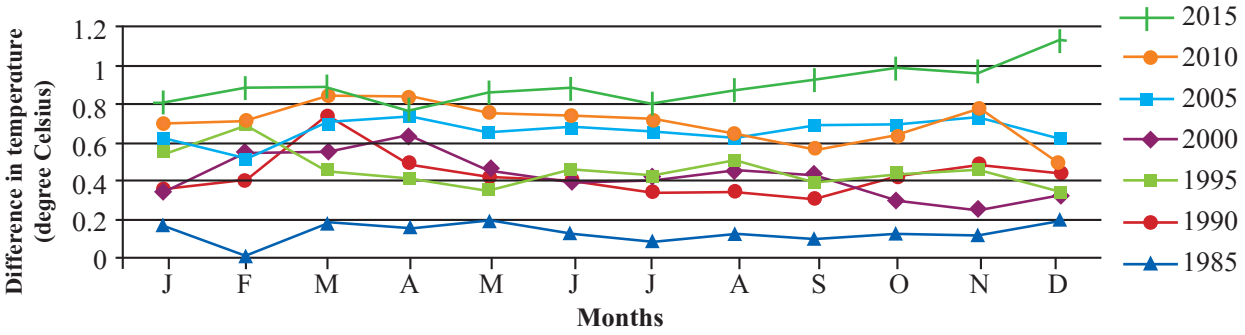



Fig. 5.1

1) In which year is the difference the least?
2) What is the difference between the mean temperatures of the twentieth century and temperature in 2015?
3) Why do the temperatures differ in different months?

## Geographical explanation

We see that the differences in 2015 are above the rest of the given years. This shows that the average temperature of the Earth is rising. Scientists around the world have collected more than a century's temperature records. These analyses all point to a rise of close to 0.8° C in the average surface air temperature of the Earth over the last century.

## Do you know?

How do scientists calculate the average earth temperature?

To get a complete picture of Earth's temperature, scientists combine measurements from the air above land and the ocean surface collected by ships, buoys and sometimes satellites, too.

The temperature at each land and ocean station is compared daily to find out what is 'normal' for that location and time, typically the long-term average over a 30-year period. The differences are called 'anomalies' and they help scientists to evaluate how temperature is changing over time. A 'positive' anomaly means the temperature is warmer than the long-term average; a 'negative' anomaly means its cooler. Daily anomalies are averaged together over a whole month. These are, in turn, used to work out temperature anomalies from season-to-season and year-to-year.

Let us have a look at the surface temperatures of a few planets in the following table.

| Planet | Average Surface Temperature (°C) |
|---|---|
| Venus | 456.85 |
| Mars | -87 to -5 |
| Mercury | 467 |
| Earth | 14 |

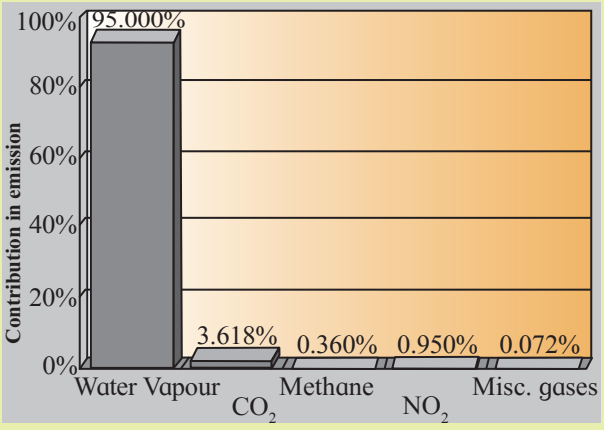
This table shows that the Earth's surface temperature makes it suitable for life to exist.

**Try this.**

Look at the following graph. Answer the following question.

1) Which of these gases has the highest contribution?
2) Which of these gases come from natural and man-made sources?
3) Which activities are responsible for their emission?
4) Out of these, whose emission can be controlled by humans?

**Global Greenhouse Gas Emissions**




## Geographical explanation

The average temperature on the surface of the Earth depends on a number of factors. These include the time of day, the time of year, and where the temperatures measurements are being taken.

The average temperature of the Earth is around 14°C. As given in the earlier graph, this average temperature has increased by 0.8° C. The average surface temperature of the earth is increasing and is likely to increase. It has been found that the impact of gases such as carbon dioxide, methane, etc. has been enormous. It has led to increase in the heat holding capacity of the atmosphere which in turn increases the temperature. This phenomenon is called global warming.

### Is this small rise a big concern?

It may sound like a 0.8° C is not such a big number, but the impact of this rise appears to be phenomenal.

**Let's look at the effects of global warming.**

1) **Heat Waves :** Increases in heat holding capacity of the atmosphere increases the temperature especially during summers. Summers can become even more intense or even deadlier and could bring hot spells. Heat waves of Chicago (1995) and Paris (2003) led to deaths of hundreds of people.

2) **Heat Islands :** Global warming serves as a base from which heat waves become much worse – especially in big cities where the heat island effect comes into play. Urban areas heat up more readily because of paved surfaces and concrete constructions

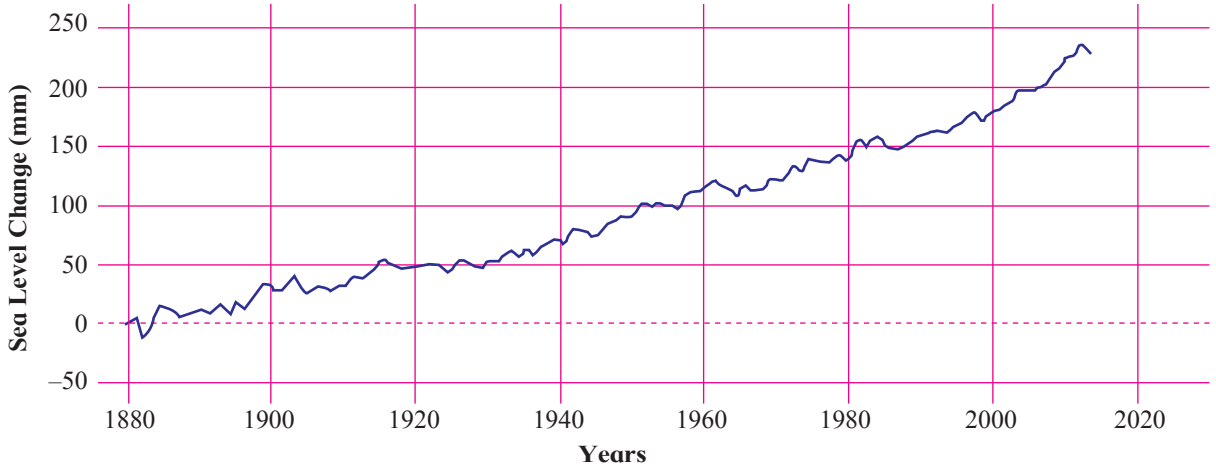



Fig. 5.2

as compared to a field or forest areas. This phenomenon may further increase the temperature of the earth.

3) **Increase in sea level :** Look at the graph in fig. 5.2 and answer the following questions:

i) What does the graph show?

ii) In which year is the change around 225 mm?

iii) What conclusions can you draw by seeing the graph?

iv) What correlation can be seen in this graph and the graph of rising temperatures?

### Geographical explanation

The graph shows increase in global sea level from 1880 till present. With continued global warming, sea levels are likely to rise. Global sea level has been rising over the past century. As seen in the graph, global sea level is around 50 mm more than that in 1990s. Sea level continues to rise at a rate of about 3 mm/ per year. This global sea level rise is apparently being caused because of increased melting of ice such as glaciers and ice sheets.

Higher sea levels may lead to deadlier cyclones and also frequent flooding of coastal areas. Many islands are also at risk of getting submerged. It also means loss of habitat for fishes, birds and plants.

In India too, sea levels are changing at different rates along the coast as per the studies carried out by the Indian National Centre for Ocean Information Services. It projects sea level rise by 9 to 90 cm between 1990 and 2100. This may result in saline coastal groundwater endangered wetlands and flooding of cities and coastal communities around Kutch in Gujarat, Mumbai parts of Konkan coast and southern Kerala. The deltas of the Ganga, Krishna, Godavari, Kaveri and Mahanadi on the East coast are threatened too.

### Do you know ?

What is the difference between global and local sea level? These are two different measurements. Sea level rise at specific locations may be more or less than the global average due to local factors like subsidence of land, flood control in upper part of the river, regional ocean currents, etc.

Sea level is measured using tidal data from stations with the help of satellite and laser altimeters around the world. Tide stations tell about local levels. Satellite data provides us with average height of the whole ocean. Together, both of these help us to know how our ocean levels are changing over time.

4) **Melting of glaciers at high altitudes and snow in polar areas :** Melting of ice is a very natural process. But when glaciers and icebergs melt at an alarming rate, it is a cause of concern. Evident impacts of global warming are retreating glaciers. Studies using satellite data from 1989 till present show that glaciers have retreated. See fig 5.3 A and B. The satellite images show the Gangotri Glacier, situated in the Uttarkashi District of Garhwal Himalayas. Compare these images. Gangotri glacier is one of the largest in the Himalayas. Over the last 25 years, Gangotri glacier has retreated more than 850 meters, with a recession of 76 meters from 1996 to 1999 alone. You can notice the change in between the years 1984 and 2018. This is an indicator of glacial retreat. This means that there is lesser ice formation each year than its rate of melting. This retreat is around 22 m per year.

Many scientists regard receding glaciers as a symptom of global climate change. Similar observations have also been made

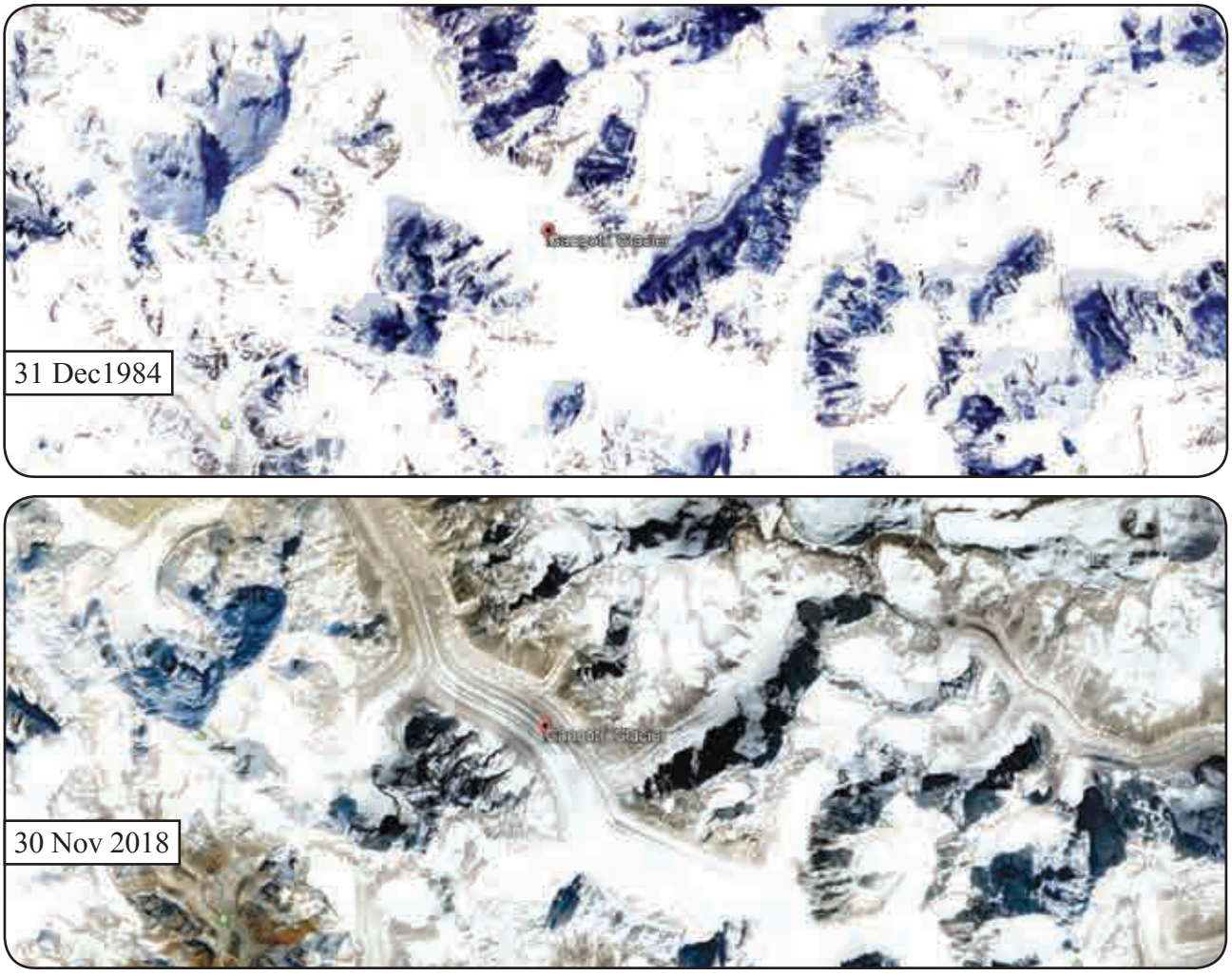



**Fig. 5.3 A) and B) Deglacification of Gangotri**

in the glaciers near Mt. Kilimanjaro in Africa. In general glaciers in polar areas have also been reported to have melting at faster rates. Similarly, glaciers all across the Alps are retreating and disappearing every year.

5) **Other effects :** Because the earth is warming up, some other indirect effects are also seen. Some of them are as follows:

i) Around the world the jellyfish seem to be reproducing heavily and congregating in places where they were never seen before. This is happening because of warmer waters and changes in the acidity level of the oceans.

ii) Spread of insects in newer regions : Global warming will apparently increase the number of mosquitoes. Adult mosquitoes prefer higher temperatures and wet conditions to breed. In areas where temperatures are now rising higher than averages, mosquitoes are thriving and diseases like dengue are spreading.

iii) Coral reefs : When temperatures change, corals throw out the algae living in their tissues. These algae are responsible for their colour. An increase of 1°- 2° C in ocean temperatures for a long time can lead to bleaching, turning corals white. If corals are bleached for prolonged periods, they eventually die. Coral bleaching leads to death of large amounts of corals. More than one-fifth of the coral reefs are already lost.

**Find out !**

Use internet and reference books on climate change and make a list of species vulnerable due to climate change.

## Climate Change :

**Try this.**

Talk to the elders in your family or those around you. Ask them what difference do they feel today than what they felt in their childhood while experiencing the seasons.

### Geographical explanation

If you have discussed the difference in experiencing seasons with the elders, they will tell you many things about the change they feel in the intensity, duration and spell of the seasons. These are some of the observations of the elders at local level. Changes in this similar pattern have been observed even at the global level. They may include changes in arrival of Monsoons, quantity and frequency of rainfall, change in seasons, changes in flowering, increase in occurrence of floods or drought, etc. This frequent change in the patterns of climate at the global level is considered as climate change.

There have been many instances where the climate patterns have shown a drastic change in their occurrence. The IPCC (Intergovernmental Panel on Climate Change) has been mentioning about these indicators in their reports regularly. Let's discuss these in detail.

1) **Increase in the number and intensity of floods :** There has been an increase in number of flash floods and also the duration of the floods. This could be because of very high precipitation in one day (Mumbai, 2005; Kedarnath, 2013) or because of changed weather conditions like cyclones (Chennai, 2015). Overall, many cities or regions have reported of increased flooding activity. Urban areas have seen more of flash floods. Also, coastal cities like Venice are facing flooding issues.

2) **Increase in the intensity of droughts and cyclones :** In addition to triggering more rainfall, global warming could also increase the occurrence of drought. A study has shown that the percentage of Earth's land area undergoing serious drought has doubled since 1970s. The roots of both flooding and drought lie in the physical process known as evaporation. As global warming heats the world's oceans, the water molecules near the sea surface become more energetic and tend to evaporate into the

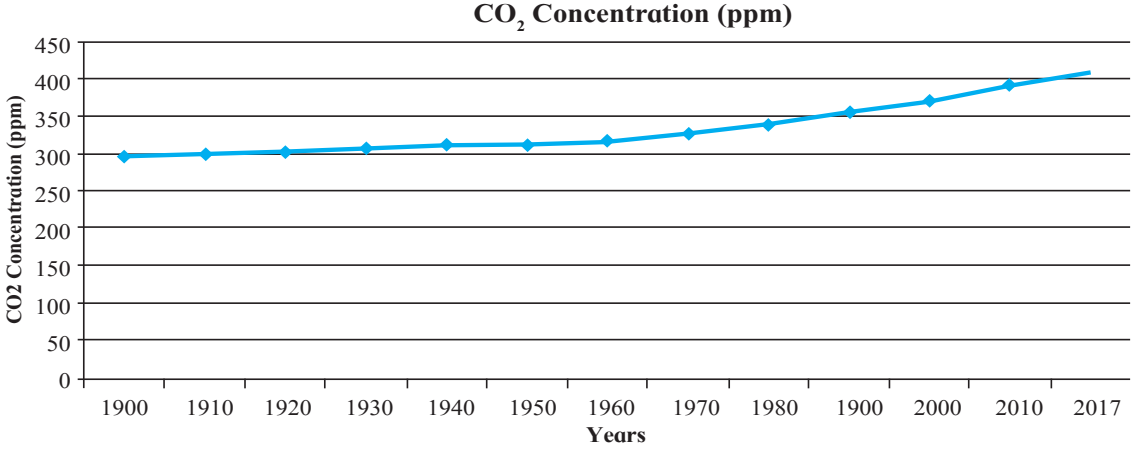



Fig. 5.4

atmosphere more readily. Thus, the air gets more water vapour. This effect gets stronger with each additional degree of warming. Similarly, the number of cyclones in a year has increased in the tropical regions and so have their intensities.

**Can you tell ?**

Look at the graph in fig. 5.4 and answer the question

1) What does the graph show?
2) What does ppm mean?
3) Since which year has the increase been phenomenal?
4) Can you think of the reasons behind the increase in carbon dioxide?

3) **Carbon dioxide and crop yields :** The graph shows increasing levels of carbon dioxide in the atmosphere in parts per million (ppm). Increasing amount of $CO_2$ in the air has an impact on health, climate, agriculture, air pollution and global warming. The World Health Organisation (WHO) suggests that more than 350 ppm of $CO_2$ is harmful to the environment. It has been observed that with more $CO_2$ in the air, crop yield has increased. Some areas in colder climates have been brought under agriculture because of warming. In some places, amount and continuity of rainfall has increased. This, in turn, affects the crop yield.

4) **Rainforests and climate change :** Studies say that rainforests play a major role in cooling the earth. But in the moist tropics, the broad leaves of a rainforest canopy help trap moisture and allow it to slowly evaporate, providing a natural air –cooling effect. When rainforests are slashed and burned over large areas, hotter and dryer conditions set in. When these forests are burned, they release huge amount of carbon dioxide adding to the atmosphere's load. Deforestation at a large scale has also been reported to alter rainfall patterns and amount of precipitation.

## Causes of climate change :

Though we believe that humans activities are a major cause behind climate change, there are some natural causes for climate change. Some of the natural causes of climate change are as follows:

1) The amount of energy output by the Sun is not the same always. Low energy output by the Sun can reduce amount of insolation received by the earth. This can lead to cooling of the earth.
2) Another cause are the Millankovitch oscillations. Earth revolves around the Sun. Variations in the earth's orbital characteristics around the sun and the changes in the earth's axial tilt occur. Scientists belive that these changes alter the amount of insolation received from the sun, which in turn, might affect its climate. They can cause the Earth to be closer to the Sun (warmer) or further from the sun (colder). Ice ages can occur when we are further from the Sun.
3) Volcanism is considered as another cause for climate change. Volcanic eruptions throw lots of particulates and aerosols (especially sulphur dioxide) into the atmosphere. These aerosols remain in the atmosphere for a considerable period of time. The winds spread it around the world reducing the sun's radiation reaching the Earth's surface. It has been observed that all of the coldest years on record in the past two centuries have occurred in the year following a major volcanic eruption. After the recent El Cion (1982) and Pinatubo (1991) volcanic eruptions, the average

temperature of the earth fell to some extent for some years.

4) The scientists believe that the earth lies in a habitable zone called the Goldilocks Zone. Earth experienced cooler climate early in its history, when it was located in the outer reaches of this zone. As the size of the Sun increses the zone moves outward over time. Such changes in the zone causes earth to warm or cool.

Besides these natural causes, we have already seen the anthropogenic effect on the climate. The emission of $CO_2$ mainly comes from fossil fuel combustion. Large scale deforestation also increases $CO_2$. The atmosphere takes around 20 to 25 years to adjust these high levels of $CO_2$. Therefore, it is generally regarded that man and his activities are a major cause of climate change.

## Is climate change happening for the first time?

**Do you know?**

**Ice age :**

An ice age is a period in Earth's history when the ice on the polar caps significantly expanded due to an overall lowering of the Earth's global temperatures. During these periods land in North America and Northern Europe were covered by huge ice fields and glaciers.

Infact, we are currently living in an ice age. The Earth is in a warmer stage of the ice age called an interglacial period.

It is not the first time that we are experiencing this change in climatic patterns. There have been many major and minor fluctuations in the type of climate we experience now. The Earth has witnessed many variations in climate since the beginning. There are various geological records that show alteration of glacial and inter-glacial periods. The sediment deposits in glacial lakes also reveal the occurrence of warm and cold periods. The rings in the trees provide clues about wet and dry periods. Historical records describe the variations in climate. All these evidences indicate that change in climate is a natural and continuous process. There are periods within ice ages that scientists define as glacial and interglacial. A glacial period is a cold period when the glaciers are expanding. On the other hand, in an interglacial period, a warm climate makes the glaciers recede.

## Some Tools for studying climate change

Paleoclimatology is the study of the weather and climate of the Earth's past. Scientists and meteorologists have been using instruments to measure climate and weather for the past 140 years only! Then how do they tell about the climate millions of years ago? They use historical evidence called proxy data. Examples of proxy data include tree rings, ice cores, coral reefs and ocean sediments.

**Coral reefs -** are very sensitive to changes in climate. Corals form skeletons by extracting calcium carbonate from the ocean waters. When the water temperature changes, densities of calcium carbonate in the skeletons also change. Coral formed in the summer has a different density than coral formed in the winter. This creates seasonal growth rings on the coral. Scientists can study these rings to determine the temperature of the water and the season in which the coral grew. See fig. 5.5.

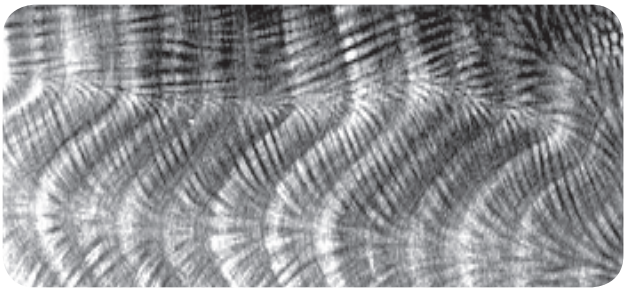


**Fig. 5.5 Coral rings under X-ray. Each of the light/dark bands in this X-ray is a cross-section of a coral core formed during a year of growth.**

**Tree rings -** Variation in these rings is due to variation in environmental conditions when they were formed. Thus, studying this variation leads to improved understanding of past environmental conditions. See fig. 5.6.

**Fig. 5.6 Tree rings**

**Ice cores -** are samples of ice taken from the inner sides of the ice sheets. Throughout each year, layers of snow fall over the ice sheets in Greenland and Antarctica. Each layer of snow is different. Summer snow differs from winter snow. Each layer gives scientists a lot of information about the climate each year. See fig. 5.7 and 5.8.

**Fig. 5.7 Ice core sample**

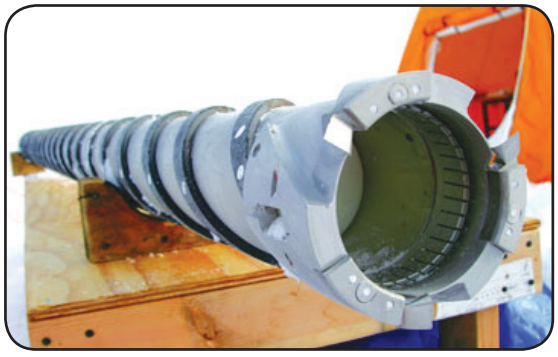


**Fig. 5.8 Ice driller used for taking sample from ice**

Many parts of the world experienced alternate wet and dry periods. Geological findings show that the Rajasthan desert experienced wet and cool climate around 8000 years back. It became drier around 4000 years ago after the Harappa civilisation. In the geological past, the earth was also warmer around 500-300 million years ago. Approximately 10,000 years ago, the last glacial period ended. The well-preserved fossils from animals and plants, such as the mammoth, are from this late era.

The changes in the climate in the past century do not actually point out that humans are involved in this.

**Find out !**

Make a list of movies based on ice age and climate change.

### If the climate of the Earth has changed many times before, then why are we concerned now?

The current warming trend is of particular significance because most of it is extremely likely to be the result of human activity since the mid-20th century and proceeding at a rate that is unprecedented over decades to millennia.

Earth-orbiting satellites and other technological advances have enabled scientists to see the bigger picture, collecting many different types of information about our planet and its climate on a global scale. This body of data, collected over many years, indicates a changing climate.

Ice cores samples drawn from ice cores in Greenland, Antarctica, and tropical mountain glaciers show that the Earth's climate responds to changes in greenhouse gas levels. Ancient evidence can also be found in tree rings, ocean sediments, coral reefs, and layers of sedimentary rocks. The ancient evidence also reveals that current warming is occurring roughly ten times faster than the average rate of warming.

### What steps have been taken to tackle climate change?

In the twentieth century, many researchers had started working on topics such as climate

history of the earth, use of fossil fuels, local climate changes, etc. In 1950s, precise measurements of $CO_2$ in the atmosphere confirmed its steady increase in the atmosphere. Later on, the greenhouse gases were also reported to increase. By 1980s, it was found that the temperature of the earth is rising.

A lot of research has been tackled by the Inter governmental Panel on Climate Change (IPCC). Till now, the IPCC has published 5 reports on climate change and several special reports with the latest one published in October 2018 on Special Report on "Global Warming of 1.5°C" (SR1.5).

The reports have given targets to all countries so that together we prevent the earth from warming. Besides these, the countries have also signed Kyoto Protocol the Paris Agreement (2016), etc.

**Do you know?**

The United Nations Framework Convention on Climate Change (UNFCCC) is an international environmental treaty adopted on 9 May 1992 at the Earth Summit in Rio de Janeiro. The Kyoto Protocol is an international treaty that commits member countries to reduce greenhouse gas emissions. The Montreal Protocol, finalized in 1987, is a global agreement to protect the stratospheric ozone layer by phasing out the production and consumption of ozone-depleting substances (ODS). In the adopted version of the Paris Agreement, the parties will also "pursue efforts to" limit the temperature increase to 1.5° C. The 1.5° C goal will require zero emissions sometime between 2030 and 2050, according to some scientists.

**Do you know?**

The Nobel Peace Prize 2007 was awarded to Intergovernmental Panel on Climate Change (IPCC) "for its efforts in combating climate change.

### Climate change and india :

Developing countries, the Least Developed Countries (LDCs) and small island nations are at the highest risk of damage due to the climate change. For example, it is predicted that Fiji will be underwater within 50 years. These countries such as India and China who now contribute significantly to global emissions have an important role to play. However, at the same time they have to fulfill their development needs through utilization of natural resources and industrialization.

India has high vulnerabilities to climate change impacts due to its peculiar economy and geography. Besides, promoting clean energy and taking steps to proetect environment, the government of India has taken the important steps for combating climate change :

1) **National Action Plan on Climate Change (NAPCC), 2008**
   It consists of 8 sub missions which together make up the national plan.

**Find out !**

With the help of Internet, find out the details of the National Action Plan on Climate Change (NAPCC), 2008 and its missions.

2) **National Adaptation Fund for Climate Change (NAFCC)**
   To assist State and UTs particularly vulnerable to the adverse effects of climate change in meeting the cost of adaptation. NABARD has been appointed as National Implementing Entity for the fund

3) **National Clean Energy Fund (NCEF)**
   Fund has been created using the carbon tax

on coal for funding R&D projects in clean energy technologies of public or private sector. An assistance of up to 40% of the total project cost will be provided either in the form of loan or grants

### Lifestyle changes and climate change :

It is now believed that we can all make changes in our lifestyle to combat climate change effectively. This could include only buying things that are necessary, walking smaller distances, using energy efficient devices, reducing our dependence on wood, not using plastic , etc.

**Try this.**

Make a list of things you need to change in your lifestyle.

## Exercise

**Q. 1) Complete the chain :**

| A | B | C |
|---|---|---|
| 1) Melting of snow | 1) Methane | 1) Flooding |
| 2) Effects of insolation | 2) Average temperature of the earth | 2) Agriculture |
| 3) Greenhouse gases | 3) Erratic rains | 3) Existence of life on earth |
| 4) Climate change | 4) Increase in sea level | 4) Increase in frequency of cyclones |

**Q. 2) Identify the incorrect factor:**

1) The causes of global warming
   a) Emission of greenhouse gases
   b) Deforestation
   c) Apparent movement of the sun
   d) Industrialization
2) The indicators of climate change
   a) Retreat of glaciers
   b) Increase in the frequency of floods
   c) Increase in the frequency of cyclones
   d) Increase in the minimum and maximum temperature
3) The tools for studying climate change
   a) Ice cores  b) Coral reef
   c) Tree rings  d) Ancient forts
4) Measures to combat climate change
   a) Banning the use of pesticides and insecticides.
   b) Promoting afforestation and banning deforestation
   c) Banning public transport
   d) Banning fossil fuels

**Q. 3) Give geographical reasons:**

1) It is important to study climate change
2) There is a great possibility that we may not see Maldives on the world map in the future.
3) The snowline is retreating
4) There is an increase in the frequency of droughts and cyclones

**Q. 4) Write short notes :**

1) Bleaching of coral reefs
2) Flash floods
3) Tools to study Paleoclimatolgy
4) Greenhouse gases

**Q. 5) Answer in detail :**

1) Climate change has not always been anthropogenic in nature. Explain.
2) What measures will you suggest to combat climate change in your village/city.

***

# 6. Ocean Resources

### Use your brain power!

Collect information of the following and discuss in the class :

- Major journeys carried out by explorers in the last millennium
- Discovery of continents, countries and islands
- Spread of culture, trade and religions

Comment on how oceans have played a major role in all the three points mentioned above.

## Geographical explanation

During discussion, you must have realised that in the early fifteenth century, only a small part of the whole world was known. Later on, besides Europeans, navigators from other parts of the world also sailed around the world and collected information about new lands. The scientific study of oceans began in the early nineteenth century. In this period an important voyage of discovery took place between 1872 and 1876 when the British ship 'Challenger' sailed around the world. It brought new information about the ocean depths and teeming life found in them. In 1920s, the Echo sounder came into regular use. With the help of this technique, the map makers began to map different ocean floors. Today, many nations are involved in the study of the oceans.

### Do you know?

The Echo Sounder is a type of SONAR (Sound Navigation and Ranging) device. It is used determining the depth of the sea bed or detecting objects in deep water by measuring the time taken for sound echoes to travel.

### Try this.

Look at figure 6.1 and answer the following question.

1) What does the figure show?
2) In which part of the figure is the ocean shallow? Which human activities can be carried out here?
3) In which part does deposition of sediments occur?
4) Where in the figure do you find islands formed due to submerged mountains?
5) Label the figure with correct names of landforms.
6) Compare these features with the landforms on the earth.

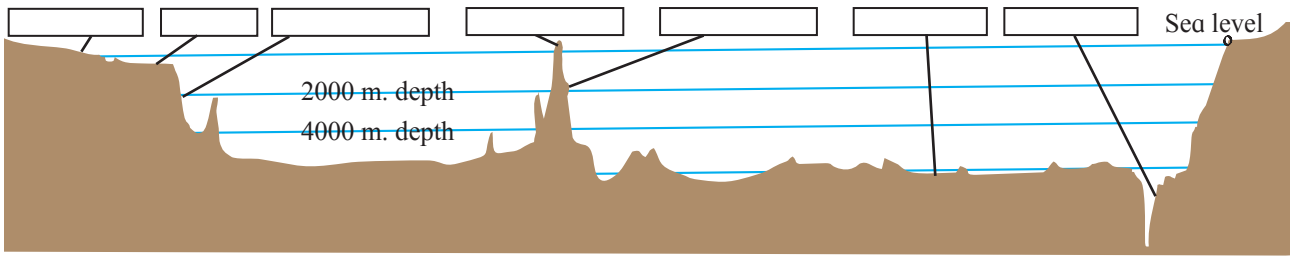



Fig. 6.1 : Ocean floor

## Geographical explanation

Now, recall the relief of the ocean floor and its parts such as continental shelf, continental slope, abyssal plain and deeps or trenches.

### The structure of ocean floor :

These days, not only are the surface or coastal areas of the ocean exploited but even advanced research is being carried out to see how the deeper part of the oceans can be useful to mankind.

i) **The continental shelf :** The portion of the continents that is submerged under water and borders the coastal areas is known as a continental shelf. The continental shelf is of great importance to man. This part occupies about 7.6% of the oceanic area. They are broad, shallow and gently-sloping plains covered by water. The continental shelf does not extend into the ocean uniformly. Near some coasts, it is narrow while in some parts it may extend for hundreds of kilometres. For example, they are almost absent or very narrow along the coasts of Chile, Sumatra etc. while the Siberian coast near the Arctic Ocean is around 1500 km in width. Generally, its depth from the sea level is about 180 to 200 m.

As the sunlight reaches this part of the ocean bed, it is rich in plankton. These millions of microscopic organisms found in sea water are an important food for fish. Millions of fishes thrive here. The shelf has some of the richest fishing grounds in the world, such as the Grand Banks and Georges Bank in North America. In fact, the fish caught in the continental shelf form the backbone of the fisheries industry the world wide.

The continental shelves contain the world's largest reservoirs of natural oil and gas. For example, the Mumbai High in Arabian sea. Besides oil and gas, minerals are also found here. The concentrated minerals are often in large enough quantities to be minable. Examples are diamonds, chromite, ilmenite, magnetite, platinum, gold and phosphorite deposits. Sand, gravel aggregates and industrial silica sand are the most important of hard minerals now extracted in the near offshore zone.

ii) **Continental slope :** After the extent of continental shelf is over, there is a sharp drop in the ocean floor. The gradient of slope in this region can be between 2° to 5° This is called continental slope. The depth of this slope extends from 200 m up to 4000 meters from sea level.

Due to its steepness, the continental slope stretches over a limited area. The deposition of sediments is also limited in this part. The continental slopes are generally considered as boundaries of continents. It covers about 8.5 percent of total ocean area. Methane hydrate, a compound of water and methane, is present on the continental slopes. e.g. The Krishna-Godavari offshore basin covering an area of 1400 $km^2$, is rich in methane hydrate. On the slope, we find many traces of submarine landslide activity, ocean canyons and huge avalanche fans. For example, Congo Canyon is a submarine canyon found near Africa.

iii) **Abyssal plains :** Beyond the continental slope, lie the abyssal plains. They stretch over great distances. Over these plains, there are features such as sea mounds, mountains and plateaus. They have gentle slope and cover about 66 percent of the oceanic floor area. The relief on the plain is produced by volcanic and tectonic activities. Other components of the abyssal plain sediment include wind-blown dust, volcanic ash, chemical precipitates and occasional meteorite fragments.

The abyssal plains are often littered with nodules of manganese containing varying

amounts of iron, nickel, cobalt, and copper. These pea to potato-sized nodules are formed by the precipitation of minerals from the seawater onto bones or rock fragments. Currently, the deposits of manganese nodules are not being mined from the ocean floor, but it is possible that they could be collected and used in the future.

iv) **The oceanic trenches :** At places, deep, narrow and steeply sloping depressions are found on the ocean floor. These are called ocean deeps or ocean trenches. Generally, the shallow ones are called deeps whereas deeper ones are called ocean trenches. The oceanic trenches are the deepest parts of the oceans. These trenches can be thousands of metres deep. They generally occur along plate boundaries and are associated with active volcanoes and strong earthquakes. The Mariana Trench in the Pacific Ocean is around 11 km deep while the Java trench in Indian Ocean is around 7.7 km deep. The knowledge of ocean trenches is limited because of their depth and their remoteness.

**Do you know ?**

Trench exploration to date has been extremely limited. Only three humans have ever visited the sea floor below 6,000 meters. Much of what is known about trenches and the things that live there has been derived from the two sampling campaigns in the 1950s.

v) **Oceanic ridges and plateaus :** The submerged mountains on the ocean floor are called oceanic ridges. They are hundreds of kilometres wide and they extend for thousands of kilometres. Some oceanic ridges have flat, extensive tops. These are called oceanic plateaus. For example, Chagos plateau in Indian Ocean. At places, the peaks of oceanic ridges appear above the ocean surface. These are called oceanic islands. They are of different types :

a) Continental islands e.g. Madagascar Island, South-Western Indian Ocean.

b) Volcanic islands e.g. Hawaiian Island, Pacific Ocean

c) Coral islands e.g. Aldabra Islands, Indian Ocean.

Seamounts are isolated habitats that have evolved slowly over millions of years and they support communities having a high degree of endemism. Studies have shown that organisms found near islands and sea mounts have been new to science whenever they are discovered or tested for research. These properties make sea mounts of special ecological significance and they are of particular interest to conservationists and environmentalists.

**Find out !**

Find out the name and locations of islands located in India and list them in above given categories.

Besides the oceanic relief features described above features such as canyons, valleys, etc. are also found on the ocean floor. You can now understand the similarity between these features and landforms on the earth surface.

**Ocean resources :**

There are variety of resources found abundantly at different levels of ocean floor. They can be classified as 1) Biotic resources, 2) Abiotic resources.

1) **Biotic resources :** It include mainly plants and animals. The oceans provide a habitat for thousands of species of marine plants and animals, which are source of food for many organisms including man. Fish forms a valuable source of food and nutrients.

Coral reefs are major part of ocean ecosystem. In addition to fish, molluscs and

seaweeds are also found. Many sea animals provide oil, leather, glue, cattle feed, and other useful products. In the medicine industry, beside medicinal plant found under water, pearls and corals are widely used. Seaweeds grow easily in seawater and have been used as food for centuries. Seaweeds are also used for making products such as skin care ointment and also used as fertilizers.

There are micro-organisms which produce organic material. They are called 'Plankton'. They are of two types : Photoplanktons and Zooplanktons. They have various colours such as blue, green, red and yellow. The marine life mainly depends upon these planktons. Whales also eat planktons.

On the coasts, a large variety of vegetation is found. On tropical coasts, mangrove vegetation is found abundantly. For marine life, these mangroves are very important, because they provide food and shelter to them. Besides marine life, some other animals also exist in mangrove forest such as tigers in Sunderban. These mangrove forests provide wood for fuel, furniture and various products useful to man.

**Do you know?**

The Great Barrier Reef lies off the northeast coast of Australia. It is the largest coral reef on Earth and one of the natural wonders of the world. It stretches for about 2,010 km and covers about 400 different kinds of corals. It is at great risk.

2) **Abiotic resources :** The world's oceans contain tremendous abiotic resources which have been partially exploited till date. The most common resources are sodium chloride i.e. common salt. A large number of metallic and non-metallic minerals are found on the ocean floor, e. g. potassium occurs in large quantities. Limestones are formed extensively in the tropical oceans of the world as a result of precipitate material by corals and plants. Gypsum forms during evaporation of sea water. The gypsum deposits are mined and converted into Plaster of Paris and used for construction. The most important minerals extracted from the sea floor are petroleum and natural gas.

To obtain fish or mineral oil, development of the technology is essential because they are available in deep oceans. While obtaining these from biotic and abiotic resources, precaution should be taken to maintain the ecological balance of the ocean environment. It is important to consider their uses with respect to sustainable development.

**Use of oceans for other purposes :**

A) **For energy : i) Tidal Energy :** The phenomenon of tides releases large amounts of energy. Thus tidal energy can be used to generate electricity. However, there are certain difficulties in tapping the tidal energy. Efforts are being made to tackle these limitations. In 2016, a massive tidal turbine in the Bay of Fundy, Nova Scotia, began generating electricity for the first time—enough to power 500 homes. Efforts to increase installation are being carried out.

**ii) Thermal energy :** The temperature differences of sea water helps in generating the energy. The surface water of the tropical region may have 25°C to 30°C of temperature while the deep sea water may have less than 5°C. This gradient of temperature is used to run a generator to produce electricity. Floating generators based on temperature differences have been designed in Belgium and Cuba

B) **For drinking water :** Due to high salt content in sea water, it is not suitable for drinking or for irrigation directly. But sea water can be converted into fresh water.

Desalination process is the removal of salt from sea water. It is done in several ways by heating or freezing water or by electrical processes. These methods are costly and can be implemented where water is desperately needed such as in a desert region. Countries such as Saudi Arabia, Oman, UAE, Spain, Algeria, Cyprus etc. use desalinated water for drinking.

The cost of desalination has kept desalination from being used more often in developing countries. There are environmental costs of desalination as well. Sea life can get sucked into desalination plants, killing small ocean creatures such as baby fish and plankton. This leads to upsetting of the food chain. Nevertheless, in the near future, many more countries may look towards oceans for potable water supply.

**Find out !**

India also produces water from desalination plants. Find out their locations with the help of internet.

C) **Trade and Transport :** Maritime transport is the transport of people or cargo by water. Transportation by water is cheaper than any other modes of transport. The seas and oceans are the most convenient natural medium for transport. The Atlantic Ocean route is the most important and busiest ocean route in the world because it joins the economically and industrially developed regions of the world such as North America and Western Europe.

D) **Tourism :** Ocean tourism comes in many forms like cruises, scuba-diving, fishing, beach tourism, etc. Such activities are increasingly becoming popular. In many areas, massive new tourist developments have been built which include resorts and marinas. These activities, in turn, affect the ocean habitats and environment.

By mid 21st century, many countries may face a problem of food security. Besides food, other sources for development are energy, minerals, drinking water, mineral oil etc. These resources are limited on land and are available in specific areas but they are largely available in the oceans.

Our future on the earth may depend on knowledge of the oceans in an increasingly over crowded world.

**Try this.**

Various institutes are presently working for exploration of ocean, its climate, resources and its impact on our lives. Prepare a list of such institutes which are in India. With the help of internet, complete the table below. One has been done for you as an example.

| Sr. No. | Name of the Institute | Location | Objectives |
|---|---|---|---|
| 1. | NIO | Goa | Undertake scientific research on ocean surrounding India |
| 2. | | | |
| 3. | | | |
| 4. | | | |
| 5. | | | |

**Who owns the oceans?**

We divide the Earth's terrain (Continental area) and establish geographic boundaries on land. The oceans have no apparent surface features - just a flat, vast expanse. This makes it difficult to divide, and so ultimately, we all own the oceans.

When ships were developed they could transport or carry humans across the globe. The governments that represented the oceans agreed that no one owned the oceans. This informal agreement was referred to as the Law of the Sea.

The modern foundation of ownership is the United Nations Convention on the Law of the Sea (UNCLOS 1982). It says that a country may claim an area extending 12 nautical miles from its coast as its own territorial sea. Additionally it can exploit 200 nautical miles of the water beyond its coast as its exclusive economic zone EEZ. The resources found there can be exploited by that country alone.

### International Resources :

There are international institutions which regulate the ocean resources. The oceanic resources beyond 200 nautical miles of the Exclusive Economic Zone belong to open ocean and no individual country can utilise these without the concurrence of international institutions.

**Try this.**

Do you know that India has got the right to mine manganese nodules from the bed of the Indian Ocean from that area which lies beyond the exclusive economic zone. Identify some other resources which are international in nature

**Do you know ?**

**News clipping from March 2018.**

*Plastic bag has been found at the bottom of the Pacific Ocean's Mariana Trench, the world's deepest, This plastic bag was made 30 years ago. This highlighting the spread of ocean pollution. Numerous international teams working around the world on over 5,000 separate dives and using deep-sea remote vehicles helped study the ocean beds to discover what lies beneath. Over a third of the debris found was micro-plastic.*

### Marine pollution :

Importance of the ocean is increasing day by day in various ways, Human dependence on oceans is likely to increase manifold in the days to come. However, nowadays, the oceanic waters are getting polluted on a large scale. This causes deterioration of the natural quality of ocean water.

The leakages of oil from oil transporting ships, oil extraction from coastal areas, disposal of solid waste containing radioactive matter, atomic tests etc. are causing large scale pollution of oceanic waters. The effluents brought by river discharges, the disposal of waste from coastal cities, the waste from industries and many other similar factors are polluting the oceanic waters. As a result, the very existence of marine life is threatened.

## Exercise

**Q. 1) Complete the chain :**

| A | B | C |
|---|---|---|
| 1) Continental Shelf | 1) deeper part | 1) Manganese nodules |
| 2) Oceanic microorganisms | 2) Abyssal plains | 2) Whales |
| 3) Oceanic trenches | 3) fishing | 3) Sunda |
| 4) Vast flat area | 4) plankton | 4) Dogger Bank |

**Q. 2) Identify the correct correlation :**

A : Assertion; R : Reasoning

1) A : Continental shelf is a storehouse of mineral oil and natural gas.

R : Continental shelf receives large quantities of load from continental areas.

1) Only A is correct
2) Only R is correct
3) Both A and R are correct and R is the correct explanation of A.
4) Both A and R are correct but R is not the correct explanation of A.

2) A: More deposition occurs in the continental slope.

R: The slope is steeper here.

1) Only A is correct
2) Only R is correct
3) Both A and R are correct and R is the correct explanation of A.
4) Both A and R are correct but R is not the correct explanation of A.

3) A : The islands are actually peaks of submerged mountains

R : Some peaks of submerged mountains come above the sea level

1) Only A is correct
2) Only R is correct
3) Both A and R are correct and R is the correct explanation of A.
4) Both A and R are correct but R is not the correct explanation of A.

4) A: The abyssal plains are the deepest parts of the ocean

R: They lie at the bottom of the ocean

1) Only A is correct
2) Only R is correct
3) Both A and R are correct and R is the correct explanation of A.
4) Both A and R are correct but R is not the correct explanation of A.

5) A : Sodium chloride and potassium are parts of inorganic oceanic resources.

R : Salt extraction is a major activity in coastal areas.

1) Only A is correct
2) Only R is correct
3) Both A and R are correct and R is the correct explanation of A.
4) Both A and R are correct but R is not the correct explanation of A.

**Q. 3) Give geographical reasons.**

1) Fishing has developed in continental shelves.
2) Our knowledge regarding the oceanic trenches is limited.
3) The ocean is a storehouse of minerals.
4) Like the land, there are landforms below the ocean too.

**Q. 4) Write short notes on:**

1) EEZ
2) Oceanic tourism
3) Abundance of minerals in oceans
4) Deposition and continental slope

**Q. 5) Answer in detail:**

1) The marine pollution is ultimately going to be harmful to the man himself. Discuss.
2) There is similarity in the relief on the land surface and the ocean bottom.
3) Discuss how development of oceanic tourism should be carried out without disturbing marine life.

**Q. 6) Show the following on the map of the World:**

1) Chagos Range
2) Mariana Trench
3) Dogger Bank
4) Mumbai High
5) Sunda Deep
6) Grand Banks

***

# 7. Indian Ocean - Relief and Strategic Importance

**Make friends with maps!**

Look at figure 7.1 and answer the following questions :

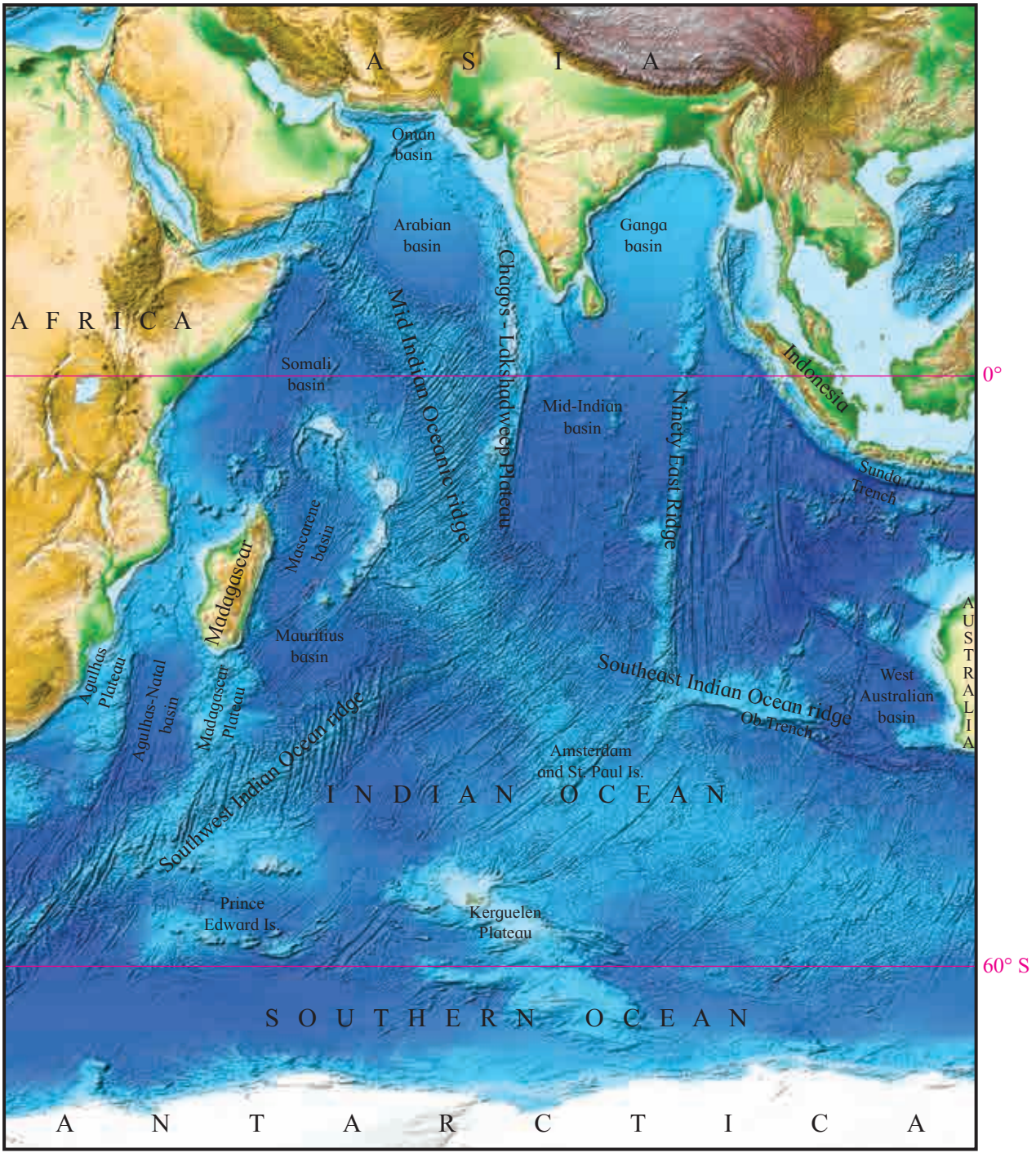



**Fig. 7.1 : Image showing relief of Indian Ocean floor**

1) What does this map show?
2) Which continents and sub-continents are visible in this map?
3) What lies between the continents?

4) Chagos Plateau, Sunda Trench, Central Mountain range are a part of what?

5) What are the conclusions you can draw after looking at the map?

## Geographical explanation

The Indian Ocean is the 3rd largest ocean in the world after Pacific and the Atlantic Ocean. It is the only ocean in the world named after a particular country i.e. India. About 20 percent of the total oceanic area is occupied by the Indian Ocean. A part of the Indian Ocean is located in the southern hemisphere. Indian Ocean spreads between Africa in the west, Asia in the north and east, Australia in the east, and Southern Ocean in the south. Look at figure 7.2 the areal extend of the oceans in given in the table. Note that unlike Pacific and Atlantic Ocean, the Indian Ocean does not extend northwards to the Arctic Ocean. This situation has resulted in complete blockage of the Indian Ocean towards its north. This peculiar arrangement of the ocean and the continental portion contributes a lot to the development of monsoon climate of the Indian subcontinent.

| Ocean | Area in sq. km. |
|---|---|
| Pacific | 166,240,977 |
| Atlantic | 86,557,402 |
| Indian | 73,426,163 |
| Southern | 20,327,000 |
| Arctic | 13,224,479 |

### Bottom relief of Indian Ocean :

The floor of Indian Ocean exhibits complex and varied features like continental shelf, mid-oceanic ridges, ocean basins, oceanic deeps, islands etc. These features are formed by tectonic, volcanic and denudation processes. These processes operate in the same manner as like that on the continents. The average depth of the Indian Ocean is 4000 m. It also has a few marginal seas.

### Continental Shelf :

It is a portion of continents, submerged under oceanic water. It is normally occupied by different gulfs, seas, bays and straits. There is a wide range of variation in the continental shelves of Indian Ocean. Quite extensive shelves are found along the Indian coasts. The Eastern coast of Africa and Madagascar record relatively narrow width of continental shelves and along the Indonesian coast, it is very narrow (160 km). The continental shelves are very wide in the west side of India whereas these are narrow along the eastern coast. Continental shelves are veneered with deposits brought down by terrestrial agents of erosion. Some of the sedimentary deposits, received over thousand years. As they remain deposited for a long time, sedimentary rocks are formed. Some of them are a potential source of fossil fuel.

**Let's recall.**

Name the fossil fuels.

### Mid-oceanic ridges :

Mid oceanic ridges are submerged mountain ranges that separate deep portions of the sea (ocean) floor. In Indian Ocean also has a Mid Oceanic ridge called as a Mid Indian Oceanic ridge. It originates from Gulf of Eden near the Peninsula of Somalia. Further it extending toward the south and at east side of Madagascar it divided into two branches Among these, one branch diverts towards southwest and extends up to Prince Edward Island. It is known as Southwest Indian Ocean ridge. Second branch extends southeast up to Amsterdam and St. Paul Island. Mid Indian Oceanic ridge has many parallel ridges. This ridge is not continuous due to many fracture zones in it. Such as Owen fracture zone, Amsterdam fracture zone, etc.

A part from it in south Indian Ocean there is Kerguelen Plateau, in south side of Madagascar

is Madagascar Plateau and in south side of Africa is Agulhas Plateau.

In the west of India in Indian Ocean lie a Chagos Plateau, which extends up to Mid Indian Ocean ridge. There are many archipelagos and islands in this part of Indian Ocean such as Lakshadweep, Maldives, Diego Garcia etc.
In the eastern Indian Ocean (Bay of Bengal) there is a long north-south extending range, called as Ninety East Ridge. It originates from the west of Andaman and Nicobar Island and extends south ward up to eastern part of Amsterdam and St. Paul Island.

**Find out !**

Why Ninety East ridge name has been given to this ridge?

**Islands of Indian Ocean :**

In this section we shall consider mostly the deep sea islands and not the coastal islands. Besides the large islands like Australia, Madagascar and Sri Lanka there are a large number of islands are located in the Indian Ocean. These can be grouped as islands of

1) Arabian Sea
2) Along Bay of Bengal
3) Australian Coast
4) Islands near Antarctica

1) **Islands in the Arabian Sea :** In Arabian sea one can identify two subgroups such as those closer to African Coast and the ones along central ridge i.e. Lakshadweep - Chagos Ridge. Amongst those closer to African Coast, Madagascar is the largest island. It has an area of 5.9 lakh sq. km. It believed by most of the geologists that Madagascar was a part of African Continent in geological past. It has under gone two separations such as first separation from Africa and later from the Indo-Australian plate. It is one of the seismologically active provinces. There are number of islands between Madagascar and the eastern coast of Africa. Noteworthy amongst them are Comoros, Bassas de India, Europa Island. To the east of Madagascar lie islands like Reunion, Mauritius and Seychelles. In the north, close to African Horn lies island of Socotra. All these islands are to the West of Mid Indian Ocean Ridge. Those forming a group of islands along Lakshaweep - Chagos Ridge are Lakshadweep, Maldives, Chagos. Most of these are in the form of archipelagos formed by coral atolls.

Besides these island there are a few islands like Bundle Island near the coast of Pakistan and a few island such as the Kish, Hendorabi, Lavan, Siri, etc. are found along the Persian Gulf part of Iran.

2) **Islands of Bay of Bengal :** The largest amongst this group is the Sri Lanka island. The islands to the east of 90°E Ridge are the group of islands like Andaman and Nicobar, a chain of islands along the western coast of Sumatra Island of Indonesia. Barring a few coral islands in Nicobar Group most of these islands are volcanic islands. All these islands are associated with the converging plate boundary. These island are the peaks of submerged mountains.

3) **Islands along Australian Coast :** There are very few islands along the western coast of Australia. Noteworthy among these are Ashmore, Christmas and Cocos (or Keeling) islands.

**Try this.**

Locate these islands on the map given in figure 7.1.

**Ocean Basins :**

The term ocean basins indicate deep flat areas on the ocean bottom. On a global scale,

all the major oceans are called ocean basins. Each of the oceans houses number of small ocean basins with in it. These ocean basins are terminal destinations for the sediments brought from the continents as well as those generated within the oceanic part. The Indian Ocean has ten major ocean basins.

**Try this.**

Given below are names of some ocean basins in the Indian Ocean. Identify these in figure 7.1. Write a note on their locations, their separators and the rivers entering into them. Rank these according to their size on the basis of your perception.

(1) Oman basin (2) Arabian basin (3) Somali basin (4) Mauritius basin (5) Mascarene basin (6) Agulhas-Natal basin (7) West Australian basin (8) Mid-Indian basin (9) Ganga basin

## Deeps and Trenches :

Trenches are the deepest portions in the oceans. There are very few deeps and trenches in the Indian Ocean as compared to other oceans. Most of the trenches of Indian Ocean are located towards its eastern boundary. These are located along the converging boundaries between the Indo-Australian Plate and the Pacific Plate. Most noteworthy among this are Java or Sunda Trench (7,450m deep) and Ob Trench (6,875m deep). This area is seismically active because of plate movements.

## Distribution of temperature and salinity in Indian Oceans :

The study of temperature of ocean is essential. It influences the biotic component in the oceans. It is also largely responsible for the movement in the oceanic water. Other factor besides the temperature it is salinity. The density of ocean water depended upon temperature and salinity of ocean water. The density and temperature differences cause the movements in sea water. Let us take up the study of temperature distribution in Indian Ocean.

**Can you do it?**

Study maps given in the figure 7.2 carefully. These maps are showing the portion of Indian Ocean lying north of equator. Maps in the figure depict the temperature conditions in three seasons : (a) pre SW monsoon, (b) NE monsoon (c) during SW monsoon.

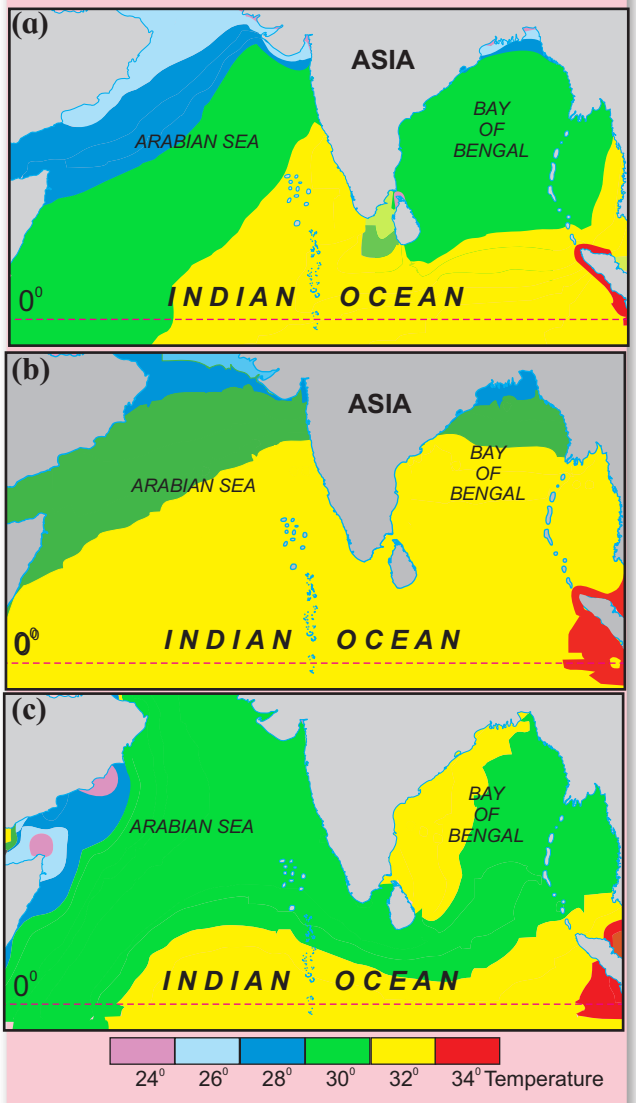



Fig. 7.2

**Answer the following questions.**

1) Why are iso therms not drawn on the continental part?
2) Why is the temperature in Arabian Sea lower than in Bay of Bengal?

3) Why is the temperature higher in southern portion of Indian Ocean during pre SW monsoon?

## Geographical explanation

During the pre monsoon season when the summer solstice is approaching the temperatures generally increase high and much higher in the southern portion closer to the equator. Once the SW monsoon sets in the temperature pattern gets altered with lowering of temperature in the Arabian Sea area which comes under the influence of monsoonal winds. By the season of NE monsoon, when the winter solstice approaches, the temperatures get reduced. The northern parts of Bay of Bengal record temperature of the order of 24° C.

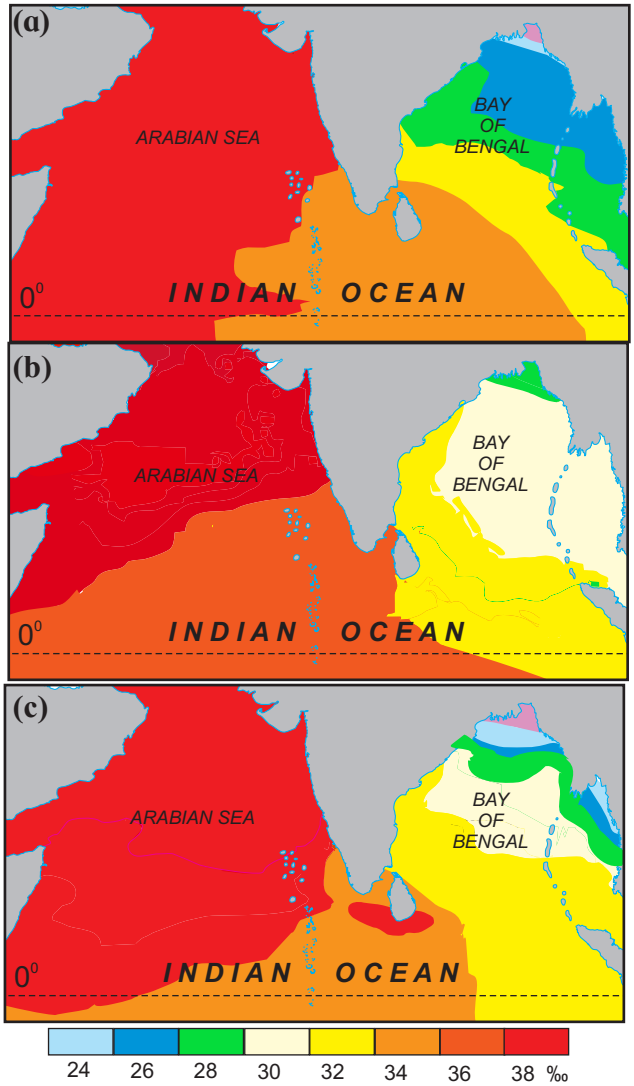



Fig. 7.3

### Indian Ocean salinity :

The other characteristic of ocean water is salinity. Salinity is a measure of amount of salts in the sea water. It is expressed as parts per thousand (‰). Average salinity of sea water is 35‰.

### Can you do it ?

Given below are the maps depicting the salinity distribution of northern Indian Ocean. Study the maps (a) NE monsoon, (b) pre SW monsoon (c) SW monsoon given in the figure 7.3 carefully and answer the following questions.

1) Why does the Arabian Sea records higher salinity than Bay of Bengal?
2) What is the minimum salinity in Bay of Bengal? In which seasons do we find it?
3) Account for the high salinity in Arabian Sea throughout the year?

## Geographical explanation

You will notice that the maps showing the distribution of salinity have a peculiar pattern. The salinity is generally high around the Somali Peninsula and closer to the Saudi Arabian Coast. These are the regions having high temperature and low rainfall. Not many rivers enter in to the sea in this area. In case of Bay of Bengal huge discharges from Ganga System and also from the Peninsular rivers lead to the lowering of salinity in this area. Comparing the three maps you will notice that the salinity is less during the period of SW monsoon.

### Ocean Currents in Indian Ocean :

The pattern of currents in Indian Ocean differs considerably from those in Pacific or Atlantic oceans. The effect of monsoon wind system is clearly seen on the currents in northern Indian Ocean.

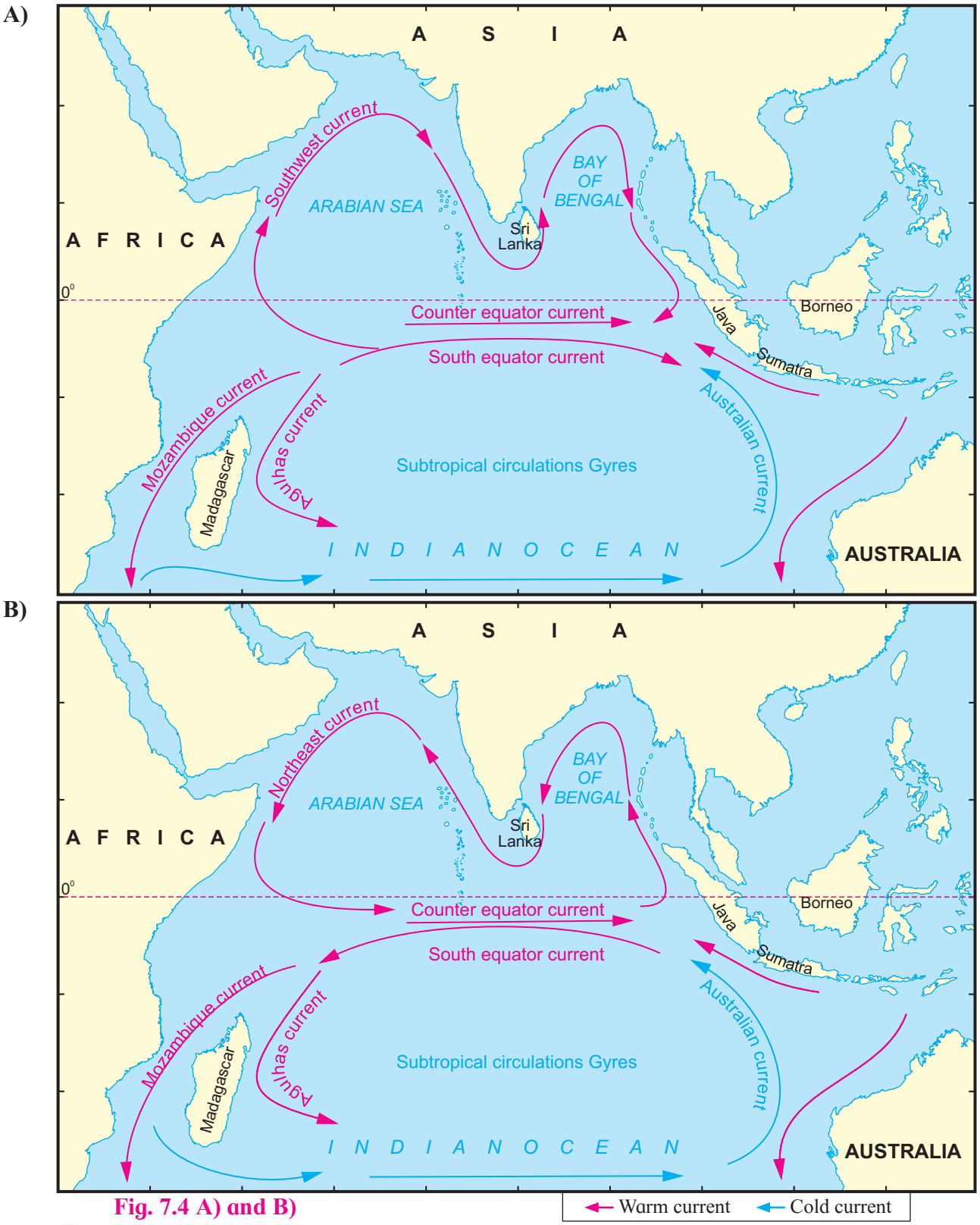



**Fig. 7.4 A) and B)**

**Do you know?**

See the maps in figure 7.4 A and B. They show the pattern of ocean currents in Indian Ocean during different seasons.

Study the maps carefully and answer the following questions.

1) Identify the season each map is representing and name them accordingly.
2) What difference do you notice in the

direction of currents between winter and summer in Northern part of Indian Ocean.

3) How many cold currents are there in the Indian Ocean? Name them.
4) Why do you think the cold currents are fewer in Indian Ocean.
5) Which currents maintain the direction in both the season?
6) Can you see any circulation in the currents of Indian Ocean? What are such circulations called? If yes name the currents sequentially.

## Geographical explanation

Ocean currents are bodies of oceanic waters maintaining their separate entity. They flow across oceans under the influence of specific wind system. They perform the function of mixing of waters and transfer of heat from one part of ocean to the other. Ocean currents are classified as warm or cold currents depending on the temperature conditions of the flowing water in them.

System of ocean currents in the Indian oceans is highly influenced by shape of its coast line, its extent, and the peculiar arrangement of the wind system that prevails in the region. It has equatorial currents but the north equatorial current is weaker than the south equatorial current. North of equator the currents are influenced by the seasonally reversing monsoon wind system.

The current system in the southern part of the Indian Ocean leads to development of a large gyre. The two major arms of this gyre are – **a)** South equatorial current flowing east to west direction under the influence of easterlies. **b)** The 'West Wind Drift' flowing from west to east under the influence of westerlies. The circulation is completed in the west by Mozambique – Agulhas currents and in the east by West Australian current. It is considered to be one of the major gyres on global scale.

In the northern portion of the Indian Ocean seasonal monsoonal winds drive the currents. Mostly these currents follow along the coast lines. During summer they follow clockwise direction and during the winter their direction shows a complete reversal and they flow in anticlockwise direction.

### Importance of the Indian Ocean:

Indian Ocean Region connects three continents namely Asia, Africa and Australia It support some of Asia's biggest economies. This alone shows the economic and political significance that it has. It contains three busiest straits namely Hormuz, Malacca, and Bab-el-Mandeb. Majority of crude oil exported by Gulf Countries passes through this route via Strait of Hormuz. Hence, the Indian Ocean serves an important route for crude oil supplies worldwide. Several island countries such as the Maldives, Seychelles are located in the Indian Ocean. The economy of these countries entirely depends upon the marine ecosystem and marine tourism in the Indian Ocean.

### Can you tell?

- Name the Gulf countries
- In which direction do they lie in the Asian content.

### Do you know?

Strait of Hormuz is a strategically important strip of water which links the Persian Gulf with the Arabian Sea. This strait is 33 to 95 km wide. It acts as the main artery for the transport of oil from the Middle East. About 30% of global oil is exported from this strait, Iran and Oman share territorial rights over the waters. Due to its importance, Iran has threatened to close it in recent times.

Due to its economic importance, the Indian Ocean region has become important for the world powers. Military and naval bases in the region have given rise to tensions in the region.

**Always remember**

Abyssal plains of the ocean have deposits of poly-metallic nodules. These nodules will also be the source of nickel, copper, manganese and cobalt. India has allotted an area of 2 million square kilometres for research and excavation of poly-metallic nodules by International Sea-bed Authority in the Indian Ocean.

### The Importance of Indian Ocean for India!

India occupies a central and strategic location in the Indian Ocean area. Its national and economic interests are inseparably linked up with Indian Ocean. Hence to keep the Indian Ocean as a zone of Peace free from superpower rivalry and increasing cooperation among littoral countries in the region has always been India's foreign Policy's goal. For example Indian Ocean Rim Association for Regional Cooperation, BIMSTECK and Ganga-Mekong Cooperation etc.

No industrial development, commercial growth, stable political structure is possible unless countries shores are protected. Most of the conflicts since the end of the Cold War have also taken place in or around the Indian Ocean region. As a result almost all the world's major powers have deployed substantial military forces in the Indian Ocean region.

A major concern of India in the Indian Ocean is energy. India is fourth-largest economy in the world. It is almost 70 per cent dependent on oil import, major part of which comes from gulf region.

**Can you do it?**

Show the route of oil import from the Gulf countries to India on a map with relevant stops.

The Indian Ocean provides major sea routes connecting the Middle East, Africa and East Asia with Europe and the Americas. It carries a particularly heavy traffic of petroleum and petroleum products from the oilfield of the Persian Gulf and Indonesia.

Large reserves of hydrocarbons are being tapped in the offshore areas of Saudi Arabia, Iran, India and Western Australia. An estimated 40% of the world's offshore oil production comes from the Indian Ocean. Beach sands, rich in heavy minerals, and offshore deposits are actively exploited by bordering countries, particularly India, South Africa, Indonesia and Sri Lanka.

With increasing trade relations with the countries of the East, India has higher stakes in the region, in the years to come. Trade volumes with the ASEAN countries have more than doubled in a decade from a mere $1484 million in 1993. The Indian market has emerged as one of the largest importers of South East Asian goods with imports touching $10,942 million in 2004-. The recently concluded Free Trade Agreements with countries like Thailand and Singapore are set to contribute to this trend. Expanding markets and larger import flows imply not only economic prosperity but also vulnerability at sea. The incidence of piracy, armed robbery and maritime terrorism are on the rise end has placed a premium on the complexity of sea-lane defense.

The northern area of the Indian Ocean is the area of great significance in economic and strategic terms. India's foreign policy orientation towards its eastern neighbours has spurred interest and attention there. India's burgeoning economy, now forecasted to become one of the

three fastest growing economies in the world entails expansion of existing export and import markets. Being a sea faring nation with island neighbours has added to the need for safe sea-lanes in the inter-lying waters. The world's busiest choke point in the straits of Malacca located here adds complexity to a strategic factor.

**Do you know ?**

Diego Garcia is an atoll just south of the equator in the Central Indian Ocean. There are 60 small Islands. It was first discovered by European and named by the Portuguese. It is an important place for navel and military activity. It has gained strategic importance in Indian Ocean due to its specific geographic location.

**Find out !**

• You must have heard about the forts on the western coast like the forts of Janjira, Alibaug, etc. Find out the historical connection between India and the countries located on the western coast of Arabian Sea through these forts. • What is the meaning of the word 'Ratnagiri' and what is its connection with the historical trade.

## Exercise

**Q. 1) Complete the chain :**

| A | B | C |
|---|---|---|
| 1) Pacific Ocean | 1) Christmas | 1) Bab-al-Mandeb |
| 2) Chagos | 2) Atlantic Ocean | 2) Lakshadweep |
| 3) Ashmore | 3) Maldives | 3) Indian Ocean |
| 4) Hormuz | 4) Malacca | 4) Cocos |

**Q. 2) Give geographical reasons :**

1) Salinity is less in the Bay of Bengal in Indian Ocean.
2) The eastern coastal part of Indian Ocean is seismically active.
3) Gyre develops in Southern Indian Ocean.
4) Temperatures are high in pre-monsoon season in equatorial region in northern Indian ocean.

**Q. 3) Write short notes on :**

1) The width of continental shelf in Bay of Bengal and Arabian Sea
2) Mineral resources in Indian ocean
3) Ocean currents in Indian ocean
4) Oil and natural gas in Indian ocean

**Q. 4) Answer in detail :**

1) Outline the importance of Indian ocean with respect to trade and transport routes
2) Evaluate the strategic location of India with respect to its location in Indian Ocean.
3) Explain the Indian ocean with respect to following aspects :
   a) Ocean Trenches b) Abyssal Plains
   c) ridges, d) Ocean Currents

**Q. 5) On an outline map of the world, locate the following and make an index :**

1) Sunda Trench
2) Diego Garcia
3) SW Monsoon
4) Agulhas Current
5) West Australian Current
6) Ninety East ridge
7) Strait of Holmuz
8) Chabahar port

***

# 8. Biomes

**Let's recall.**

Look at the fig. 8.1. Answer the following questions:

1) What does the figure show?
2) What do the numbers on the figure represent?
3) How does latitude influence the vegetation?
4) How does latitude influence the fauna of a place?
5) Which latitude will have more biodiversity?

## Geographical explanation

As shown in the figure, a variety of natural vegetation and wildlife is found in different regions of the world from the equator to the poles. These changes occur according to latitudes. Thus, we see that in the same region, different types of plants and animals co-exist together. Such an area where different types of flora and fauna live together in the same region in the same type of climatic conditions is called a biome. Thus, a biome can be defined as the total assemblage of plant and animal species interacting within specific conditions.

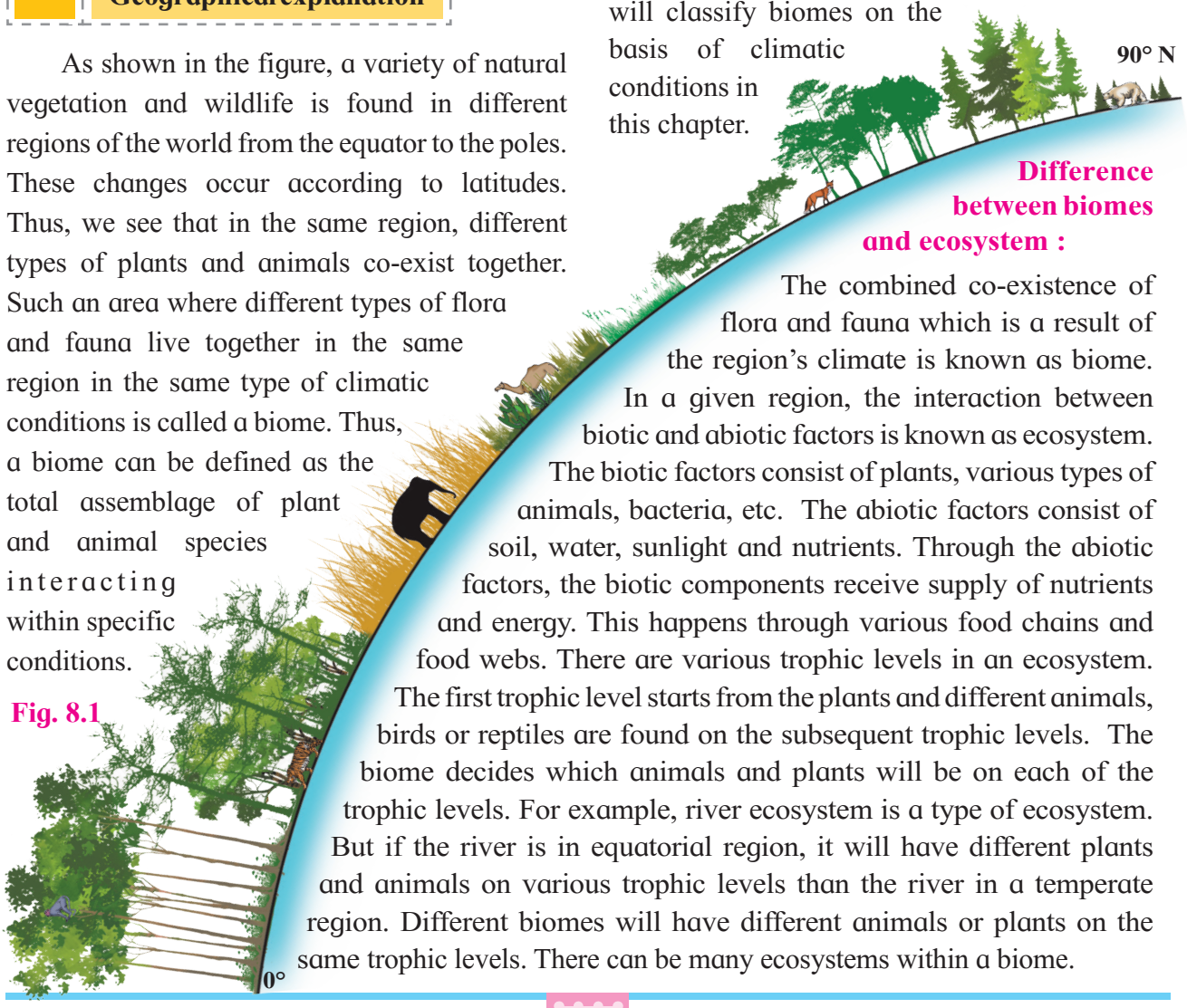



Fig. 8.1

**Think about it.**

Besides latitudes, what other conditions influence the biome?

## Geographical explanation

The boundaries of different biomes on land are determined mainly by climate. These include conditions like rainfall, temperature, humidity, amount of insolation received and soil conditions. Different types of trees and animals living in a biome are adapted to the climatic conditions found in that region. We will classify biomes on the basis of climatic conditions in this chapter.

### Difference between biomes and ecosystem :

The combined co-existence of flora and fauna which is a result of the region's climate is known as biome. In a given region, the interaction between biotic and abiotic factors is known as ecosystem. The biotic factors consist of plants, various types of animals, bacteria, etc. The abiotic factors consist of soil, water, sunlight and nutrients. Through the abiotic factors, the biotic components receive supply of nutrients and energy. This happens through various food chains and food webs. There are various trophic levels in an ecosystem. The first trophic level starts from the plants and different animals, birds or reptiles are found on the subsequent trophic levels. The biome decides which animals and plants will be on each of the trophic levels. For example, river ecosystem is a type of ecosystem. But if the river is in equatorial region, it will have different plants and animals on various trophic levels than the river in a temperate region. Different biomes will have different animals or plants on the same trophic levels. There can be many ecosystems within a biome.

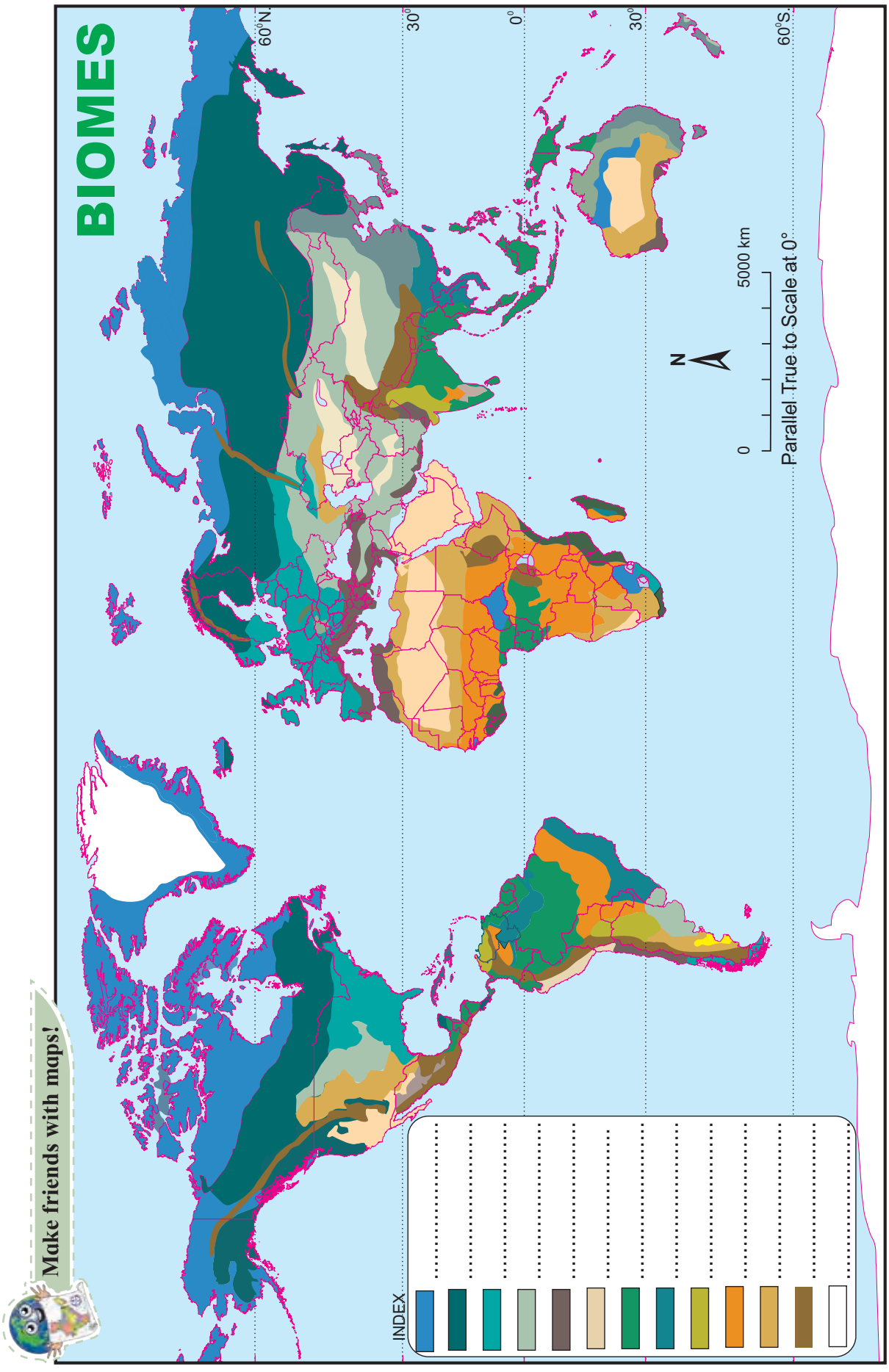



Fig. 8.2

**Try this.**

Find out more differences between an ecosystem and a biome. You can use the following points: scale of area occupied, types, flow of nutrients and energy, examples, etc.

**Can you tell ?**

A person staying in Sahara desert and a person staying in Arabian desert belong to the same biome or ecosystem?

## Terrestrial Biomes :

You have already studied about the climatic conditions in Chapter 4. Refer to them when you study each of the biomes.

### 1) Tropical rainforest biome :

**Latitudinal extent :** 0° to 10° N and S

**Try this.**

1) Various biome regions have been shown on the map in figure 8.2. Considering the latitudinal location, select tropical rainforest biome and write the name in its respective place in the index.
2) Write the names of the major countries that lie in this biome.

**Vegetation :** In this biome, biodiversity is very high. More than half of the species found on the Earth are found in this biome. Most trees are broad-leaved and grow densely. They are usually 50 m tall. To acquire sunlight, many trees grow taller. They have a dense canopy which looks like a roof.

These forests can be categorized into three layers mainly on the basis of the height of the trees. In the most underneath layer, dense growth of bushes covers the ground. The second layer consists of low trees while the third layer consists of very tall and huge trees. In between, we find hundreds of climbers and creepers. These forests are, therefore, very dense.

The soils are very fertile and contain lot of humus. Most of the trees are hard-wooded trees. Mahogany, ebony, rosewood, rubber, palms, coconut, orchids, wild flowers, ferns, etc. are found here. See fig. 8.3.

**Animals life :** Monkeys, birds from the vulture family, hornbills, parrots etc are found. Various species of insects, butterflies, reptiles, etc are also found in huge numbers in this biome. As the trees have a three-tier system, every bird and animal has its own niche in the areas from the ground to the top of the tree. These species only inhabit their respective areas only.

**Human life :** Human life is not very easy in this climate. Indigenous humans in these parts are still in their primitive stage. They are engaged in primary occupations such as gathering forest products, hunting, etc. For example, Pygmies in Congo, Boro Indians in Amazon, Sentinels Onges, Jarawahs, etc. in Andaman and Nicobar Islands in India,

**Use of biome by man :** Hardwood is used in construction and making furniture. For this, some regions are being over exploited. For example, Brazil, Java-Sumatra islands.

**Current scenario :** There is a degradation in this biome because of increasing agriculture and industrialisation. The biodiversity found in this biome is getting destroyed. Golden lion tamarin, gorilla, orang-utan, harpy eagle, chimpanzee, poison dart frogs are threatened. At the same time, many new species are still being discovered in this biome.

**Find out !**

Find out the regions in this biome where plantation agriculture has developed.

**Try this.**

Obtain information about those species of plants, animals and birds which were easily found in your surroundings around 20 years ago. Also, find out if they are still found easily in your surroundings. Discuss about them in your class. Write down your observations.

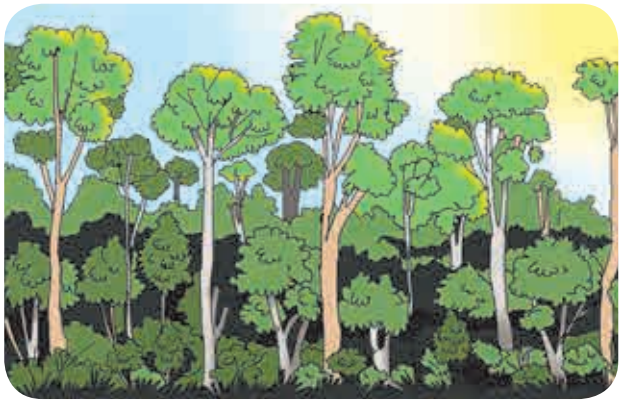


**Fig. 8.3 : Tropical rainforest biome**

### 2) Tropical decidouos biome :

**Latitudinal extent :** 5° to 30° N and S.

You have already studied about the climatic conditions in this biome in Chapter 4. Study the biome on that basis.

**Try this.**

1) Various biome regions have been shown on the map in figure 8.2. Considering the latitudinal location, select Tropical decidouos biome and write the name in its respective place in the index.
2) Write the names of the major countries that lie in this biome.

**Vegetation :** The trees shed their leaves in dry season and are dense and lush in rainy season. Therefore these forests are called deciduous forests. In wet forests, trees are tall and extensive. The branches are large in size and the roots of the trees are large and deeply rooted in the ground.

The density of the trees is less in deciduous forests than rainforests. These are not found in a row continuously. They are found in groups in a dispersed manner. The trees are shorter and like shrubs.

Teak is the main tree in this biome with respect to its economic value. Various types of bamboos, teak, sal, rosewood, sandalwood, oiltree, etc are other important trees. See fig. 8.4.

**Animal life :** In tropical and sub-tropical biomes, a large diversity exists in fauna. The biodiversity found in these biomes ranks second in the world. This ranges from microscopic organisms till large elephants, hippopotamus, rhinos, tiger, lion, gaur, monkeys, etc. Greater Coucal, hornbills, Asian koel, peacock, vultures, falcon, pigeons, sparrows, etc. are found here. Similarly, ants, butterflies, insects and worms are also found in plenty. In this biome, many species of animals can be reared.

**Human life :** The human life in this biome is easier than that in the rainforest. Primary and secondary occupations based on forests are found here. By rearing the animals found here, animal husbandry, milk production and meat production is carried out. In earlier times, animals such as bull, horse and donkeys were used for transportation and ploughing the fields. Various tribal communities inhabit the regions under this biome. One can find rural and urban areas too. As a result of expanding human settlements, the forests under these biomes are being encroached upon.

**Find out !**

Look for the names of the tribes dependent on this biome in India including Maharashtra along with their habitats and show them on a map of India.

**Use of biome :** The wood obtained from teak is mainly useful for furniture, construction, ship-building, for making berths in railways, etc. Many plants are used for making medicines

and secondary products. For example, oil from sandalwood, its scented wood, etc. The bamboos are used for construction of houses and agriculture. Besides, various fruits and spices are also obtained.

**Let's recall.**

Make a list of products found in your home which have come from this biome.

**Current status :** The forests in these biomes are in danger because of deforestation and wildfires. Extensive use of fertilizers by human and spray of insecticides has threatened many wild species. For example, The white-rumped vulture. This biome is being influenced by the human population.

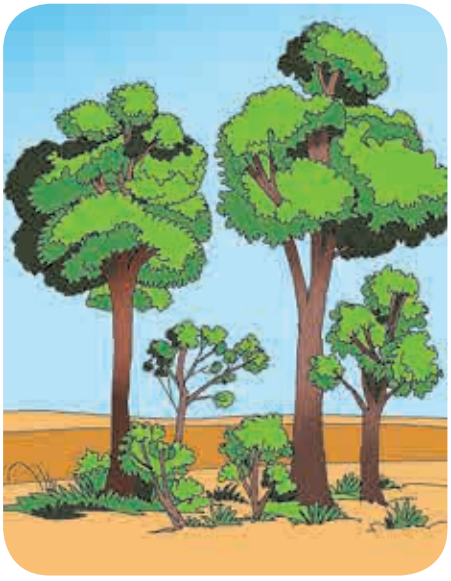


**Fig. 8.4 : Tropical decidouos biome**

### 3) Savannah grassland biome :

**Latitudinal extent :** 10° to 20° N and S

You have already studied about the climatic conditions in this biome in Chapter 4. Study the biome on that basis.

**Try this.**

1) Various biome regions have been shown on the map in figure 8.2. Considering the latitudinal location, select Savannah grassland biome and write the name in its respective place in the index.
2) Write the names of the major countries that lie in this biome

**Vegetation :** These grasslands are characterised by continuous cover of perennial grass that grows about 3 to 6 m height. The grass is thick, coarse and broad-leaved. It is known as elephant grass. There are very few shrubs and trees found here. The number of grass-eating animals is more here. Therefore, carnivores which are dependent on them are also high here. See fig. 8.5.

**Animal life :** The abundance of grass cover and its perennial nature have made savanna biomes rich in herbivore animals. Seasonal change in colour of grass has provided natural shelter for animals. These grassland support large number of hoofed animals. A variety of herbivore animals of different size from rabbits to elephant are found here. Main species are antelopes, buffalo, zebra, rhinos, wild beasts, giraffes, elephants, warthogs, etc. Obviously with rich herbivores density, these grasslands also support a number of carnivore animals as well. They include variety of Cats like lions, leopards, cheetah, wild dogs, Jackals, hyenas, etc. In birds, vultures, great Indian bustards, twitter and ostriches are found.

**Human life :** Human life is comparatively difficult here. In the grassland areas of Africa, Masais live here along with their cattle.

**Use of biome :** As number of wild animals are more in this biome, in earlier times, human used to hunt for trophies. Infact, these areas were known as the heaven for hunting.

**Current status :** Savanna grasslands are victims of frequent forest fires that cause severe loss of biodiversity of region. Overgrazing and industrialisation is leading to decrease in area

under grassland. This leads to increase in extent of the Sahara desert in Africa. Besides, the area under forests is being taken up for agriculture.

**Find out !**

Obtain information regarding the tribes inhabiting this biome. Find out about their habitat, life-style, conventional ways of living with nature, cultural heritage, etc.

**Fig. 8.5 : Savannah grassland biome**

### 4) Tropical desert biome :

**Latitudinal Extent :** 20° to 30° N and S

You have already studied about the climatic conditions in this biome in Chapter 4. Study the biome on that basis.

**Try this.**

1) Various biome regions have been shown on the map in figure 8.2. Considering the latitudinal location, select Tropical desert biome and write the name in its respective place in the index.
2) Write the names of the major countries that lie in this biome

**Vegetation :** The vegetal life is found in a dispersed manner. This includes date palms and thorny trees such as khejari, acacia and bushes such as century plant, cactus etc. There is hardly any vegetal cover because of dry climatic conditions. See fig. 8.6.

**Characteristics of forests:**

1) Thick leaves with capacity to store water
2) Thorny nature reduces speed of evaporation, safety from animals
3) Trunk like leaves carry out photosynthesis

**Animal life :** As the vegetation is sparse, biodiversity is also limited. There are relatively few large animals in desert. The animals are small and tend to burrow, or stay in hideaways till dusk to avoid the heat. They are adapted to survive in hot climate with very little water. They are mainly small carnivores, camels, many species of snakes, types of lizards, desert turtles, rats, mongoose along with goats, sheep, donkeys, etc.

**Birds :** Ostriches; various raptors;, guinea fowl, and bustards; desert eagle owls and barn owls; sand larks and pale crag martins; and brown-necked and fan-tailed ravens.

**Insects :** Houseflies, beetles, moths, types of termites, etc.

**Human life :** As this biome has extreme temperatures, the human life is very difficult here. Depending on the availability of water, animal husbandry or agriculture might be followed. Human settlements are found only near oases. They occur in a dispersed pattern. Here you can find nomadic life in some areas. In earlier times, Bedouin tribe used to trade by travelling on camels.

**Use of biome :** Dates are important as food item across the world. Agriculture is being carried out with the help of irrigation. Minimal vegetation has made it easier to extract minerals from these regions.

**Current status :** As sand from this part is getting transported to nearby regions, desertification is increasing. As a result, desert area is spreading in regions such as the Nile valley.

**Think about it.**

In which region in India, is desertification occurring?

**Can you tell ?**

1) The tropical deserts are mainly found in which direction of the continents? What could be the reason behind their formation there?
2) In which continent is desert not found?

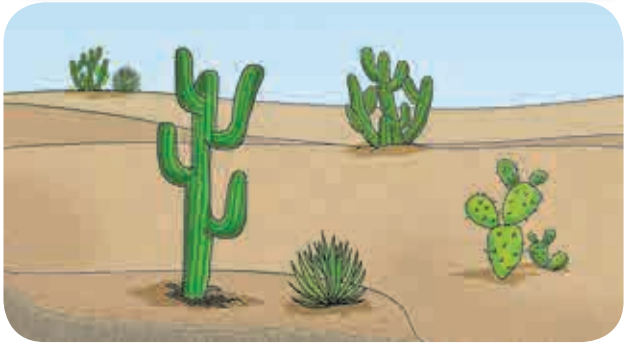


**Fig. 8.6 : Tropical desert biome**

### 5) Mediterranean biome :

**Latitudinal extent :** 30° to 40° N and S

You have already studied about the climatic conditions in this biome in Chapter 4. Study the biome on that basis

**Try this.**

1) Various biome regions have been shown on the map in figure 8.2. Considering the latitudinal location, select Mediterranean biome and write the name in its respective place in the index.
2) Write the names of the major countries that lie in this biome

**Vegetation :** In this vegetation, the height of the trees is less. The vegetation is mixed type: evergreen and deciduous. The leaves of the trees are waxy and thick. As a result, the evaporation is less and they can sustain longer in tough conditions. Here trees of the citrus family and shrubs of coloured flowers are found. Rosemary, cork, oak, olive, eucalyptus, peach, pine, sweet chestnut, cedar, cyprus, etc. are found. See fig. 8.7.

**Animals life :** Rabbits, deer, goats, pigs, horses, brown bears, fox, berry deer, wild cats, goats and sheep are found. Vultures, eagle are found in high numbers here. Alligators, reptiles are also found. Various types of insects and honeybees are found.

**Human life :** The climate here is very pleasant and hence human life has flourished here very well. Various industries based on fruits and flowers have flourished here. These include making wine, packing fruits in air tight containers,, processing olive oil, making jellies out of fruits, making perfumes out of flowers, etc. Due to natural beauty, pleasant climate, fruits and flowers make this area ideal for tourism and development of cinema industry here.

**Current status :** As the tertiary occupations have increased here, urbanisation has increased. The biodiversity found in plants and animals is decreasing as a result of human interference.

**Fig. 8.7 : Mediterranean biome**

### 6) Temperate deciduous biome :

**Latitudinal Extent :** 40° to 50° N and S mainly in the eastern parts of the continents

You have already studied about the climatic conditions in this biome in Chapter 4. Study the biome on that basis.

**Try this.**

1) Various biome regions have been shown on the map in figure 8.2. Considering the latitudinal location, select Temperate

deciduous biome and write the name in its respective place in the index.

2) Write the names of the major countries that lie in this biome

**Vegetation :** Here, the trees have broad leaves. The vegetation here has adapted to the cold climate here. They are found in three layers. Tall growing trees (18 to 30 m), short trees and shrubs such as laurels and berries. In this biome, hardwood and deciduous trees are found. Examples are beech, elm, chestnut, oak, willow, cherry, maple, pine, walnut, deodar, etc. See fig. 8.8.

**Animal life :** In this biome, animals having thick and soft fur like brown bears, red fox, sable, mink, etc. are found. Birds such as peregrine falcon, woodpecker, cardinals can be seen. Similarly, many types of insects are also found.

**Try this.**

Read the following news item.

*A grizzly bear that killed a mother and her baby in Yukon last fall was emaciated and desperately pursuing unusual food sources at the time of the attack, according to an investigation by the territory's government. Valérie Théorêt, 37, and her 10-month-old daughter, Adèle Roesholt, died on Nov. 26, 2018, when a grizzly bear attacked them near their trapping cabin in the remote Einarson Lake area northeast of the village of Mayo. Gordon Hitchcock, chief conservation officer for the Government of Yukon, said the 18-year-old male grizzly bear was emaciated to the point that it was incapable of hibernation. Additionally, it was in significant and chronic pain from having eaten a porcupine – which bears do not typically eat – and had quills penetrating its digestive system from mouth to stomach. "This bear had started turning to uncommon food sources," said Mr. Hitchcock, who presented findings of a necropsy in Whitehorse on Wednesday.*

*-CNN News*

- Why do such things occur?
- Give examples of such similar incidents in Maharashtra where in some animal has attacked people in a particular region.

**Human life :** The forest bounty here provides food, wood and ample amount of oxygen. The forest is cut for wooden products. Paper (for newspapers), paper bags, etc. it is seen that forests are being encroached upon for agriculture.

**Current status :** This biome is reducing because of agriculture and encroachment by settlements. And, therefore, sometimes, animals enter the human settlements in search of food. The biodiversity has reduced in this region. The habitat of these animals is being encroached upon.

**Fig. 8.8 : Temperate deciduous biome**

### 7) Temperate Grasslands biome :

**Latitudinal extent :** 40° to 55° N and S

You have already studied about the climatic conditions in this biome in Chapter 4. Study the biome on that basis

**Try this.**

1) Various biome regions have been shown on the map in figure 8.2. Considering the latitudinal location, select Temperate

Grasslands biome and write the name in its respective place in the index.

2) Write the names of the major countries that lie in this biome

**Vegetation :** In this vegetation, grass is dominant. The grass is soft. As the rainfall is just sufficient, the wetness does not reach the lower layers of the soil. Therefore, not many types of trees are found. Despite, willow, elder, poplar trees are found along the streams. The various species of grasses include purple needle grass, blue grama, buffalo grass, and galleta.

As rainfall is less, the moisture in the soil does not reach the sub-surface. This is the reason why trees are almost absent. But willow, elder, poplar trees can be found near the streams. Grass is green during rainy season. Flowers include asters, blazing stars, coneflowers, goldenrods, sunflowers, clovers, psoraleas, and wild indigos. See fig. 8.9.

**Animal life :** The animal life in this biome is very rich and varied. Herbivore animals include gazelles, zebras, wild horses, wolves, deer, rabbits while coyote is a carnivore. In Veld grasslands, ostriches are found. In Downs of Australia, kangaroos and dingos are found.

**Human life :** Human settlements are sparse here.Earlier, hunting was the main occupation here. Now, it is favorable for agriculture and animal rearing. Now, livestock raising is done on a large scale here to obtain meat, milk, wool, hair and hide. In grassland regions such as Prairies, Steppes, Downs, Pampas, Velds, etc. extensive type of agriculture has developed. Crops like maize, wheat are produced on a large scale. The fields extend to hundreds of hectares and therefore advanced machines are used for agriculture. As these areas have abundant yields, the countries lying in this biome are famous as exporters. The Marino sheep of Australia is world famous for its quality wool.

**Find out !**

Find out the names of the countries who produce and export wheat and maize.

**Current Status :** The extent of commercial agriculture is increasing in this area. Industries are also increasing. Also meadows and pastures are reducing because of over grazing. Consequently, the biome is getting degraded.

**Fig. 8.9 : Temperate Grasslands Biome**

### 8) Taiga biome :

**Latitudinal extent :** 50° to 55° N

You have already studied about the climatic conditions in this biome in Chapter 4. Study the biome on that basis

**Try this.**

1) Various biome regions have been shown on the map in figure 8.2. Considering the latitudinal location, select Taiga biome and write the name in its respective place in the index.

2) Write the names of the major countries that lie in this biome

**Vegetation :** One type of tree species is the characteristic of this biome. Evergreen coniferous forests are found here. The resin and the oil in these trees helps them to face the tough climate. Trees are tall and tapering to the apex. Leaves are waxy and branches tapering to the ground. This structure does not let snow stay on the trees.

Spruce fur, Douglas Fir, pine, juniper, cedar larch, oak, hemlock etc. are the major species of trees found here. Rasberry, salmonberry, gooseberry, strawberry, blueberry, etc. are fruit trees found here. See fig. 8.10.

**Can you tell ?**

In India, where do you find such fruits? What are the reasons for them being found here?

**Animal life :** As the ground is snow-covered for the most part of the year, the animals here have thick hides. They have a thick layer of fats and are hairy. Reindeer, grizzly bears, elk, caribou, etc are herbivores found here. Fox, mountain lions, puma and panthers are the carnivores.

**Human life :** As the climate is very cold here, human settlement is sparse. The coniferous trees are famous for their soft wood. Thus lumbering is followed here on a large scale. Saw mills, paper pulp and wooden furniture industries are found here.

**Current status :** Only one type of species is found here in a large area. The remoteness of the forests is less here. Deforestation is easy here as the wood is soft.

**Think about it.**

Why is this type of biome not found in Southern Hemosphere!

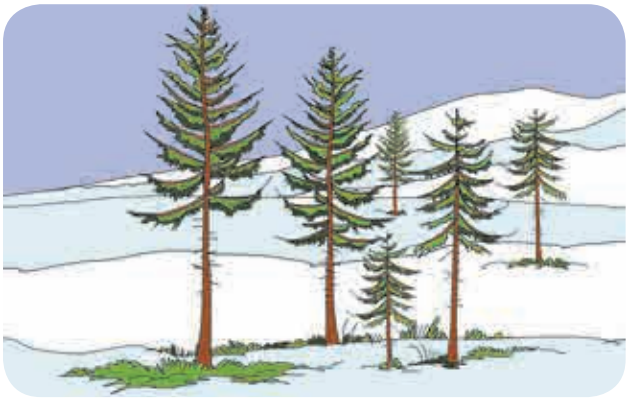


**Fig. 8.10 : Taiga biome**

**9) Tundra biome :**

**Latitudinal extent :** 65° to 90° N , Regions south of the ice caps of the Arctic and extending across North America, Europe, and Siberia.

You have already studied about the climatic conditions in this biome in Chapter 4. Study the biome on that basis

**Try this.**

1) Various biome regions have been shown on the map in figure 8.2. Considering the latitudinal location, select Tundra biomeand write the name in its respective place in the index.
2) Write the names of the major countries that lie in this biome

**Vegetation :** The Tundra is the coldest of the biomes. The ground is frozen for 8 months of the year . There is a layer of permanently frozen ground below the surface, called permafrost. This permafrost is a defining characteristic of the tundra biome. In the tundra summers, the top layer of soil thaws only a few inches down, providing a growing surface for the roots of vegetation.

Vegetation in the tundra has adapted to the cold and the short growing season. Mosses and lichens are common, while few trees grow in the tundra. The trees that do manage to grow stay close to the ground so they are insulated by snow during the cold winters. See fig. 8.11.

**Animal life :** Animal life is very scarce here. Thick fur and layer of fats in their body helps them to face very cold climate. Herbivores such as musk ox, bears, reindeers, caribou, lemming, rabbits along with carnivores like Arctic fox, dogs, jackals are found. Ptarmigan, ravens, snowy owls, and redpolls-remain year-round in the tundra. The bulk of arctic birds are migrants. In coastal areas, seals and walruses are found.

**Human life :** Because of very cold climate, human settlements are very sparse. Lapps,

Samoyeds and Eskimos live in adverse climate. Life of Eskimos has changed after they have come in contact with Westernizers. As they have started getting advanced instruments, their life has changed and fishing methods have changed. Thus they have started exploitation of fish is happening at a higher speed in this biome.

**Think about it.**

Which activities of human life are affected most by the cold climate ?

**Current status :** This biome is seeing development due to increased transportation and means of communication. The standard of life has improved and this has affected the protected factors of this biome. Due to global warming, the snow cover and the species dependent on it are getting affected badly.

**Fig. 8.11 : Tundra biome**

### 10) Mountain or highland biome :

**Latitudinal Extent :** Not specific; depends on altitude, slopes of high mountain ranges such as the Himalayas, the Andes and the Rockies

You have already studied about the climatic conditions in this biome in Chapter 4. Study the biome on that basis.

**Try this.**

1) Various biome regions have been shown on the map in figure 8.2. Considering the latitudinal location, select Mountain or highland biomeand write the name in its respective place in the index.

2) Write the names of the major regions that lie in this biome

**Vegetation :** The vegetation here ranges from deciduous to tundra varying according to altitude. Because of low temperatures and the winds, most plants are small and perennial. In Himalayas, for example, Rhododendron plants grow on most mountains. Oak, laurel and chestnut trees are also found up to 2000 m above sea level. Pine trees are found up to 4000 m. Beyond that, only lichens, grass and moss can be found. Regolith soils are found over slopes which are not very fertile. See fig. 8.12.

**Animal life :** Fauna hence any deer, bears, wolves, mountain lions, leopards, squirrels, rabbits, and a wide variety of birds, reptiles, and amphibians. Animals with special adaptation to snow can be found. In Himalayas, for example, one of the main animals of this mountainous biome here is the yak. It has a lot of long hair for warmth. Other animals are tigers, monkeys, leopards and elephants according to altitude.

**Human life :** In some regions, people grow crops such as tea, rice and barley on mountains. Grazing and sheep rearing are primary occupations. Tourism has developed in such biomes. People come here for trekking, para-gliding, and to get relief from heat. Transhumance is also practiced. Sherpas, Bakarwals,Lepchas Bhutiyas etc. are communities living in Himalayan mountain biomes.

**Current status :** These places are being over crowded now because of over –tourism. Mountain biomes are also threatened by deforestation, wildfires, hunting, poaching, and urban sprawl.

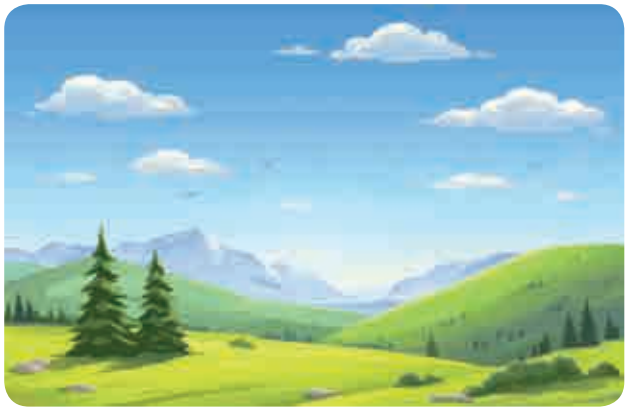


**Fig. 8.12 : Mountain or highland biome**

**Aquatic biomes :**

You have now studied the terrestrial biomes of the world. Besides, these biomes we find biomes in the water too. Here, the plants and animals have adapted themselves to the existing climatic conditions. Approximately 70% of the earth's surface is covered by oceans. Besides the oceans, we have rivers, lakes, etc which are freshwater sources. The aquatic biomes consist of any part of the earth that is covered with water. This includes freshwater and salt water. The aquatic biome can be further divided into freshwater biomes, marine biomes, wetland biomes, coral reef biomes, estuaries, etc. These sub-divisions are based on the salt content of the water and the aquatic plants that live there.

In marine biomes, there are three layers to recognize. The top layer is euphotic. The sunlight reaches here. This can be around 200 m deep. This is home to many fishes, sea turtles, jellyfish, seals, coral, zooplankton, and mangroves.

In the middle is the disphotic layer. Here, some light penetrates to the bottom part. This is around 1000m deep from mean sea level. Except few phytoplanktons sunk from upper layer, plants are not found here. Squid, cattlefish, wolfish, swordfish, eels, sea dragons, etc. are found. The animals are adapted to darkness, cold water and high pressure.

The third layer is the deepest layer known as apotic layer. It ranges from 1000m to 4000m depth. No light penetrates here. There is no living plant life. Inhabitants of this cold, dark environment include elusive giant squid, bioluminescent jellyfish, angler fish, hatchet fish, etc. Sperm whales enter this zone to hunt but return to the upper layers.

Beyond the layer, lies the darkest and the deepest zone extending upto the sea floor. Here, the animals are adapted to survive on detritus under even greater pressure.

## Exercise

**Q. 1. A) Complete the chain :**

| A | B | C |
|---|---|---|
| 1) Boreal forest | 1) Hard wood species of trees | 1) Siberia |
| 2) Deserts | 2) Tropical deciduous forest | 2) Myanmar |
| 3) Teak | 3) Wide spectrum of bio-diversity | 3) Sahara Desert |
| 4) Tropical rain forest | 4) Tundra Region | 4) Brazil |
| | 5) Taiga forest | 5) Greenland |
| | 6) Narrow spectrum of bio-diversity | |

**Q. 1 B) Fill in the blanks with appropriate alternatives given below and rewrite the sentences.**

1) Ecosystem consists of interaction between …….. and abiotic factors.

a) Biotic factors b) Animals

c) Human beings d) Plants

2) The original meaning of savanna is…….

a) Land with many trees.

b) Extensive perennial grass land.

c) Land which is full of trees with much grass.

d) land which is without trees but with much grass.

3) In Africa tropical evergreen forest is predominantly found in …….. .

a) Amazon basin

b) Sahara desert

c) Congo basin

d) Savanna

4) Mediterranean forest is also known as …….. forests.

a) Hard wood

b) Chaparral

c) Man made

d) Soft wood

**Q.2 A) Arrange the given statements as per given instructions.**

1) Arrange the following biomes in proper order from Equator to Pole.

a) Tundra b) Tropical rain forest

c) Boreal forest d) Sahara desert

**Q. 2. B) Select the inappropriate factor or statement**

1) Trees in the tropical rain forest-

a) Mahogany b) Ebony

c) Pine d) Rosewood

2) Temperate grasslands in the world.

a) Prairies – North America

b) Steppes – Eurasia

c) Downs – Africa

d) Pampas – South America.

4) Major hot deserts in the world are-

a) Gobi – Asia

b) Kalahari – Africa

c) Atacama – South America

d) Arabian – Asia

**Q. 3) Give geographical reasons:**

1) The trees in the tropical rainforests are broad-leaved while those in the Taiga are coniferous.

2) Desert biomes have thorny vegetation.

3) Lumbering activity has developed in Taiga forests.

4) Mediterranean biome has proved to be a catalyst to the development of cinema industry.

**Q. 4) Write short notes on:**

1) Agriculture in temperate grassland biome

2) Human life in Tundra biome

3) Animal adaptation in grasslands

4) Marine biomes

**Q. 5) Distinguish between :**

1) Biome and ecosystem.

2) Tropical and temperate grassland biomes.

3) Human activities in tropical evergreen and Monsoon regions.

**Q. 6) Answer in detail :**

1) Give an account of the desert biome with the help of following points :

a) location b)plant life

c) animal life d) human life

2) Explain the reasons behind deforestation in your area. What measures will you suggest to minimize deforestation?

***

# 9. Disaster Management

**Try this.**

Read about the following disasters which have occurred across the world and answer the following questions.

| Major Disasters | | | |
|---|---|---|---|
| **Year** | **Disaster** | **Location** | **No. of deaths/loss incurred (approx.)** |
| 1920 | Earthquake | China | 2,35,000 |
| 1923 | Earthquake | Japan | 1,42,000 |
| 1970 | Bhola Cyclone | India and Bangladesh | 5,00,000 |
| 1984 | Release of gas Methyl Isocyanate | Bhopal, India | 10,000; 5.5lakh affected |
| 1985 | Ruiz Volcanic Eruption | Colombia | 25,000 |
| 1994 | Land slide | Varandha Ghat, Maharashtra, India | 20; Breaching of ghat road, Konkan Coast damaged to the extent of 1 km at several places |
| 1995 | Rail accident | Firozabad, India | 400 |
| 1999 | Cyclone | Odisha, India | 10,000 |
| 2004 | Tsunami | India, Indonesia, Sri Lanka | 2,50,000 |
| 2005 | Earthquake | India and Pakistan | 80,000 |
| 2005 | Flash Floods | Mumbai, India | 1100 |
| 2014 | Hailstorm | Maharashtra, India | Affected many standing crops, 2700 farm animals dead |
| 2019 | Cyclone Fani | Odisha, India | 89 |

1) Classify these disasters into natural and man-made disasters.
2) Which of these disasters occurred due to climatic conditions?
3) Which of these disasters occurred due to geological causes?
4) Can you relate the location of a disaster with its cause?
5) Besides the number of deaths, what other losses might be occurring after the disasters?
6) Comparing the cyclones of 1999 and 2019, can you think of the reasons behind the reduction in the number of deaths?
7) Which of these disasters can be predicted in advance?
8) Of those disasters for which prediction can be made, can the people be evacuated from the area?
9) Why do some people get affected by the disaster in specific regions?

## Geographical explanation

Natural disaster have caused widespread loss of life and property. Human beings are now becoming more aware and various steps have been taken at different levels to reduce the effect of disasters. Identification and classification of disaster is considered the first step to deal with disasters.

### Types Of Disasters :

Disasters can be classified into various types depending on their origin. They can be of the following types:

1) Tectonic Disasters : Earthquakes, volcanic eruptions, Tsunamis, etc. e.g. The great Tsunami and earthquake of Indonesia occurred on 26th December, 2004
2) Geological : Landslides, mudslides, avalanches. e.g. The Malin mudslide of 2014 in Maharashtra.
3) Meteorological : Flood, cyclone, storm, heat wave, etc. e.g. The floods of Kerala, 2018
4) Biological : locust attacks, pest attacks, epidemics such as flu, dengue, cholera, etc. e.g. The Surat plague of 1992.
5) Anthropogenic or man-made : Industrial accidents, Transportation accidents, Nuclear accidents, etc. e.g. Bhopal gas tragedy 1984

Thus, we see that disasters can be natural or man-made. Some disasters can be prevented. Generally, man-made disasters can be prevented as they happen due to mistakes or carelessness by humans. Thus, disasters affect human population while some ever may occur only in nature. For example, volcanic eruption is a natural process which cannot be prevented. Such natural events are called hazards. When they occur in areas inhabited by humans and cause damage, they are termed disasters.

### Hazards :

Hazards are phenomena that pose a threat to people, structural or economic assets and which may cause a disaster. They could be either naturally occurring in the environment or man-made. Thus, high rainfall is a hazard as it may cause floods which may be disastrous. A hazard becomes a disaster when it affects human population, settlements and their activities.

**Always remember**

Difference between a hazard and a disaster

Disaster and hazard are often used interchangeably. But they are two different terms. A disaster is the result of the impact of a hazard on society. Disaster is more of an anthropocentric concept, while hazard is a result of natural process. An earthquake or a storm occurring anywhere in the world is a hazard but the same event occurring in inhabited areas is called a disaster. A disaster occurs when the people are unable to cope with the impact of the hazard, causing death, injury, loss of property as well as economic losses.

### Vulnerability :

In the examples given in the table, we find that population living in certain areas are exposed to particular disasters. In the above example, in case of cyclone, people in the coastal areas of India are more likely to be affected than those in the interior. People living in seismically active areas are prone to earthquakes. At times, the social economic and political conditions may make people or more likely to be affected by disasters in the same region. For example, the poor are more likely to be affected by disasters. Similarly, old people and children can easily become victims of disasters. Densely populated areas are more likely to be affected than sparsely populated areas. The geographical conditions and circumstances of people or region that make them susceptible to a disaster is known as

vulnerability. Thus, if you are more vulnerable, you have to be better prepared. And, if we are better prepared, we can reduce the risk of getting affected by the disaster.

### Capacity to cope :

The ability of people, organisations and systems, using available skills and resources, to face and manage disasters is known as their capacity to cope. Thus, vulnerability is reduced if the capacity to cope with the disaster is high. For example, in 1999 the cyclone had caused 10,000 deaths but in 2019, only 89 deaths occurred due to a cyclone. This shows that capacity to cope has improved.

**Can you tell ?**

If an earthquake occurs with a magnitude of more than 6 in Sahara desert area which is totally uninhabited by humans and a similar one occurs in Assam, which one would you call a disaster ?

### Effects of Disasters :

The disasters can bring lot of immediate and long-term effects on various sectors of a society. Primary effects occur as a result of the disaster itself. For example, damage during a flood or collapse of buildings during earthquake. Secondary effects occur because a primary effect has caused them. For example: fires ignited, disruption of electrical power and water service as a result of earthquakes.

Tertiary effects are long-term effects that are a result of a primary and secondary effect. These include things like loss of homes, permanent changes in the position of river channel and adverse effect on tourism in an affected area due to an earthquake etc.

**Find out !**

With the help of internet or library, collect old newspaper cuttings of disasters. Bring them in the class and discuss how people faced them. Find out how governments and various institutions tackled the situations together.

### Disaster management :

In all the examples of disasters, given in the table, disasters like gas leakage and rail accident could have been prevented. Disasters like volcanic eruption, tsunamis, earthquakes etc. cannot be prevented but their effect can be reduced. Events like cyclones and floods can now be forecast and people can be evacuated from vulnerable areas. This process of creating awareness about disasters, taking steps to reduce its effects, evaluating the damage caused by the disasters, providing relief, food and medical aid in affected areas involves many people, organizations and processes.

Disaster management is a multi-disciplinary task which in the following tasks. :

- Preparedness
- Monitoring, Early warning and mitigation
- Evacuation, search and rescue
- Providing relief in terms of medical help, basic needs such as food clothes and shelter
- Reconstruction and rehabilitation

Disaster management seeks to reduce risk to damages or losses. It focuses on the hazard that causes the disaster and attempts to minimize the adverse impact of the same on communities. It involves coordination from governments, local self governments, police, military and paramilitary forces, NGOs, doctors, scientists, planners, volunteers and groups or communities.

**Can you do it!**

Classify the above components of disaster management into pre-disaster and post-disaster.

## Geographical explanation

### Disaster management cycle :

In disaster management, disaster prevention, disaster mitigation and disaster preparedness constitute the pre–disaster planning phase. Pre–disaster planning is the process of preparing in advance, to face disasters in future.

### Disaster preparedness :

It involves measures taken to prepare for and reduce effect of disasters. This include carrying out awareness campaigns, strengthening the weak structures, preparing plans for households and community level etc. For example, if a building catches fire, its residents should know how to escape. For this to occur they should be trained before hand. People living in the flood prone areas should be prepared with items such as medicine, food, water etc.

It is the action taken to reduce or avoid disasters and their effects. It should be included in development policy and planning at regional, national and international levels. It is a continuous process.

**Use your brain power!**

In 1988, an earthquake of magnitude 6.9 struck Armenia and took 25,000 lives. On the other hand, an earthquake in 1989 in California of magnitude 7 took only 63 lives. Can you think of the reason behind this difference?

### Mitigation :

Mitigation mean any measure taken to minimize the impact of a disaster before it occurs. Mostly, it refers to action taken against potential disasters. It is mainly carried out for those disasters which cannot be prevented. Mitigation efforts help the people by creating safer communities and reducing loss of life and property.

Some mitigation measures can be • community level disaster planning, • public awareness and information campaigns, • preparedness of hospitals • construction of houses away from hazardous areas, etc. Mitigation efforts can be categorized as structural and non-structural. Structural efforts include construction of river embankments strengthening existing buildings, etc. whereas non-structural effort include areas training in disaster management, regulating land-use, public education etc.

These measures involve all possible steps to reduce the losses. For example, use of satellites in forecasting floods or cyclones can help in knowing the timing of their landfall. People can be evacuated from vulnerable areas. In the case of Cyclone Fani, effective mitigation efforts have helped to bring down the number of deaths. Mitigation lessens the financial impact of disasters on government agencies.

### Disaster response :

'Disaster response' is the way the community responds to the disaster. Though, this is a post disaster process, it reflects the preparedness of the community. It includes the immediate period after the disaster strikes. It is concerned with providing food and shelter to the disaster victims, restoring normal condition and providing financial supports. Thus, those initiatives taken to ensure that the needs and provisions of victims are met and suffering is minimised are taken under this stage. The main focus in this phase is making people safe till further measures are taken.

### Recovery :

These steps involve measure taken to bring life back to normal in affected areas. This involves restoration of basics services and repair of physical, social and economic damages. Cleaning of debris, giving finical assistance to victims, rebuilding roads and bridges and providing sustained medical care for displaced human and animals population is included in this stage.

**Rehabilitation :**

Though, this is the last phase of disaster management, the process of disaster management does not end here. This phase involves efforts taken to restore normalcy in the long term. This phase may take many years efforts. This may include providing to housing to the affected, taking important decisions regarding economy, agriculture etc. which have been affected by disasters.


**Fig. 9.1 : Disaster management cycle**

**Use your brain power !**

Why is disaster management called a cycle? (See fig. 9.1)

**Always remember**

**Structural and non-structural measures :**

Structural measures include any physical construction to reduce or avoid possible impacts of hazards. It is achieved by or the application of engineering or technology. Nonstructural measures do not involving physical construction. It includes mainly the use of knowledge, practice or agreement to reduce disaster risks and impacts. In particular it is achieved through policies and laws, public awareness, training and education.

**Give it a try.**

Given below are a list of measures taken for disaster. Write whether they are pre-disaster or post-disaster and structural or non-structural. Also write the name of the disaster for which they are used. One has been done for you an as example.

| Sr. No. | Measures | Pre-disaster / Post-disaster | Structural / Non structural | Disaster/ (s) to which they are applicable |
|---|---|---|---|---|
| 1 | Conducting mock drills. | Pre- disaster | Non structural | Earthquake, landslides, fire |
| 2 | Discussions about disaster risks and community problems and solutions. | | | |
| 3 | Using art, documentaries, music and drama to portray the impact of disasters on communities. | | | |
| 4 | Inviting emergency services personnel to provide lectures/demonstrations. | | | |
| 5 | Making booklets on disaster related information. | | | |
| 6 | Retrofit old buildings. | | | |
| 7 | Constructing shelters and evacuation chambers . | | | |

| Sr. No. | Measures | Pre-disaster / Post-disaster | Structural / Non structural | Disaster/ (s) to which they are applicable |
|---|---|---|---|---|
| 8 | Making change in land use policy regarding construction of houses in low-lying areas. | | | |
| 9 | Constructing buildings and houses using disaster resistant material, design to comply with relevant BIS (Bureau of Indian Standards) codes. | | | |
| 10 | Constructing proper drains. | | | |
| 11 | Carrying out plantation activities. | | | |
| 12 | Regular disaster related activities through radio, TV newspaper, etc. | | | |
| 13 | Using satellites for early warning. | | | |
| 14 | Evacuation routes in disaster management plans should be delineated. | | | |

**Find out !**

Who is responsible for looking after disaster management in our country?

### Role of Remote sensing, GIS and GPS in disaster management :

Today, Information Technology (IT) is used in this field for increasing the efficiency and effectiveness in coping with disaster. Map and spatial information are important components of all information in case of any disaster. Hence, mapping and spatial information acquisition becomes vital for any disaster management.

Remote sensing is very effective in mapping disaster prone areas particularly flood- affected areas. Microwave data can provide information on flood-inundated areas. Remote sensing satellites monitor the path of cyclone and it can provide ample time with warning for evacuation and preparedness in advance. The data obtained from meteorological satellites is used for cyclone tracking, intensity and landfall predictions and forecasting of extreme weather events. The data from earth observation satellites is used for monitoring disaster events and assessing the damages. The communication satellites help to establish communication in remote and inaccessible areas. Navigation satellites are used for providing location based services.

The GPS (Global Positioning System) is also important tool. GIS has emerged as a very important methodological tool for effective planning, communication and training in the various stages of the disaster management cycle. It also has a vital role to play in determining the extent of hazards and disasters. These techniques are very helpful to make planning and policy very easy for implementation.

In pre – and post disaster activity management role of GIS, GPS and remote sensing assume greater importance.

### Disaster Management In India :

India's geo-climatic conditions as well as its high degree of socio-economic vulnerability, makes it one of the most disaster prone country in the world.

After the tsunami in 2004, approach towards

disaster management has drastically changed. Various state governments were requested to set up a disaster management office. At the Government of India level, two institutes were set up in New Delhi - the National Institute of Disaster Management (NIDM) and the National Disaster Management Authority (NDMA). The aim was to mitigate the damage potential of natural disasters in future.

The National Disaster Management Authority has been established at the centre, and the SDMA at state and district authorities at district level are gradually being formalized. In addition to this, the National Crisis Management Committee, part of the earlier setup, also functions at the Centre.

The nodal ministries, are identified for different disaster types of function under the overall guidance of the Ministry of Home Affairs (nodal ministry for disaster management). This makes the stakeholders interact at different levels within the disaster management framework.

For disasters such as drought, the Ministry for Agriculture is the nodal agency. Military forces and para military forces such as Home Guard, etc. play an important role. Various agencies such as ISRO, NRSC (National Remote Sensing Centre), etc. also play an important role in disaster management.

**Find out !**

Find out about the role of military and paramilitary forces in disaster management of India.

**Do you know ?**

The Union Ministry of Earth Science has launched India Quake application. The mobile App has been developed by the National Centre for Seismology (NCS). Through this App, location, time and magnitude of earthquakes can be known after their occurrence. It also will help in reducing panic amongst people during an earthquake.

**Project :**

Make a list of satellites which are used in disaster management. Collect their pictures and paste on the class notice board.

## Exercise

**Q. 1) Choose the correct alternative :**

1) Which of the following groups shows the correct type of disasters?

| a) | b) | c) | d) |
|---|---|---|---|
| Tectonic | Floods | Tectonic | Tectonic |
| Geological | Geological | Geological | Human |
| Human | Human | Volcanic | Biological |
| Climatic | Climatic | Climatic | Volcanic |

2) The Meteorological Department has given information that a cyclone is likely to make a landfall at Odisha in 2 days. Which of the following group shows the correct sequence of management processes?

| a) | b) | c) | d) |
|---|---|---|---|
| Recovery | Rehabilitation | Preparedness | Response |
| Rehabilitation | Preparedness | Mitigation | Recovery |
| Preparedness | Mitigation | Response | Rehabilitation |
| Mitigation | Response | Recovery | Preparedness |
| Response | Recovery | Rehabilitation | Mitigation |

3) Statement A - The cyclonic depression originating in the Bay of Bengal is marching towards Tamil Nadu at a velocity of 350 km/hr.

Statement B - The loss of life was not much but property loss occurred on a large scale.

i) A indicates a disaster and B indicates a hazard.

ii) A indicates a hazard while B indicates a disaster.

iii) A indicates a disaster but B does not indicate a hazard.

iv) A does not indicate a disaster but B indicates a hazard.

4) India has been successful in mitigating the effects of the following disaster:

a) earthquake

b) volcanic eruptions

c) floods

d) cyclones

**Q. 2) Write notes on :**

1) Vulnerability
2) Disaster
3) Hazard
4) Man-made disasters

**Q. 3) Write in short :**

1) Mitigation for cyclones
2) Preparedness for floods
3) Rehabilitation after earthquake

**Q. 4) Answer in detail :**

1) Explain the types of disaster according to origin
2) Explain the effects of disasters with the help of examples
3) Write about the preparedness in Disaster Management in India.
4) Explain, with example, how will you carry out disaster management in your region/ premises.

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# PRACTICALS

# CONTENTS

# Practical No. 1 - Interpolation

**Aim :** Construction of isolines on a map

**Objectives :**

1) To understand the purpose of using isolines in maps
2) To interpret isopleth maps for different variables.
3) To understand the method of drawing isolines on a map with the help of given data

**Introduction :**

Isolines are lines drawn on a map to link different places that share a common value. The prefix 'iso' is a Greek word meaning equal; so an isoline is a line joining points showing equal values. For example, a line drawn on a map to join up all the places that have the same height above sea level is called a contour. There are many examples of isolines used in maps. Isotherms are used to show temperatures, isobars for atmospheric pressure, etc. Values of the variable are not available for all the places in a given area. In such a situation,using collected and available information, the values for intermediate locations are estimated on the basis of those for which the values are available. For this , technique of interpolation is used. Once the values for intermediate locations become available ,one has to look for points of equal values and such points are joined by a line to draw isolines. The technique of interpolation is used for drawing the lines. Interpolation is used to insert the intermediate values between the observed values of two stations.

**Materials required :**

Tracing paper, pencil, rubber, scale, marker pen 0.5, Base map showing locations of different points, with values for the given variable.

**Procedure :**

**STEP 1 -** You will be given a set of data which contains values of temperatures, heights, pressure, etc. In this example, we are giving a set of data for temperatures in degree Celsius. See fig 1.1.

Study the given data. Note the minimum value and the maximum value. Here, 2° C is the lowest value and 32° C is the highest value. Decide the interval of drawing the isolines. Here, you can take the interval of 5° C. This implies that the value of minimum isotherm will be 5° C while that of maximum will be 30° C. Therefore, we need to draw isotherms of 5°, 10°, 15° , 20° , 25° and 30° C.


**Fig. 1.1**

**STEP 2 -** Now observe the data. See where you can see points having. 5° C. Some values are 5° C given directly but at other locations, you will not find value of 5° C. These will have to be found on the basis of available other values. For example, 5 can lie between 2 and 10 or 4 and 7, 4 and 8 etc. You have to locate value of 5° C in between all these points. Select any two points out of these. Suppose you take between A - 10° and B - 2° C. To fix the location of the 5° C isotherm between these two points, draw a straight line between them. Divide this line into 8 (10 - 2 = 8) equal

parts using a scale. The divisions could be rounded off to make the division easier. Mark the 5° C point of the isotherm by counting it from either 2° or 10°. Thus, one 5° C isotherm point is fixed. Repeat this process till you get all the possible 5° points. See fig 1.2.

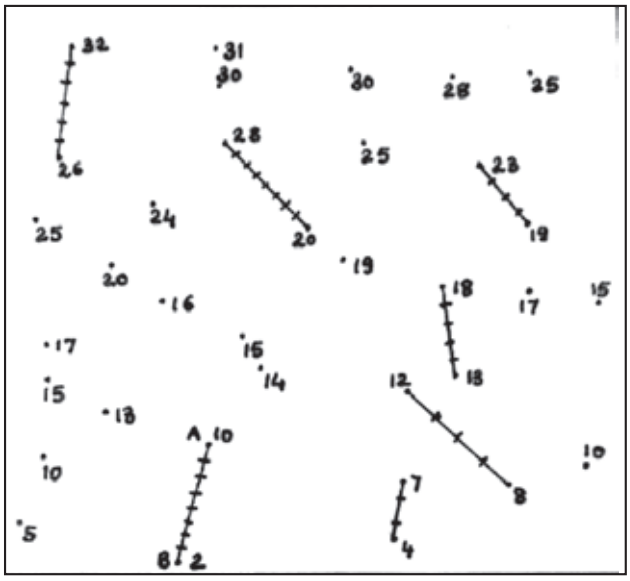

Fig. 1.2

**STEP 3 -** Join all the points of 5° C. Make sure it is a smooth line. Do not use scale to join the points. Mark 5° C near the margins. After 5° C isotherm, take 10° C isotherm. Some points of 10° are already given. Find the others using two points. Similarly, take 2 points in such a way that 10° C isotherm point will lie between them.

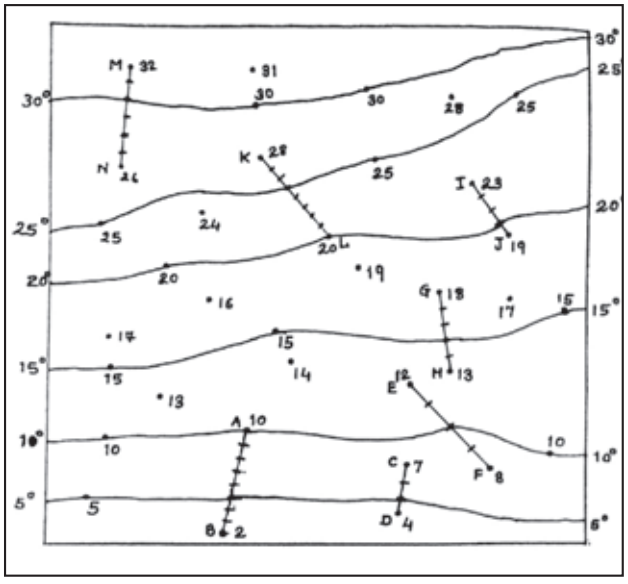

Fig. 1.3

Join the two points and divide them into equal parts according to the difference between them (Higher value - lower value). Repeat this procedure till you get points for all isotherms till 30° C. (maximum value of the data).

**STEP 4 -** After you get all the points of isotherm, join the points of equal values from one edge to the other. Make sure your lines are smooth and continuous. Do not use a scale to join the points. Write the respective values at the margins. See fig 1.3.

**Observation and learnings:**

Write a note on your observations and interpretation of the isotherms after your map is complete. Comment on the nature of isolines you have drawn. Think of more parameters which you can show using isolines. Discuss the advantages and disadvantages of the interpolation method in the class.

**Practice more :** Draw the isolines for the data given in figure 1.4. The figure you obtain after interpolation will be used for practical 2.

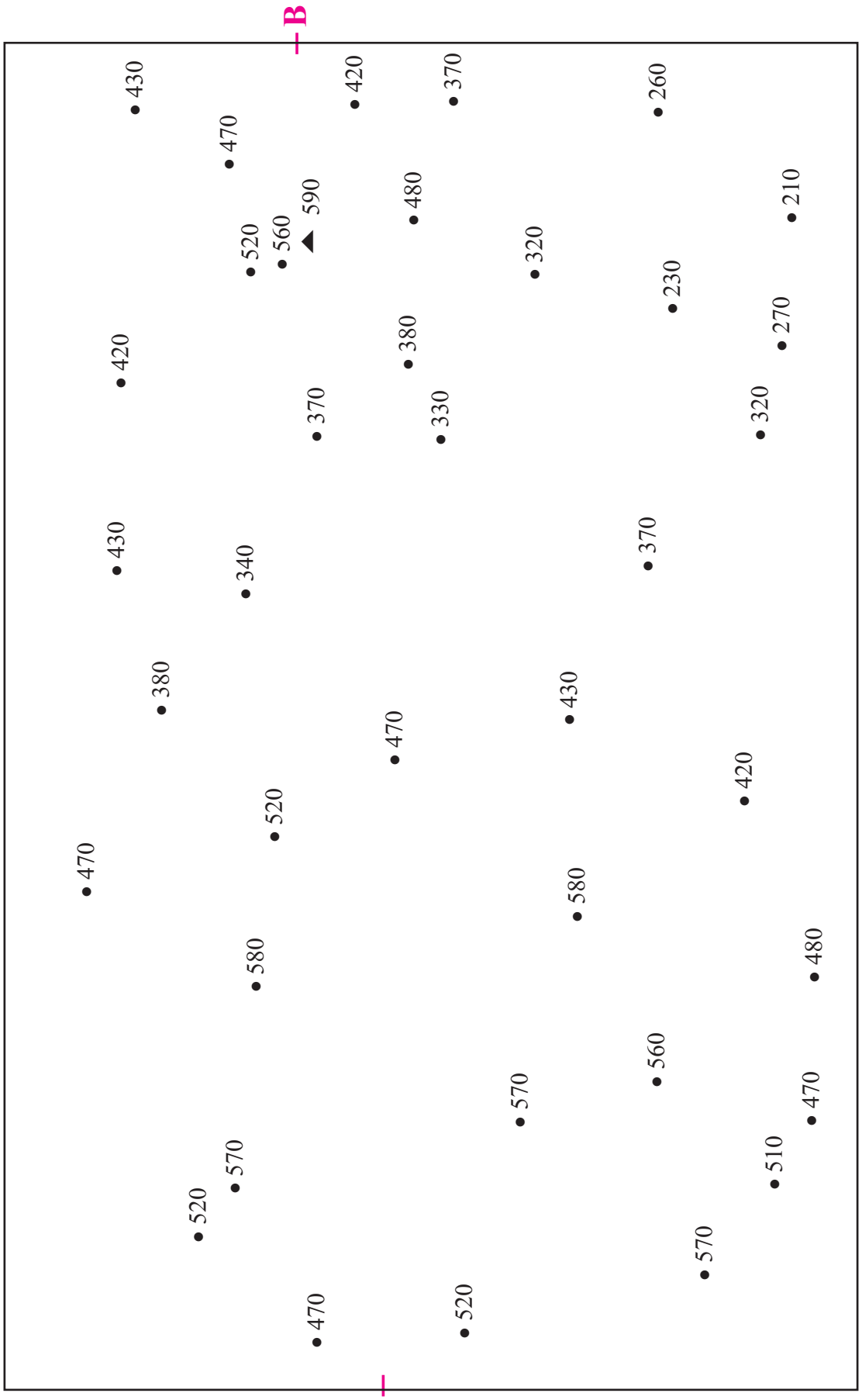


Fig. 1.4

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# Practical No. 2 - Cross Profile

**Aim :** To interpret various contours showing different landforms and draw their profiles.

**Objectives :**

i) To understand the use of contours in understanding various landforms.

ii) To understand various types of slopes with the help of profiles.

iii) To draw profiles of various landforms using contours.

iv) Interpreting the relief of the area with the help of profiles.

**Introduction :**

Contour lines are used to represent a three-dimensional image on flat surfaces. They are commonly used on topographic maps. Here contour lines connect continuous points of equal elevation. They are shown in centimetres or metres. A 5m contour show that the locations are at a height of 5m.

The rate of rise or fall of a terrain feature is known as its slope. Four types of slopes are as follows :

1) Uniform slope : Equidistant contour lines on a map indicate a uniform slope.

2) Gentle slope: When the contour lines on a map are far away from one another , they indicate a gentle slope.

3) Steep slope : if the contour lines on a map are close to one another, the slope is steep

4) Concave and convex slope: On a map, if the contours with higher values are closer to one another, and those with lower values move far away from one another, it indicates a concave slope. As against this, if the contours with higher values are farther away and those with lower values are closer, they represent a convex slope.

**Profile :**

Contour maps use the contour lines to represent the third dimension of elevation. A topographic profile is a diagram that shows the change of elevation of the land surface along a given line. A topographic profile is a cross-sectional view along a line drawn through a portion of a topographic map.

**Materials required :** pencil, scale, color pencils, cross section profile from a toposheet, strip of paper

**Procedure :**

We will now learn to draw a cross profile of a part of toposheet or landscape. We need to understand the relief shown on a topographical map with the help of contours. In such a case , we draw a cross-section of the relief to understand various relief features in the area.

Following figure is given to you as example.

**STEP 1 -** Obtain the contour map you get after interpolation on Page 109 fig. 1.4. To construct a topographic profile, you must first draw a line across the profile so that the maximum area is covered. See fig. 2.1. Draw a line joining A and B.

**STEP 2 -** Place a blank piece of paper as shown in the figure, along the line you have drawn.

**STEP 3 -** On both the blank paper and the map, mark clearly the starting and ending points of your line of section. Below these marks, write down the elevation of the starting and ending points of the section.

**STEP 4 -** Make a tick mark wherever the paper crosses a contour line on the map, making larger ticks for the index contours and smaller ticks for the intermediate contours. Write the elevation of the index contours below their ticks on your paper.

**STEP 5 -** Once you are certain you have all of the appropriate tick marks and elevations, remove your paper from the map. Take a graph paper . Place your paper with the tick marks on the graph paper and mark the starting and ending

points of your line of section on the graph paper.

**STEP 6 -** Draw vertical lines above your starting and ending points. These will be the boundaries of your profile. Use the maximum and minimum elevations along your line of section to determine how long to draw these lines.

The scale is same as the scale of the toposheet from where this cross section has been taken. The scale can be taken as 1: 50000.

**STEP 7 -** Beginning with your starting elevation, go directly above the tick mark on your paper and make a small dot on the graph paper at the corresponding elevation Make a small dot for each tick mark on your paper.

**STEP 8 -** Connect the dots on the graph paper, and you have a topographic profile.

**STEP 9 -** Though you get the profile, the scale of X-axis is different from the scale of Y axis. This means the profile is vertically exaggerated . i.e. vertical scale is larger than the horizontal scale. To determine the amount of vertical exaggeration, convert both the axes in the same unit and then divide the horizontal axis by vertical axis.

**V.E = Horizontal Axis / Vertical Axis**

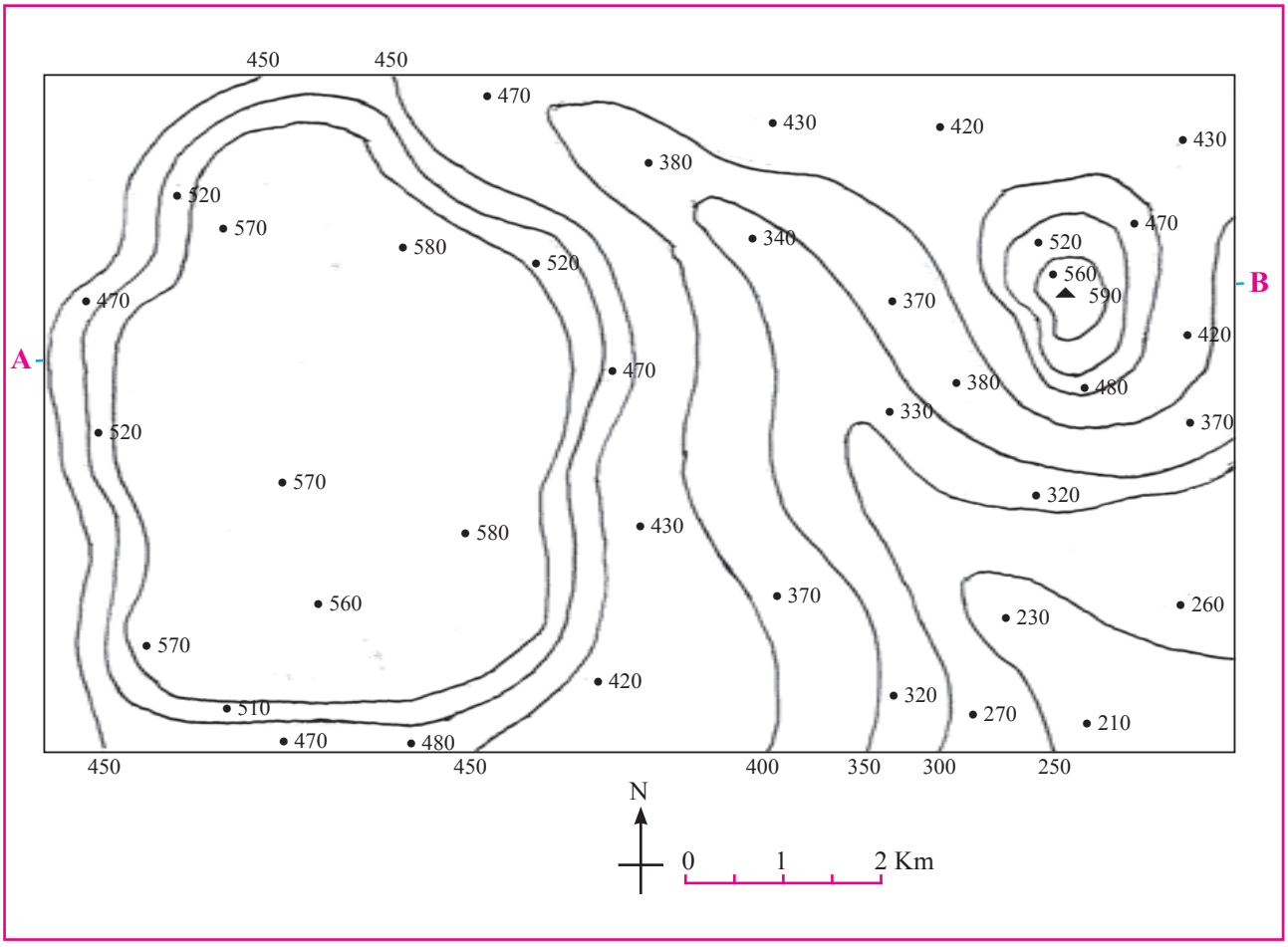


**Fig. 2.1**

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# Practical No. 3 - Toposheet-Introduction and Marginal Information

**Aim :**

1) To understand the purpose of a toposheet.
2) To extract information about the toposheet from its margins.

**Introduction :**

The topographical maps, are of utmost importance to geographers. They serve the purpose of base maps and are used to draw all the other maps. Topographical maps, also known as general purpose maps, are drawn at relatively large scales. These maps show important natural and cultural features such as relief, vegetation, water bodies, cultivated land, settlements, and transportation networks, etc. These maps are prepared and published by the Survey of India in India for the entire country. The topographical maps are drawn in the form of series of maps at different scales.

Knowledge of map language and sense of direction are essential in reading and interpreting toposheets.

**Materials required :** Any toposheet preferably 1: 50000 scale. Teachers can download the toposheets of respective districts from https://soinakshe.uk.gov.in/ and print them for use in the class.

**Procedure :**

1) You must first look for the north line and the scale of the map and orient yourself accordingly.
2) Look for the scale of the map. See where the scale is written on the map.
3) Once you know the north direction and the scale of the map, find its latitudinal and longitudinal extent.
4) Now look at the margins of the toposheet. You will find lots of information above and below the frame of the map. This information is necessary for gathering the basic knowledge of the toposheet. It includes the topographical sheet number, its location, grid references, its extent in degrees and minutes, scale, the districts covered, etc.
5) Study the given fig. 3.1, match the respective numbers with corresponding places on the toposheet in your hand and then write your observations in the table below.

| Sr. No. | Name of the information | Purpose | Example |
|---|---|---|---|
| I | | | |
| II | | | |
| III | | | |
| IV | | | |
| V | | | |
| VI | | | |
| VII | | | |
| VIII | | | |
| IX | | | |
| X | | | |
| XI | | | |
| XII | | | |
| XIII | | | |
| XIV | | | |

You must have noticed that at number 5 is the index number of a toposheet. This is related to number 11 where the scale of the toposheet is given. This is known as the indexing of the toposheet. We can identify the scale of a toposheet by its index number.

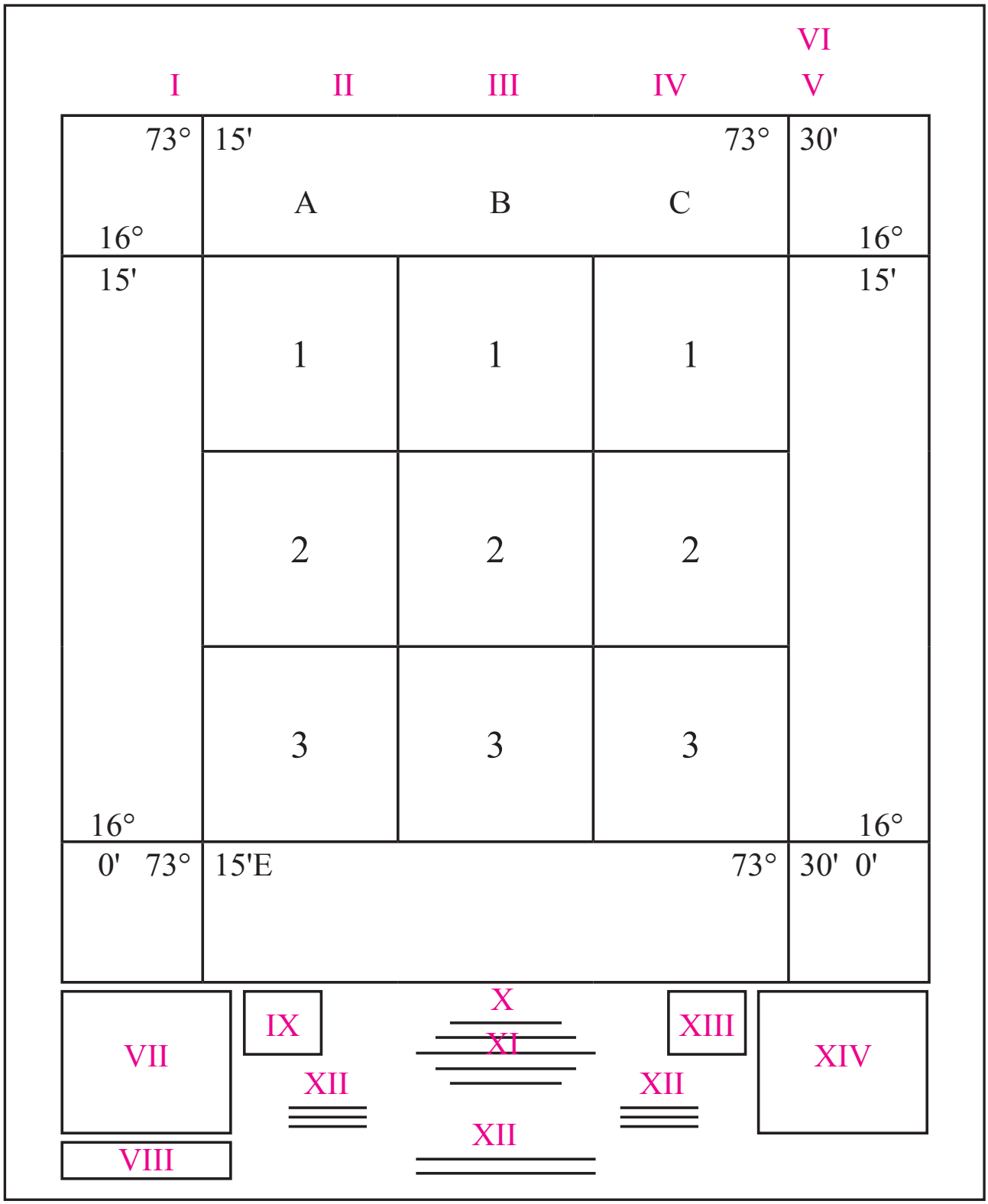


Fig. 3.1

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## Practical No. 4 - Toposheet - Grid -referencing

**Aim :**

1) To understand the purpose of grid references
2) To locate a place on a toposheet with the help of its 6 –point grid reference.

**Introduction :**

You might have noticed by now that toposheets are covered in a series of grid lines or squares. These grid lines help you to pinpoint an exact location anywhere on the map. The vertical lines are called 'eastings', as they increase in value as you travel east on the map. The horizontal lines are called 'northings' as they increase in value as you travel north on the map. These lines help you in knowing the exact location of a place on a toposheet. A grid reference can be four digit or six-digit. A six-digit reference is a more exact way of locating a place than a four digit.

**Materials required :** Any toposheet with grid (preferably 1: 50000 scale). Teachers can download the toposheets of respective districts from https://soinakshe.uk.gov.in/ and print them for use in the class.

**Procedure :**

1) Take the toposheet and select any place. It can be a town or a city or a fort or a village.
2) Count the number of grids towards the east and towards the north. A six figure grid reference takes the form EEANNB. EE represents the easting which is immediately to the left of the object and NN represents the northing which is directly under it. Therefore EE and NN represent the four figure grid reference for the object in question. A is a digit which tells us how close to or far away from the easting the object is located. The higher the number, the farther away from the easting the object is. Similarly, B is a digit which tells us how close to or far away from the northing the object is found. X and Y can have a value ranging from zero to nine
3) To determine the 3rd and the 6th digit, we need to divide the space between easting and the northing before the place and easting and the northing after the place into ten equal parts.
4) This will give the exact location of the place.
5) With the help of the above explanation, complete the table below. An example has been given.

| Sr. No. | Grid Reference | Easting | Northing | Name of the location |
|---|---|---|---|---|
| 1 | 223456 | 22 | 45 | Village X |
| 2 | | | | |
| 3 | | | | |
| 4 | | | | |

## Practical No. 5 - Toposheet - Interpretation of Relief

**Aim :**

1) To understand how relief is shown on a toposheet.
2) To interpret various landforms, slope and relief shown on the toposheet.

**Introduction :**

You know that toposheets contain a lot of information. After giving the preliminary information, one starts with interpreting the toposheet. To interpret a toposheet, one needs to

see the following items :

1) Relief
2) Drainage
3) Vegetation
4) Human Settlements
5) Occupations
6) Transport and Communication

**Materials required :** Any toposheet preferably 1: 50000 scale. Teachers can download the toposheets of respective districts from https:// soinakshe.uk.gov.in/ and print them for use in the class. We have taken 63 K/12 as example.

**Procedure :**

**STEP 1 -** After looking at the marginal information, look for contour interval. Also look for contour patterns of contours and with the help of profiles, interpret the major landforms.

**STEP 2 -** Look for the highest points – BM, Spot heights and triangulation points. This will give an idea of the slope and general altitude of the place.

- Convert 1:50,000 into a verbal scale using metric system.
- What is the value of the highest point on the map.
- What major landforms do you see in the toposheet?
- Name the major physical divisions you see in the toposheet .
- What is the average elevation of the area in the north part of the toposheet?
- What is the difference in the elevation of the southern part and the northern part of the toposheet?
- Comment upon the nature of the contours in the southern part.
- Write a short paragraph on the relief of the area shown in the toposheet

***

## Practical No. 6 - Toposheet - Interpretation of Drainage

**Aim :**

1) To understand how drainage is shown on a toposheet.
2) To identify rivers, their origin, direction of flow, landforms carved by them, tributaries and transport.

**Introduction :**

You know that toposheets contain a lot of information. After giving the preliminary information, one starts with interpreting the toposheet. To interpret a toposheet, one needs to see the following items :

1) Relief 2) Drainage 3) Vegetation

**Materials required :** Any toposheet preferably 1: 50000 scale. Teachers can download the toposheets of respective districts from https:// soinakshe.uk.gov.in/ and print them for use in the class. We have taken 63 K/12 as example.

**Procedure :**

**STEP 1 -** After looking at the marginal information and relief, we look for the drainage system in the area. Note the major rivers and coastal areas, if any in the toposheet. Make use of conventional signs and symbols given in marginal information.

**STEP 2 -** Look for tributaries of the rivers. Note the places where tributaries are meeting the rivers.

**STEP 3 -** Look at the general relief of the area whether it is a plain or a hilly or a mountainous region. Look for major landforms by the rivers like the meanders, waterfall, flood plains, etc.

The teachers should ask questions in such a way that students will interpret the drainage aspects. Some sample questions are given here for toposheet number 63 K /12

1) Name the major river in the toposheet.
2) In which direction does the river flow.

- What are the landforms in the shape of loops being formed by the river known as?
- Name the waterfalls and the rivers on which they lie.
- Name the major tributaries of the main river which come from the Plateau region .
- By what names is river Khajuri known as in its upper and middle course?
- Comment upon the slope of the region on the basis of the drainage pattern in the area.
- Which bank of the main river is steeper?
- Are the rivers navigable throughout the year?
- Comment upon the drainage in the area in 5 sentences.

***

## Practical No. 7 - Toposheet - Interpretation of Vegetation

**Aim :**

1) To understand how vegetation is shown on a toposheet.
2) To identify the types of vegetation and relate them with relief and drainage.

**Introduction :**

You know that toposheets contain a lot of information. After giving the preliminary information, one starts with interpreting the toposheet. To interpret a toposheet, one needs to see the following items:

1) Relief 2) Drainage 3) Vegetation

**Materials required :** Any toposheet preferably 1: 50000 scale. Teachers can download the toposheets of respective districts from https:// soinakshe.uk.gov.in/ and print them for use in the class. We have taken one as example.

**Procedure :**

**STEP 1 -** After looking at the marginal information and relief, we look for the natural vegetation in the area. Make use of conventional signs and symbols given in marginal information which are important in interpreting the vegetation.

**STEP 2 -** Vegetation in a region is expressed by green colour. Presence of green colour shows vegetation. Shades of green show the density of forests.

**STEP 3 -** Look for any Reserved Forest , Protected forest, open scrub in the region.

**STEP 4 -** Identify important tree species, plantations or grasses given in the toposheet.

**STEP 5 -** Relate vegetation with relief and drainage.

The teachers should ask questions in such a way that students will interpret the vegetation aspects. Some sample questions are given here for toposheet number 63 K /12

- Which part of the toposheet is comparatively devoid of any vegetation? Why?
- Name the major forest regions in the area.
- Name the major tree species found in these areas,
- Comment upon the land use in the areas devoid of vegetation.
- Why is some part of plateau devoid of any vegetation?
- Name some villages with planted trees. What plantations could bethere?
- Comment upon the nature of vegetation in the area in 5 lines. Correlate with the relief and drainage in the area.

***

# Practical No. 8 - Interpretation of Weather Maps -1

**Select any three weather charts out of five seasons:**

1) Summer
2) Winter
3) MONSOON
4) Retreating Monsoon
5) Cyclone (a map in which cyclones are visible)

**Aim :**

1) To understand the purpose of weather maps
2) To read and understand a weather map
3) To interpret a weather map and forecast the weather of a place

**Introduction :**

Weather denotes the atmospheric conditions of weather elements at a particular place and time. The weather elements include temperature, pressure, wind, humidity and cloudiness. Each day weather maps are prepared for that day by the Meteorological Department from the data obtained from observations made at various weather stations across the world. In India, weather-related information is collected and published under the auspices of the Indian Meteorological Department, New Delhi, which is also responsible for weather forecasting.

**Weather Maps :** A weather map is the representation of weather phenomena of the earth or a part of it on a flat surface. It depicts conditions associated with different weather elements such as temperature, rainfall, sunshine and cloudiness, direction and velocity of winds, etc. on a particular day. Such observations being taken at fixed hours are transmitted by code to the forecasting stations. Since the inception of the Indian Meteorological Department, the weather maps and charts are prepared regularly. Meteorological observatories transmit the data to the Central Observatory at Pune twice a day.

**Weather Charts :** The data received from various weather observatories are in plenty and detailed. As such, they cannot be incorporated in one single chart unless the coding designed to give the economy of expression is used. These are called synoptic weather charts and the codes used are called meteorological symbols. Weather charts provide the primary tools for weather forecasting. They help in locating and identifying different air masses, pressure systems, fronts and areas of precipitation.

**Weather symbols :** The messages received from all the observatories are plotted on the map using weather symbols standardized by the World Meteorological Organization and the National Weather Bureaus. See the adjoining figures to understand what each symbol means.

Much of the climatic data is represented by line symbols. The most common of these are the isometric lines. These lines are depicted on the map as isopleths. The Isopleths can be interpolated for places having the same mean values of temperature, rainfall, pressure, sunshine, clouds, etc. Some of these lines and their uses are mentioned below:

Isobars : Lines connecting places of equal air pressure.

Isotherms : Lines connecting places of equal temperature.

Isohyets : Lines connecting places of equal amount of rainfall over a given period of time.

Isohels : Lines connecting places of same mean daily duration of sunshine.

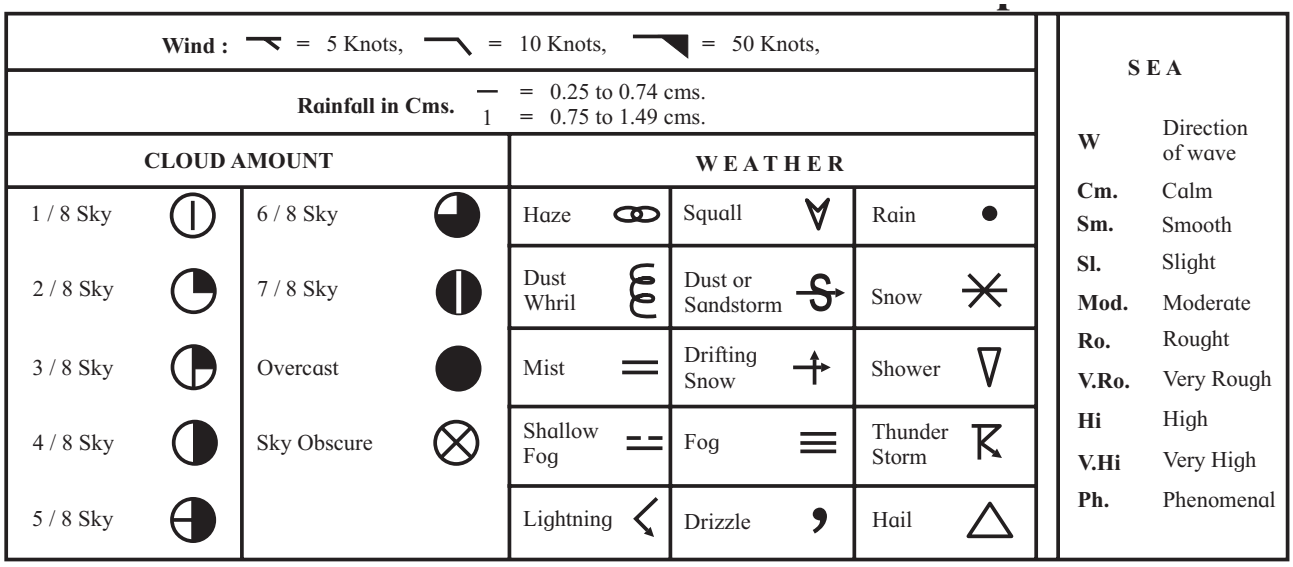



**Fig. 8.1 IMD Weather symbols**

Isonephs : Lines connecting places of same mean value of cloud cover.

**Materials required :** Five IMD weather maps representing five different seasons-summer, monsoon, retreating monsoon, cyclone and winter.

**Procedure :**

On the basis of the above information, we can analyze a weather map and understand the general pattern of weather conditions prevailing in different parts of the country.

See the weather symbols and try to remember what each one of them signifies. On the basis of the following heads, interpret the information given in the weather map.

1) **Introduction :** First look at the date of the weather map. Mention the date, day, year and month of the map. Also mention the time at which it has been presented. Also mention the season.

2) **Pressure distribution :** Under this head, you mention the low pressure areas and high pressure areas. You will understand these areas with the help of isobars. Mention the values of the isobars. Isobar values are in millibars (mb) or HectaPascal (HPa).

a) Also look at the patterns of isobars. Different shapes indicate different weather conditions. e.g. Cyclones are indicated by a circular isobaric pattern. A 'V' shape indicates low pressure area.

b) Direction of isobars : look at the trend of isobars. This means what is their direction? In which direction is the low pressure or the high pressure. Generally, the isobars are closely spaced and parallel to each other at the coastal areas in an east-west direction. On the other hand, they are spiral on land.

c) Pressure Gradient- It is the difference between the values of the highest isobar and the lowest isobars. If the isobars are closely spaced, it shows high gradient. If they are away from each other, then the gradient is low. The gradient determines the wind velocity. High gradient shows high wind velocity.

3) **Winds :** the wind velocities are shown by lines attached to circles on a map. A wind is named after the direction it comes from. For example, if a line is joint to a circle in eastern direction, then it shows that the wind is coming from east. The symbol also denotes the sped of the wind in knots. Refer to the symbol chart for speed of the wind.

4) **Cloud Cover :** Spheres are used to show the ratio of cloud cover in the sky. The way they are coloured in black tells the

intensity of cloud cover. This ranges from 1/8th of the cloud to total overcast (fully covered). While interpreting you should also link cloud coverage with chances of precipitation in an area.

5) **Sea condition :** To know the weather conditions at Bay of Bengal, Indian Ocean and Arabian Sea, refer to the weather symbols which show sea conditions. They can be rough or very rough or calm. This should be linked to the weather conditions of the rest of the country. Also the direction of the sea waves needs to be mentioned.

6) **Temperature conditions :** Besides the main map, two maps are given which shows departure from average temperature of the country. These departures are shown through isotherms. These will give you an idea of the temperatures of various parts of the country. These are mainly used for forecasting for the next 24 hours .

7) **Other weather conditions :** Other weather conditions like hail, fog, snow, precipitation, etc are shown by specific weather symbols.

With the help of the above given points, you have to interpret the weather conditions of 3 different seasons. One has been done for you as example. The teachers can also ask questions in such a way that interpretation of weather maps becomes easier. Some examples of questions are given below. Teachers can choose to give different questions of their own. Choose any 3 Plates from Plate 1 to Plate 8 for interpretation of Weather Maps in Practical No 8 , 9 and 10.

Study the map and answer the following questions for practical 8.

- Which season is being shown in this map?
- What is the value of the highest isobar and through which part of the country does it pass?
- What are the values of the highest and the lowest isobars and where are they located?
- What are the patterns of temperature distribution in both the maps?
- In which parts do you see the highest and the lowest mean temperatures?
- What relationship do you see between the distribution of temperature and pressure in both the maps?

## Practical 9 - Interpretation of Weather Maps -2

- Which season is being shown here.?
- What does SCS mean?
- Where do you see a high pressure area?
- In which part of the country is the maximum temperature less by 6 degrees than normal?
- In which part of the country is the minimum temperature 4 degrees more than normal temperature ?
- What is the wind velocity in the area under VSCS?
- In which parts do ypu observe the sky is obscured?
- In which part of the country can one observe haze?
- Write a concluding statement about the weather conditions in the country.

## Practical 10 - Interpretation of Weather Maps -3

- Which season is shown here?
- In which part of the map do you see a high pressure area? Why?
- What is the lowest value of isobar?
- Which area do you see the isobars are closely spaced?
- Which part of the country is experiencing minimum temperatures 4 degrees below the normal?
- Which part of the country is experiencing rainfall?
- Write a concluding statement about the weather of the country

***

# Practical No. 11 - Use of GPS to find area and perimeter

**Introduction :**

You can find out the location of any place on the earth with the help of GPS instruments. Like the internet and mobile, GPS is an essential element of the global information infrastructure. The free, open and dependable nature of GPS has led to the development of hundreds of applications affecting every aspect of modern life.

GPS is used in farming, communication network, banking, financial markets, supply management system, mining, surveying, package delivery, security and tracking crimes, weather forecasting, earthquake monitoring, environmental protection, etc. A GPS consists of three segments:

a) **Space or satellite :** Each GPS needs to be connected to satellites. These satellites are orbiting around the earth around 20,200 kms above the earth. Each satellite circles the Earth twice a day.

b) **Control Segment :** This segment consists of ground stations located around the world. They track the GPS satellites, monitor their transmission, perform analysis and send commands and data to the constellation to make sure the satellites are working properly.

c) **User Segment :** This consists of our instrument which receives satellite signals and transmits information to user for calculating position, time and speed. (fig. 11.1)

**Aim :**

1) To find out the latitude and longitude of a place with the help of GPS (Global Positioning System) instrument.
2) Measure perimeter and area of a plot.

**Materials required :** A smartphone with internet facility,( can use GPS hand-held instrument too), notepad, pen, pencil

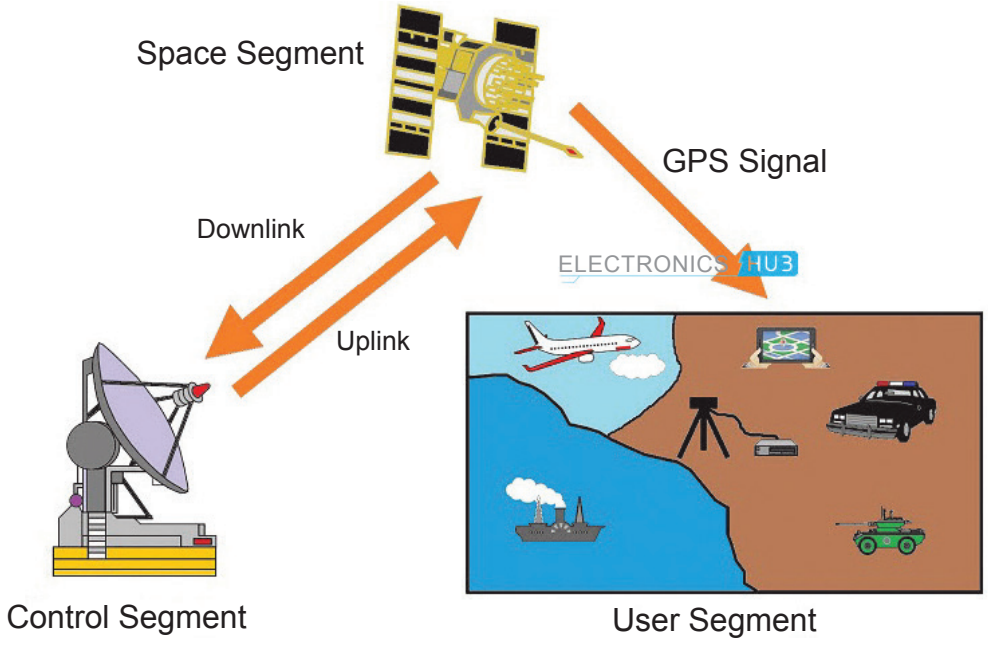



Fig. 11.1

**PART I: Determining latitude and longitude of a place**

**Procedure :**

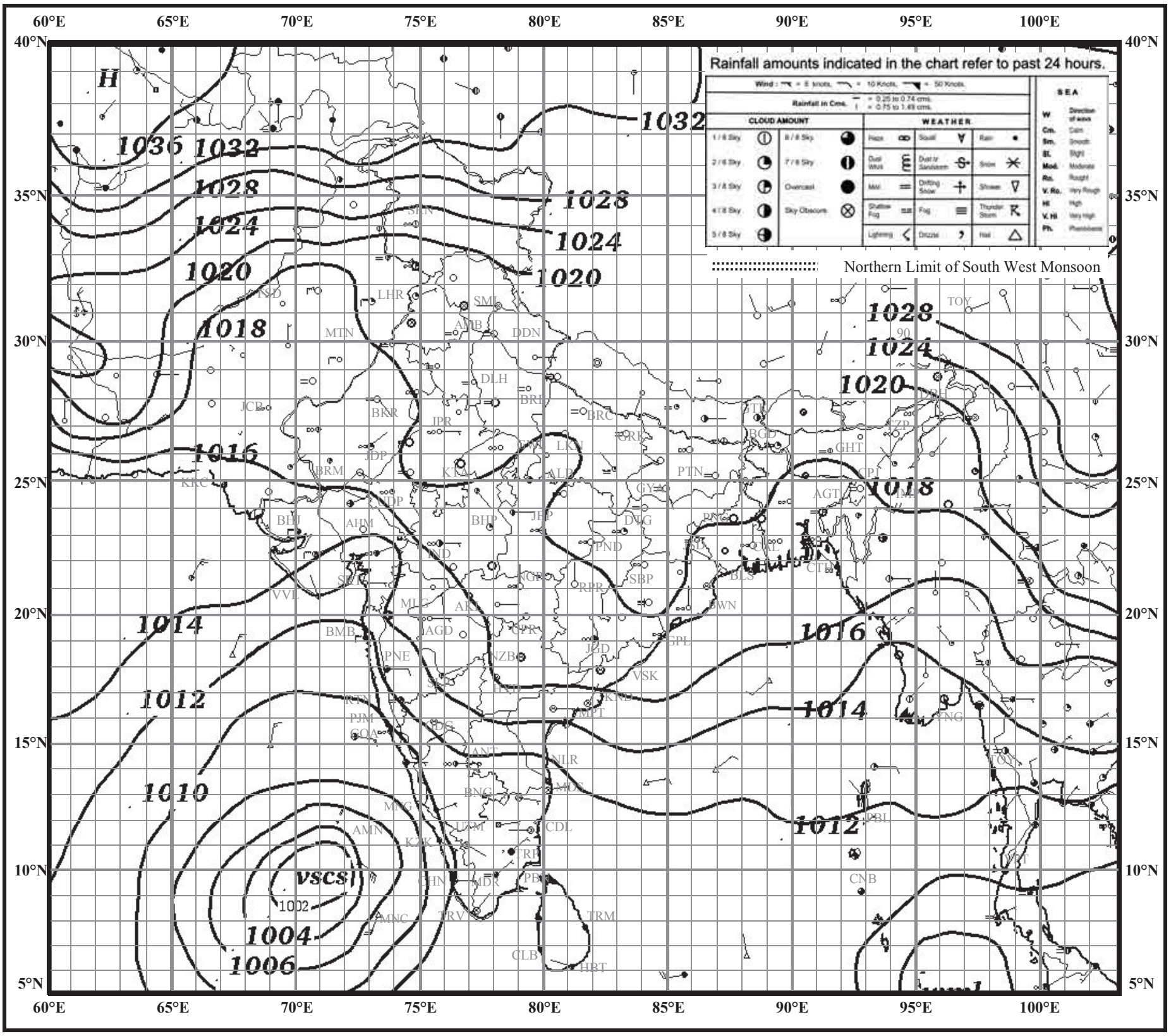
1) Take a Smartphone and install the Simple GPS app from Google Play Store. Following screen will appear. Fig. 11.2.

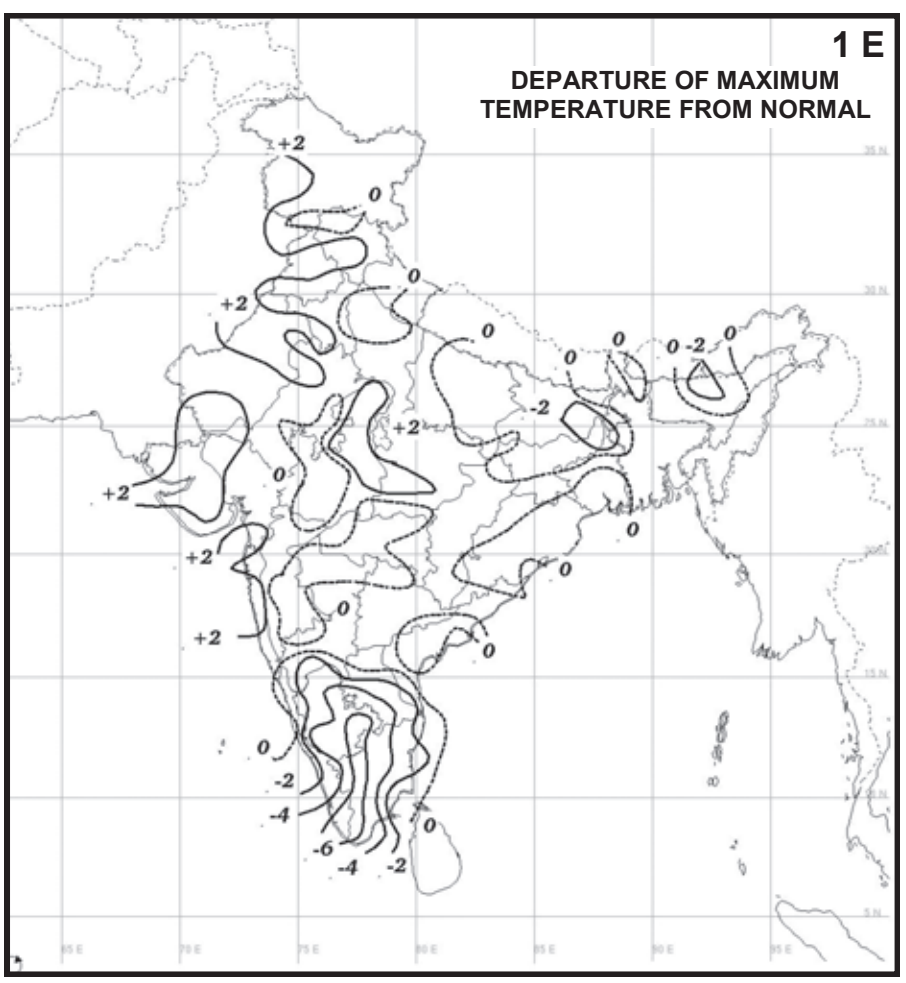
# INDIAN DAILY WEATHER REPORT

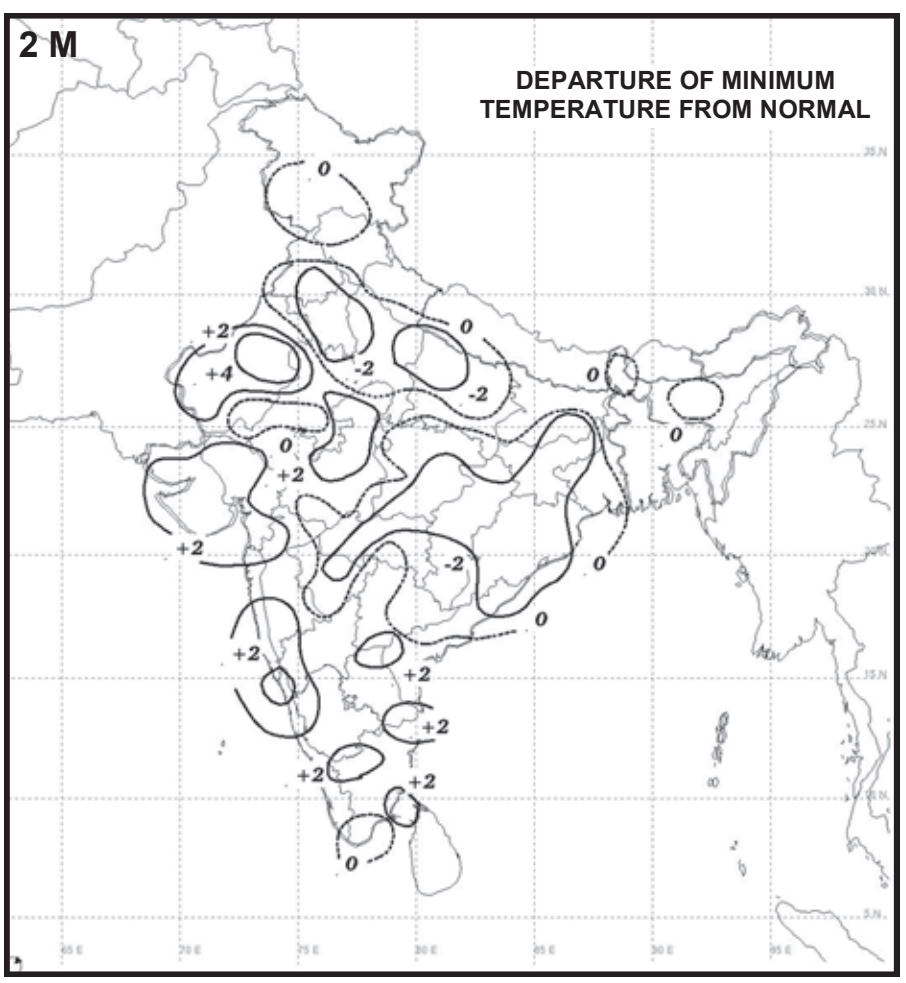
## WEATHER MAP AT 0830 hrs. I.S.T. (0300 hrs. U.T.C.)

### Saturday, 02 December 2017 (11 Agrahayana 1939 Saka)

**PLATE - 1**



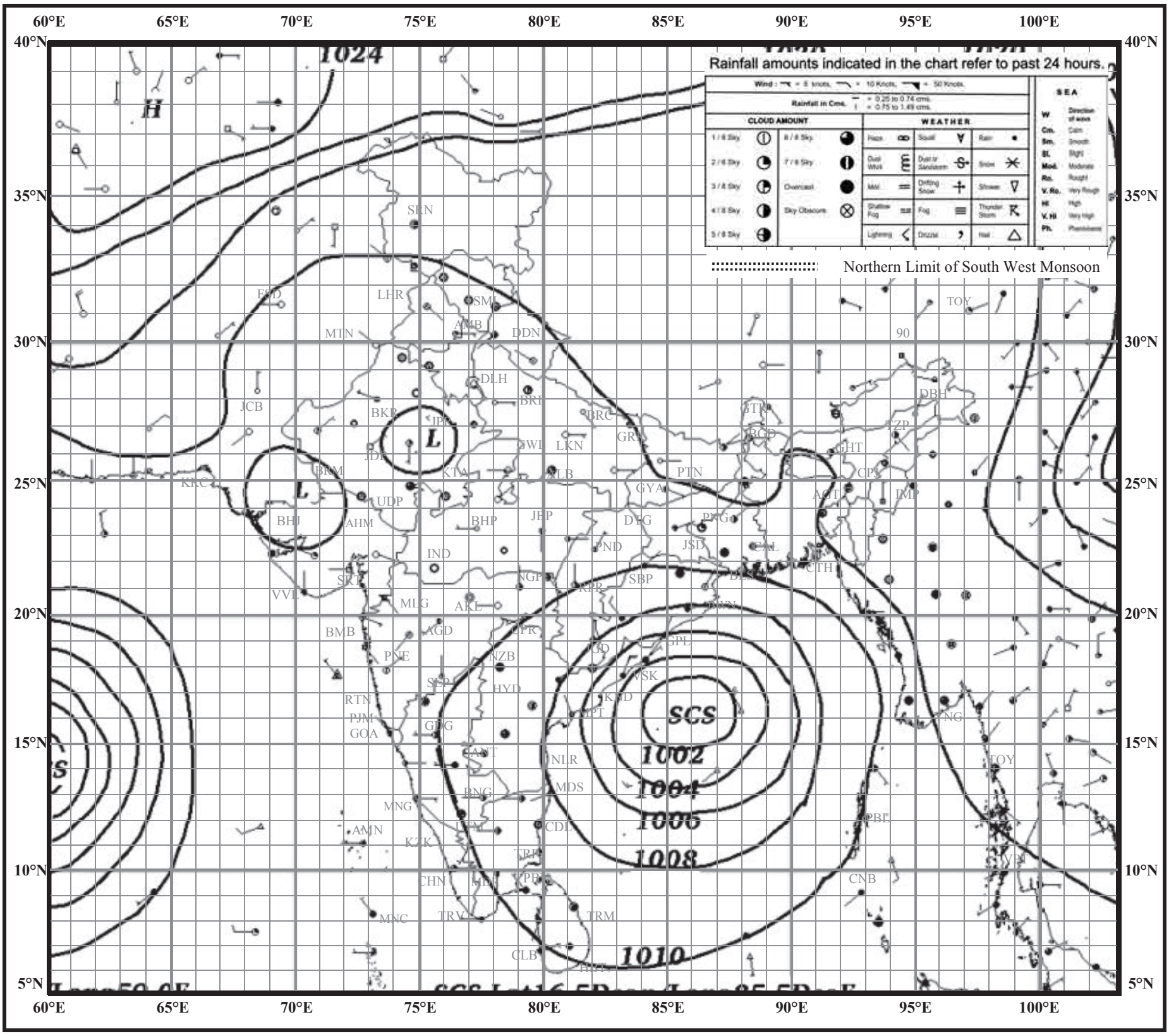



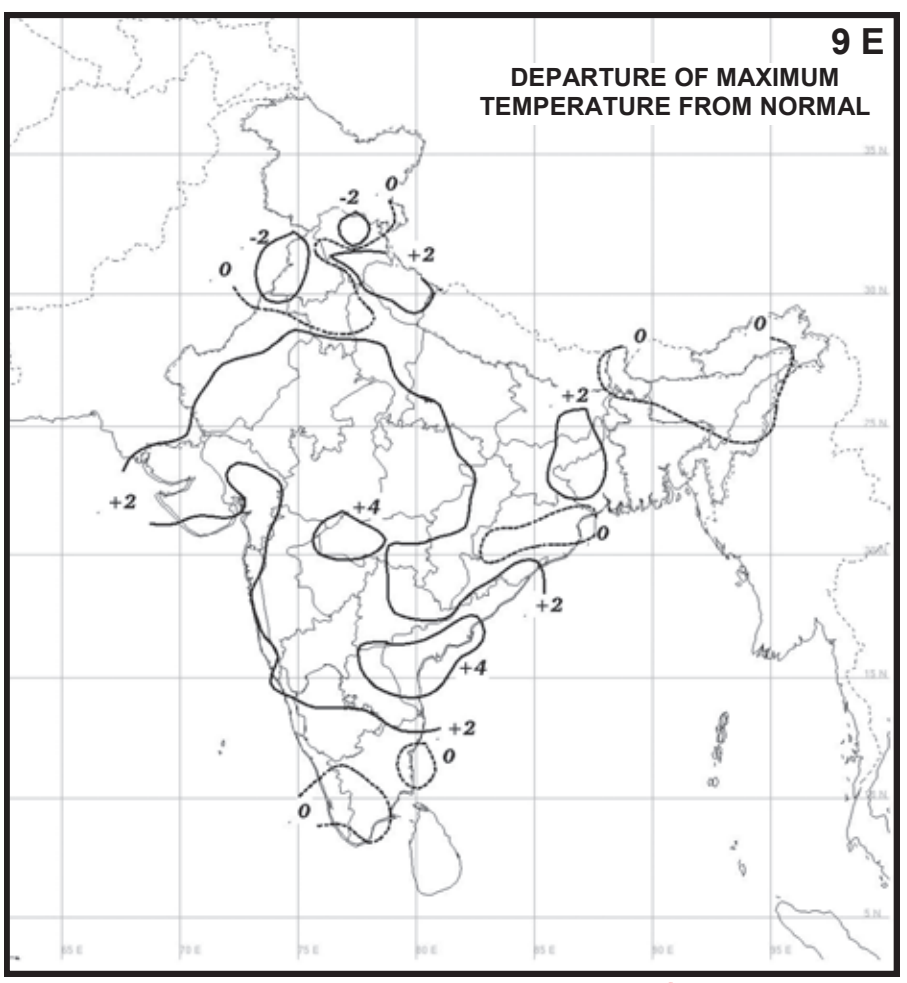
# INDIAN DAILY WEATHER REPORT

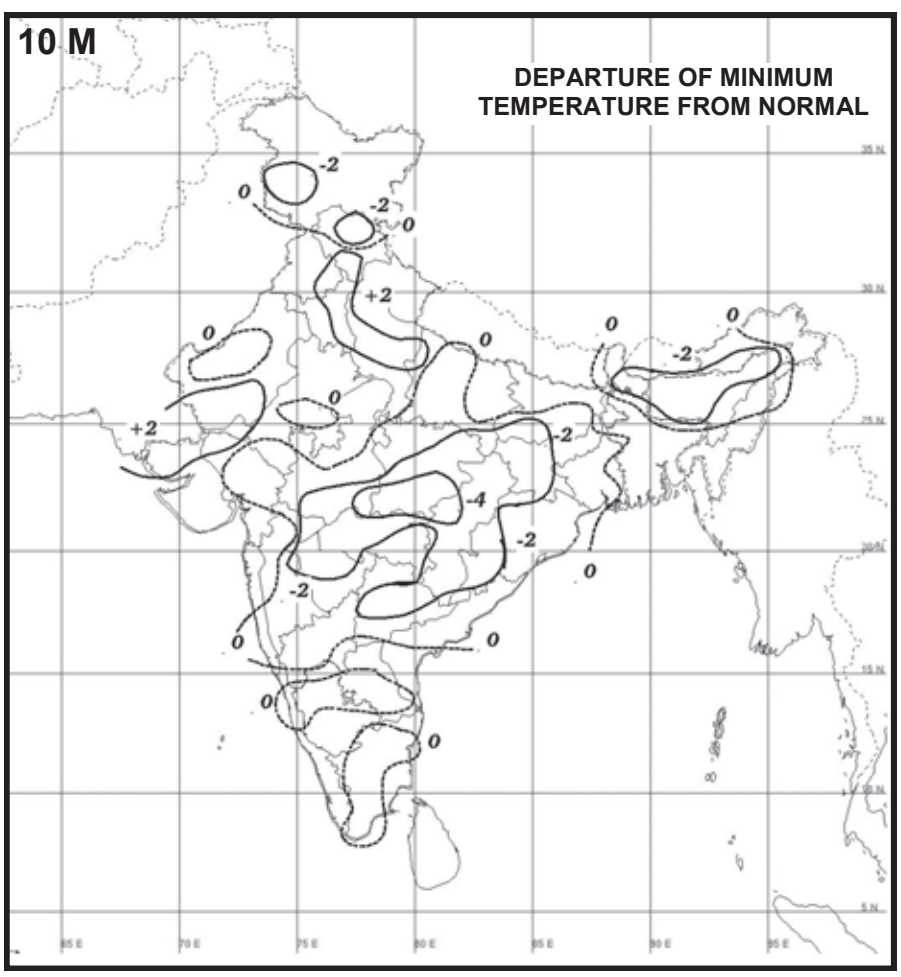
## WEATHER MAP AT 0830 hrs. I.S.T. (0300 hrs. U.T.C.)

### Wednesday, 10 October 2018 (18 Asvina 1940 Saka)

**PLATE - 2**



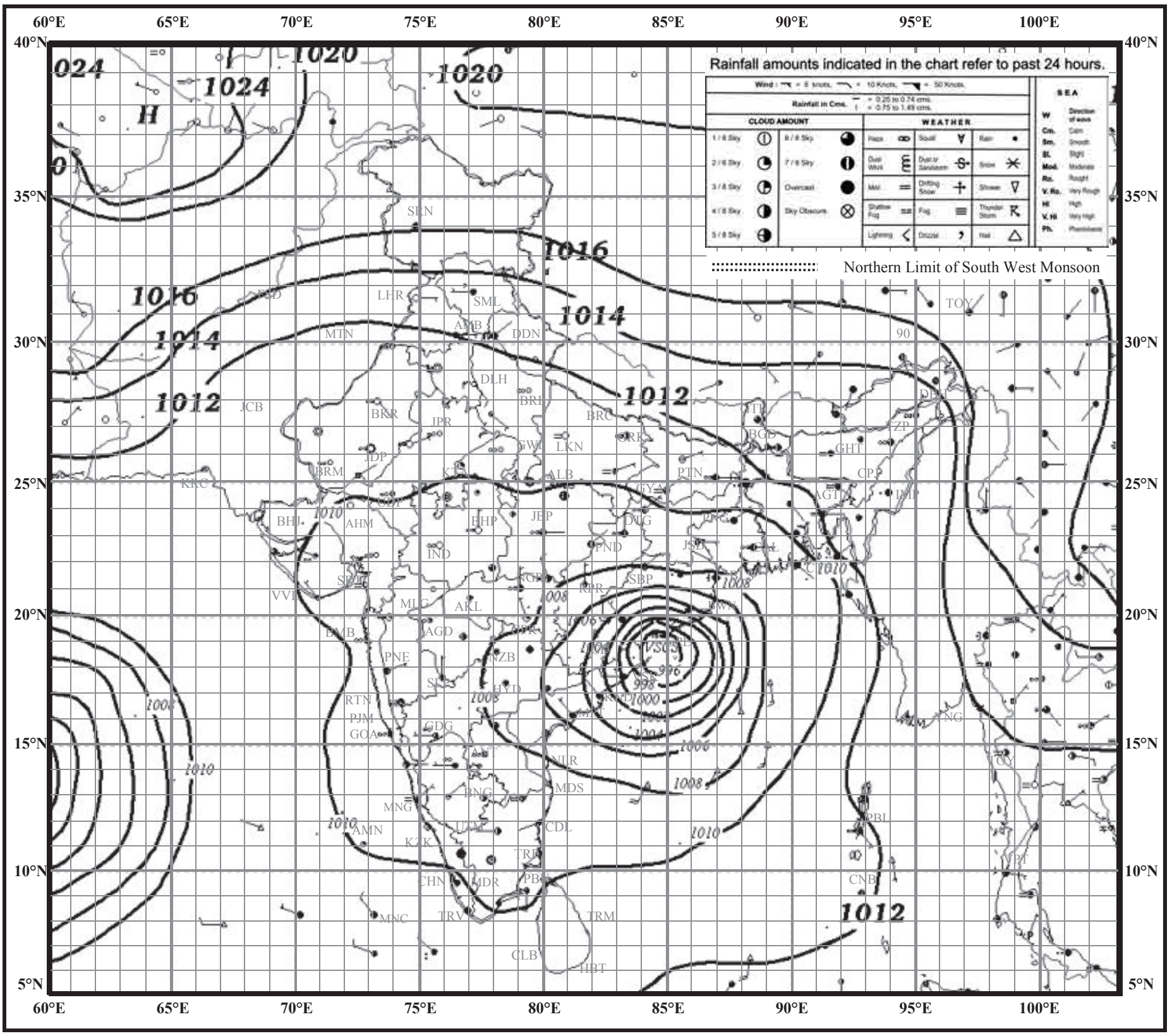



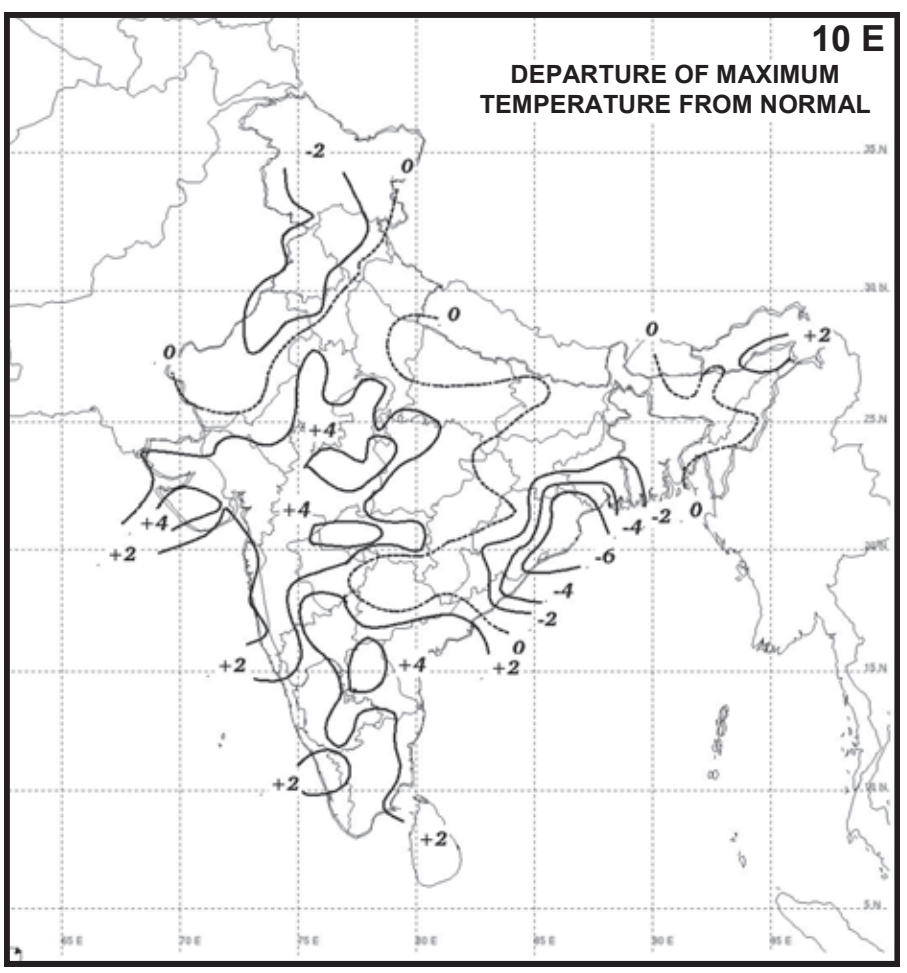
# INDIAN DAILY WEATHER REPORT

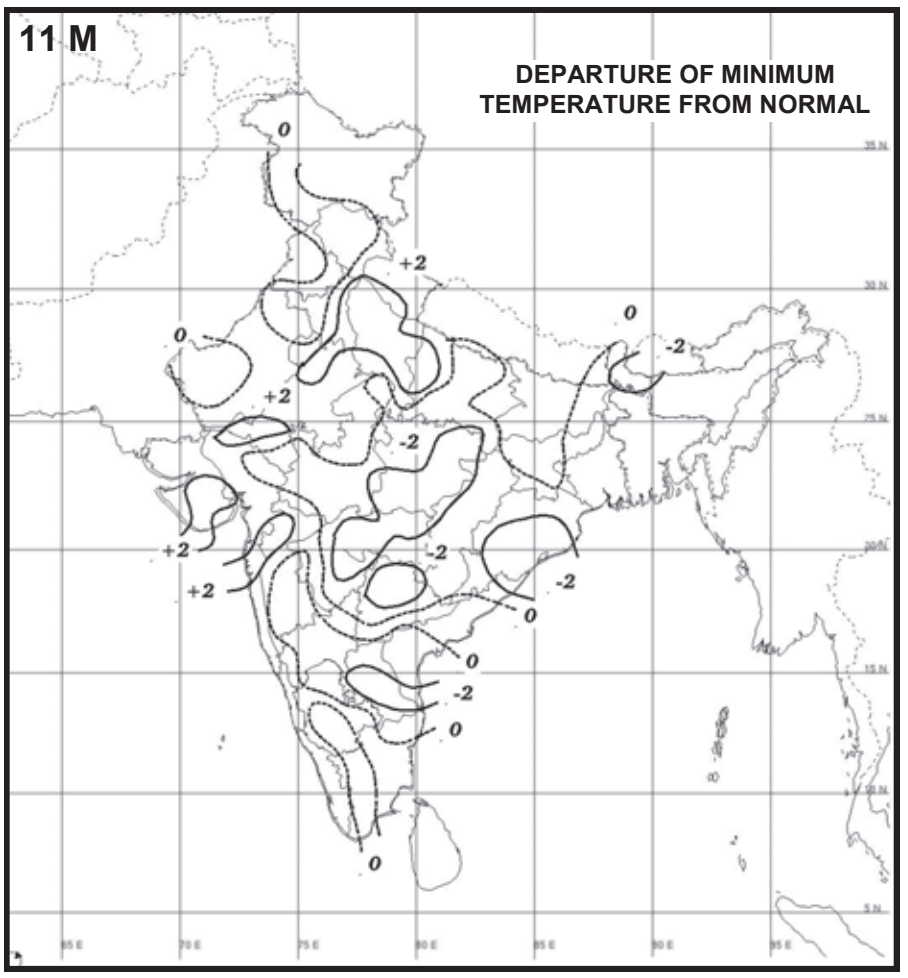
## WEATHER MAP AT 0830 hrs. I.S.T. (0300 hrs. U.T.C.)

### Thursday, 11 October 2018 (19 Asvina 1940 Saka)

**PLATE - 3**



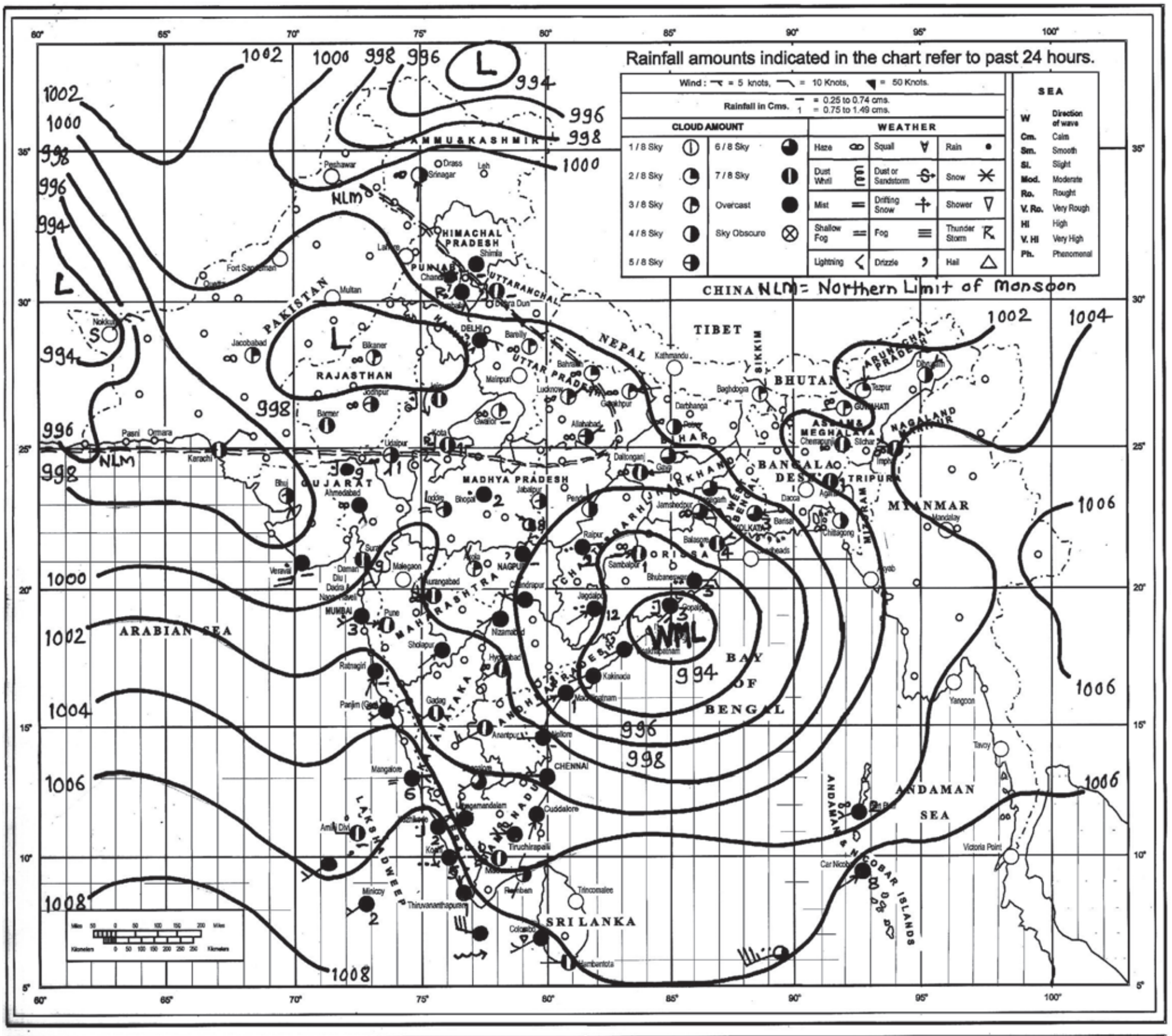



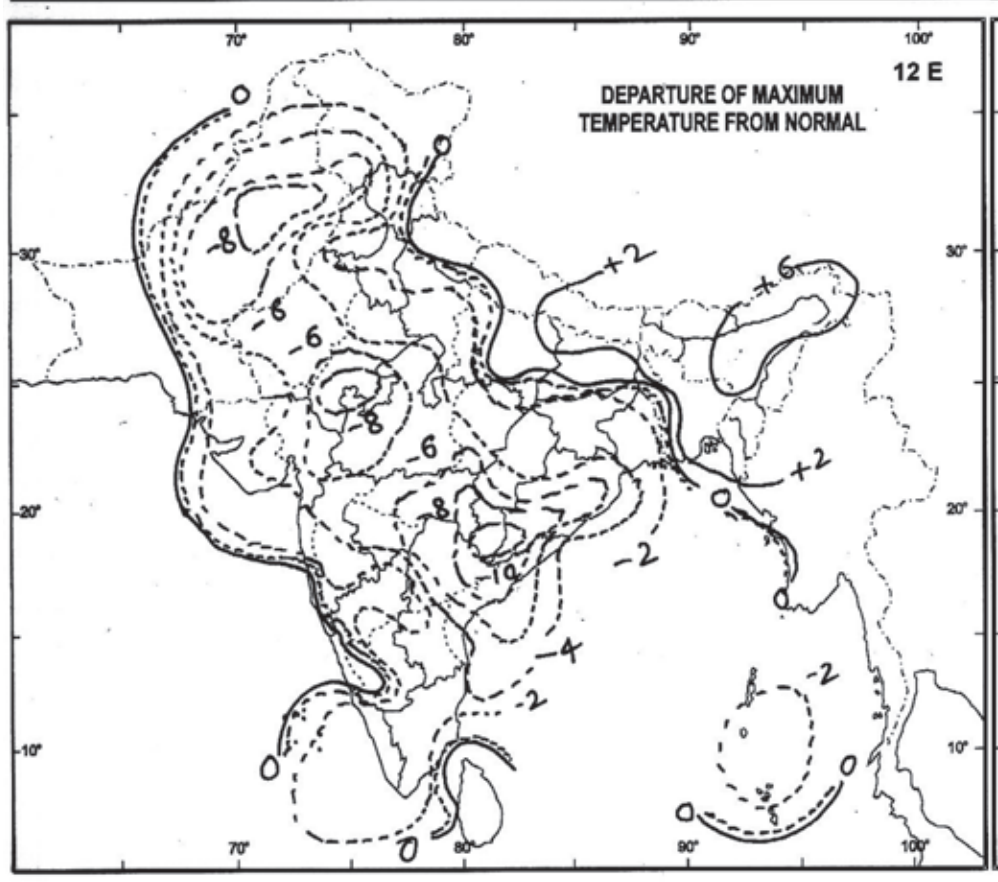
# INDIAN DAILY WEATHER REPORT

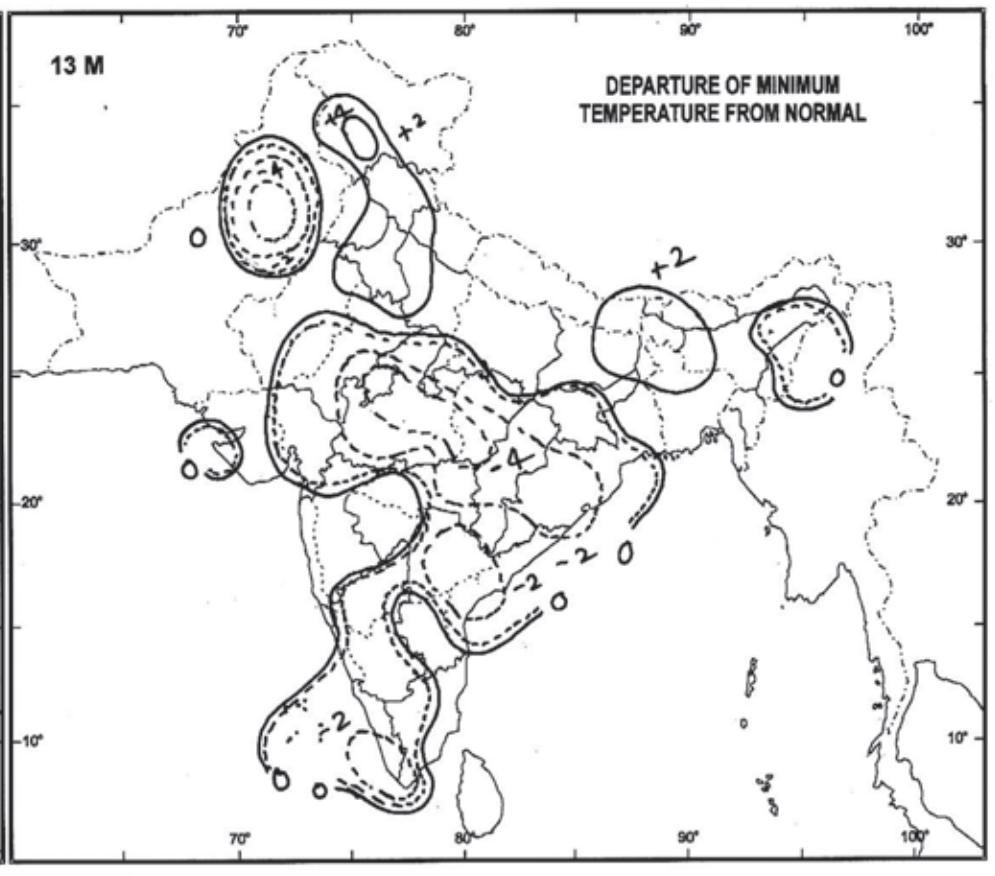
## WEATHER MAP AT 0830 hrs. I. S. T. (0300 hrs U.T.C.)

**PLATE - 4**

### Thursday, 13 June 2013 (23 Jyaistha 1935 Saka)



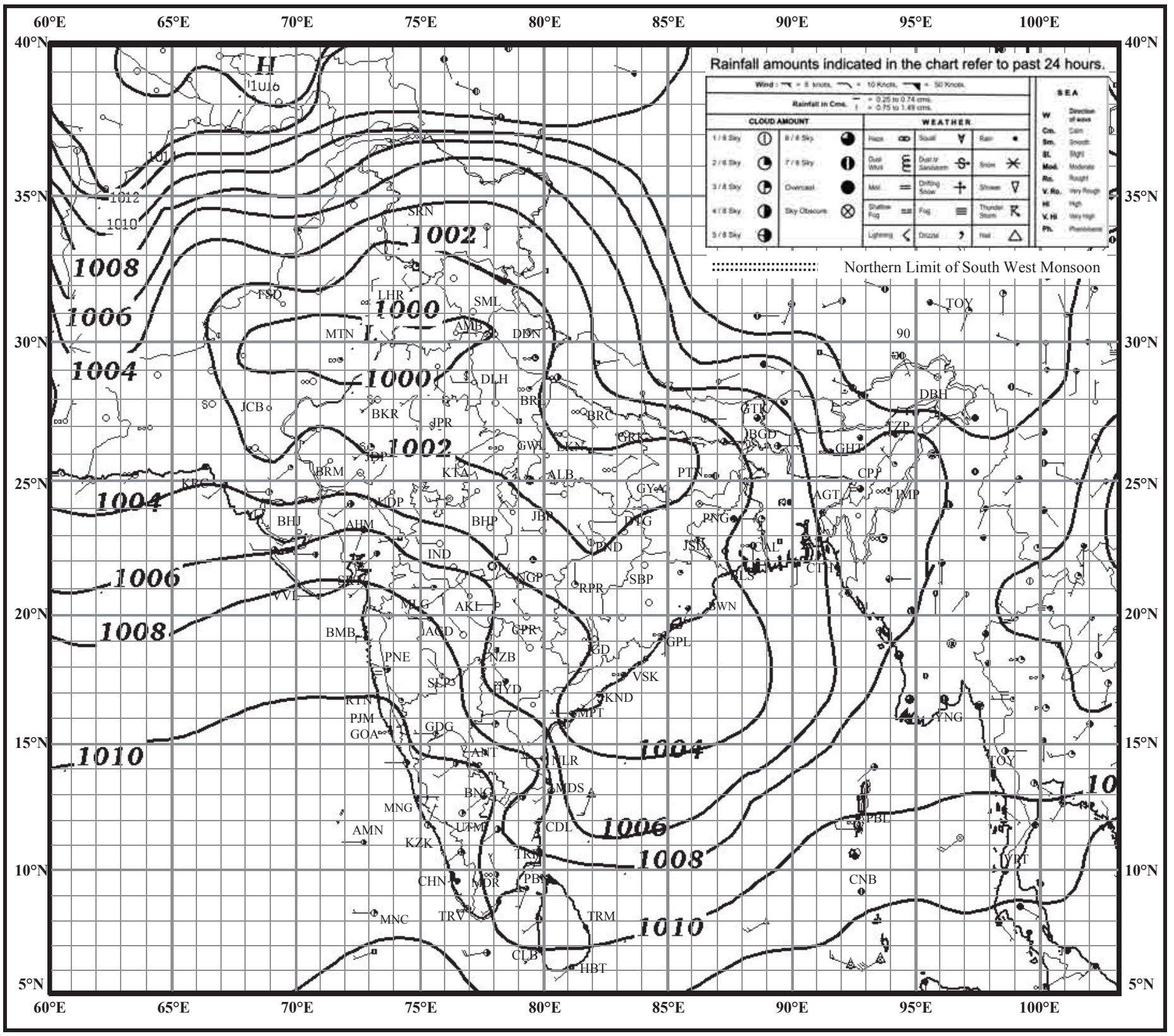



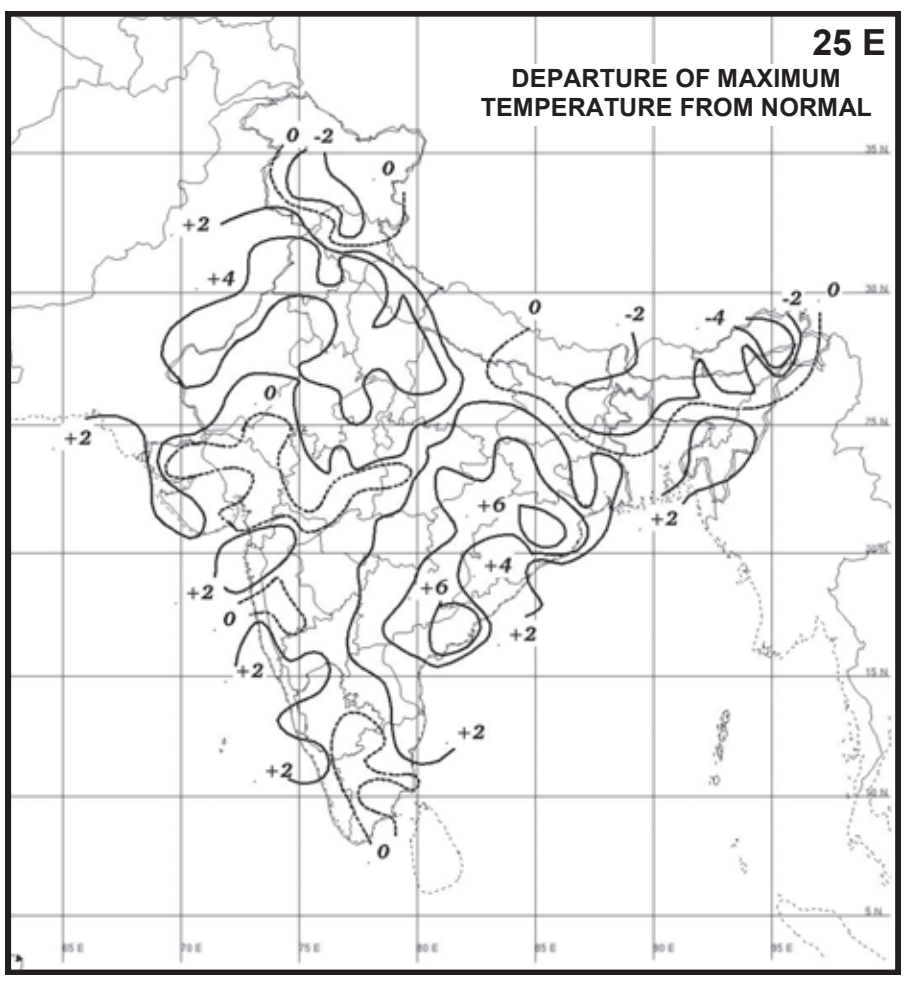
# INDIAN DAILY WEATHER REPORT

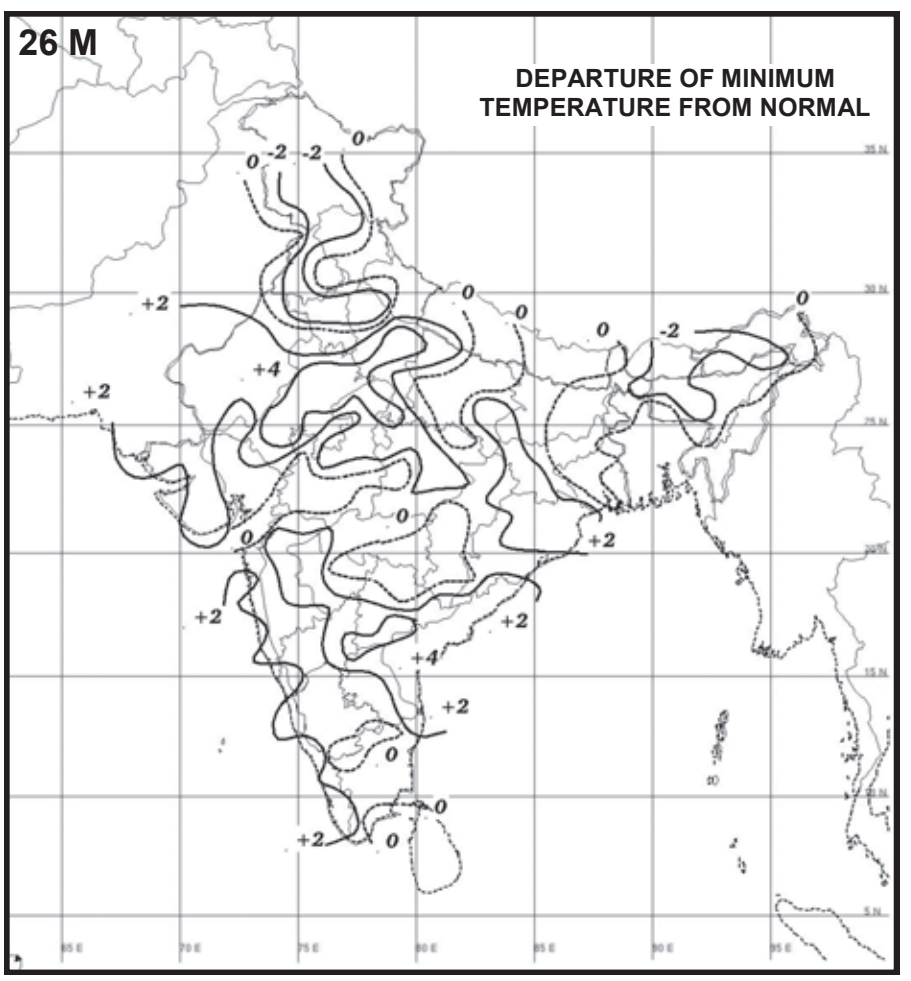
## WEATHER MAP AT 0830 hrs. I.S.T. (0300 hrs. U.T.C.)

### Tuesday, 26 May 2015 (05 Jyaistha 1937 Saka)

**PLATE - 5**



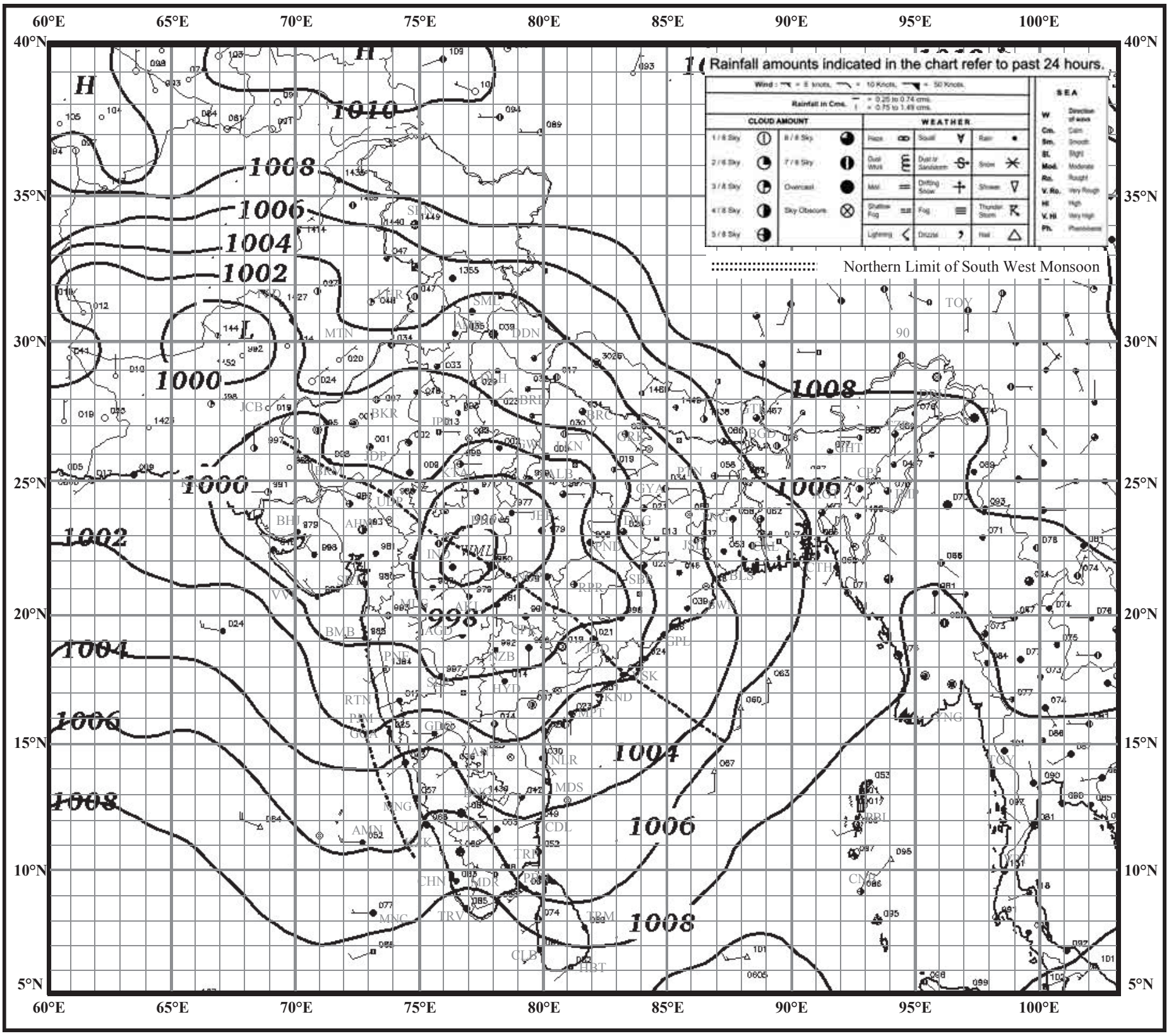



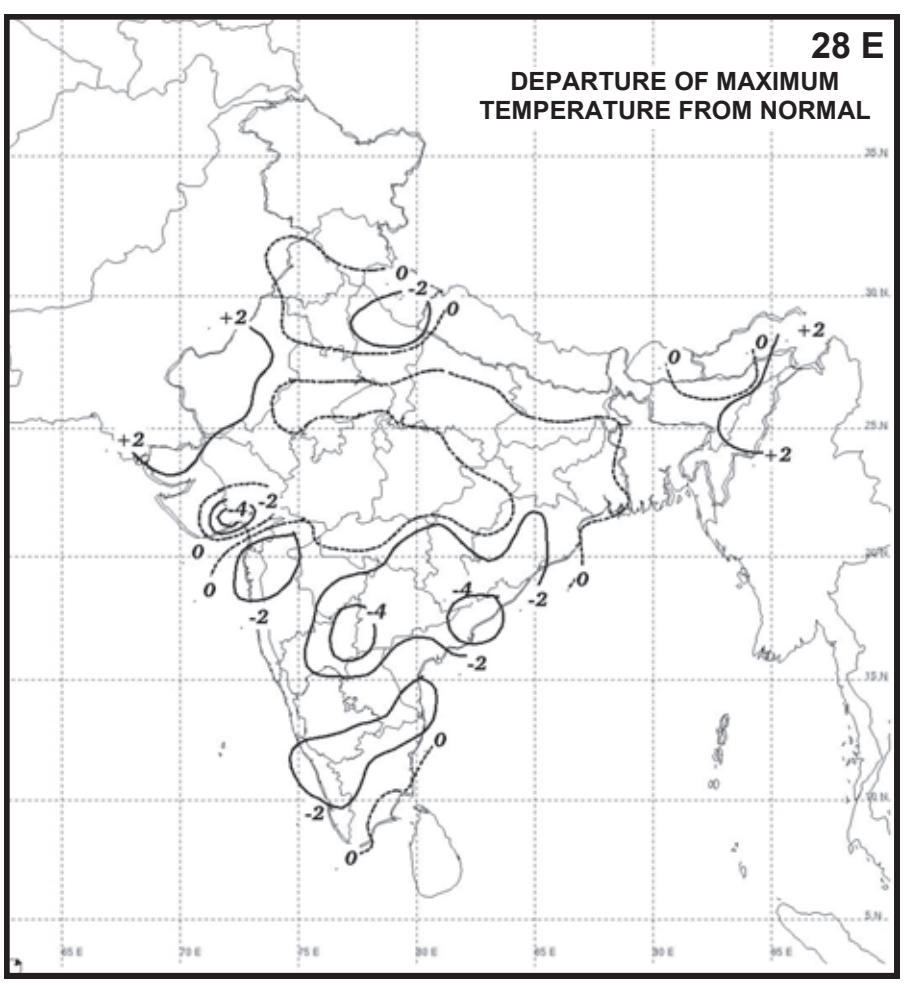
# INDIAN DAILY WEATHER REPORT

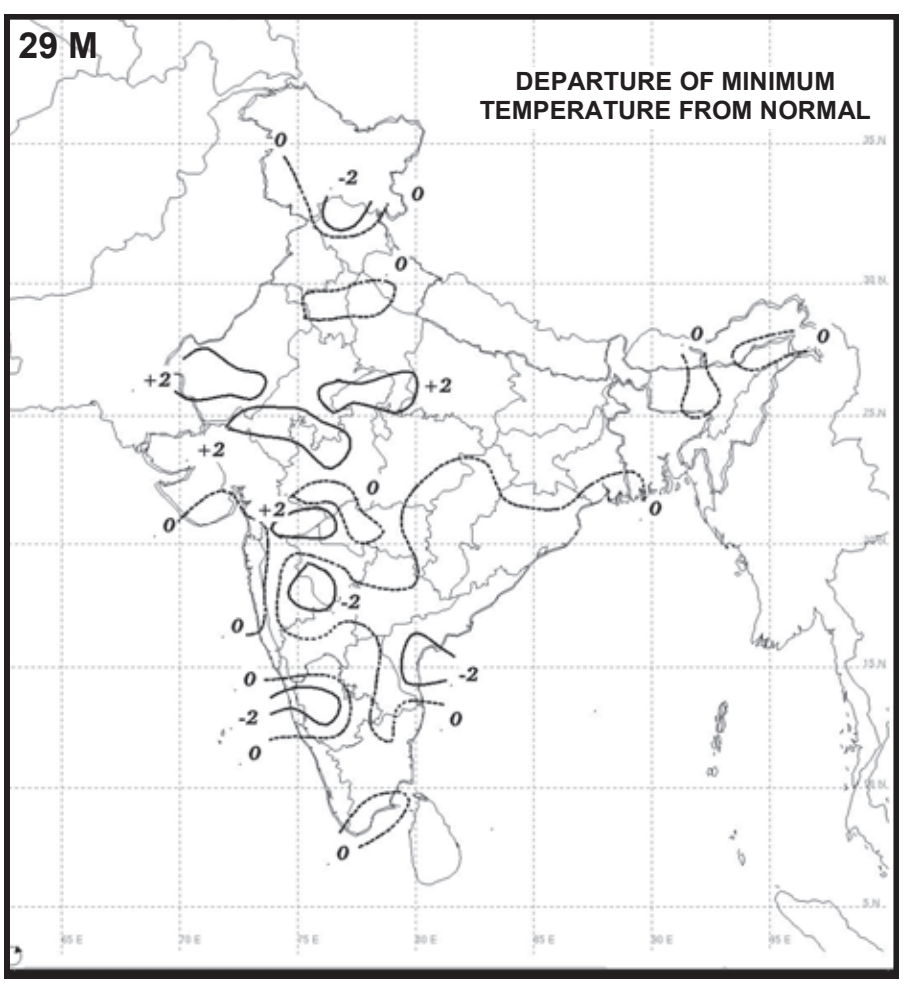
## WEATHER MAP AT 0830 hrs. I.S.T. (0300 hrs. U.T.C.)

### Tuesday, 29 August 2017 (07 Bhadrapada 1939 Saka)

**PLATE - 6**



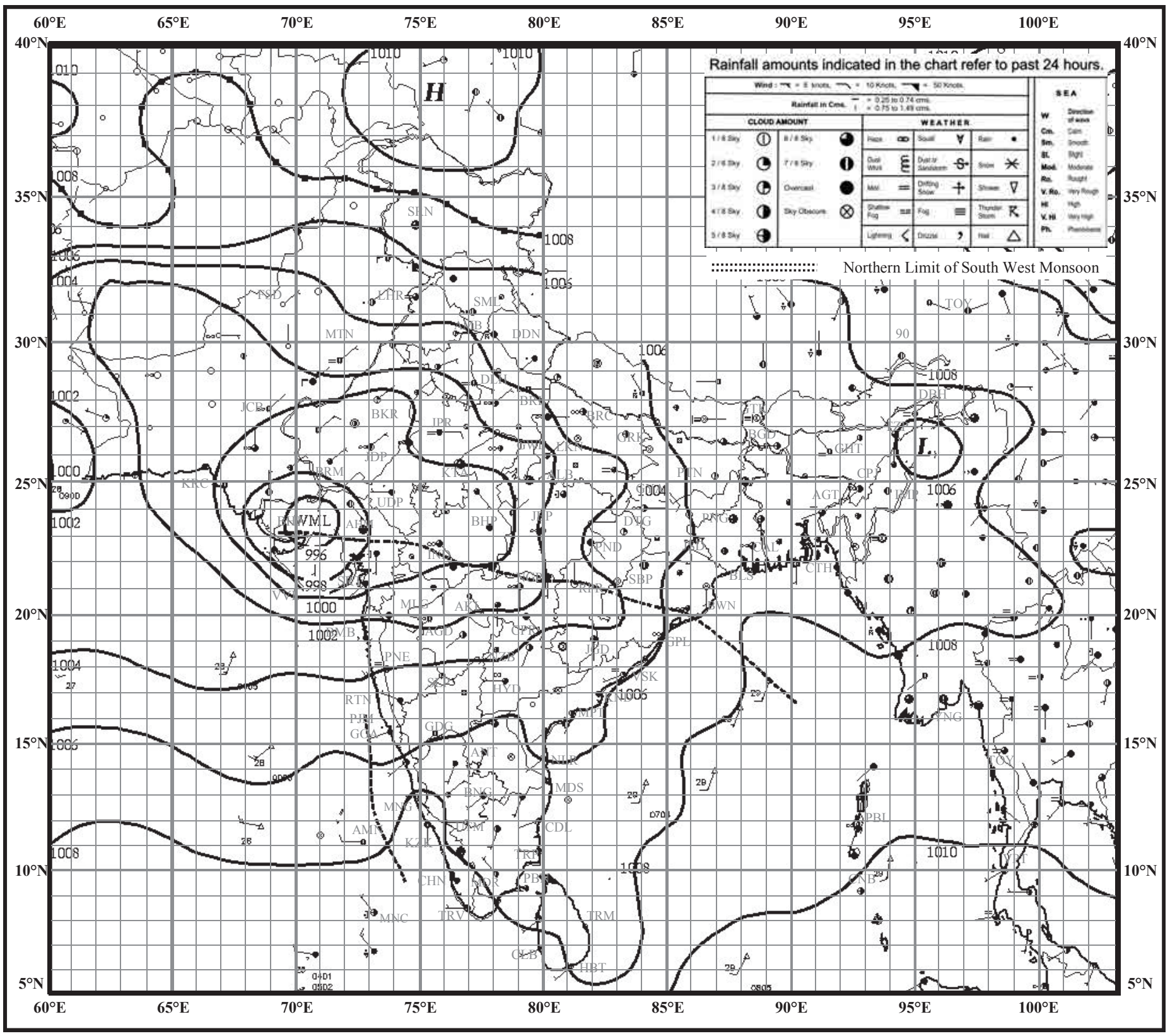



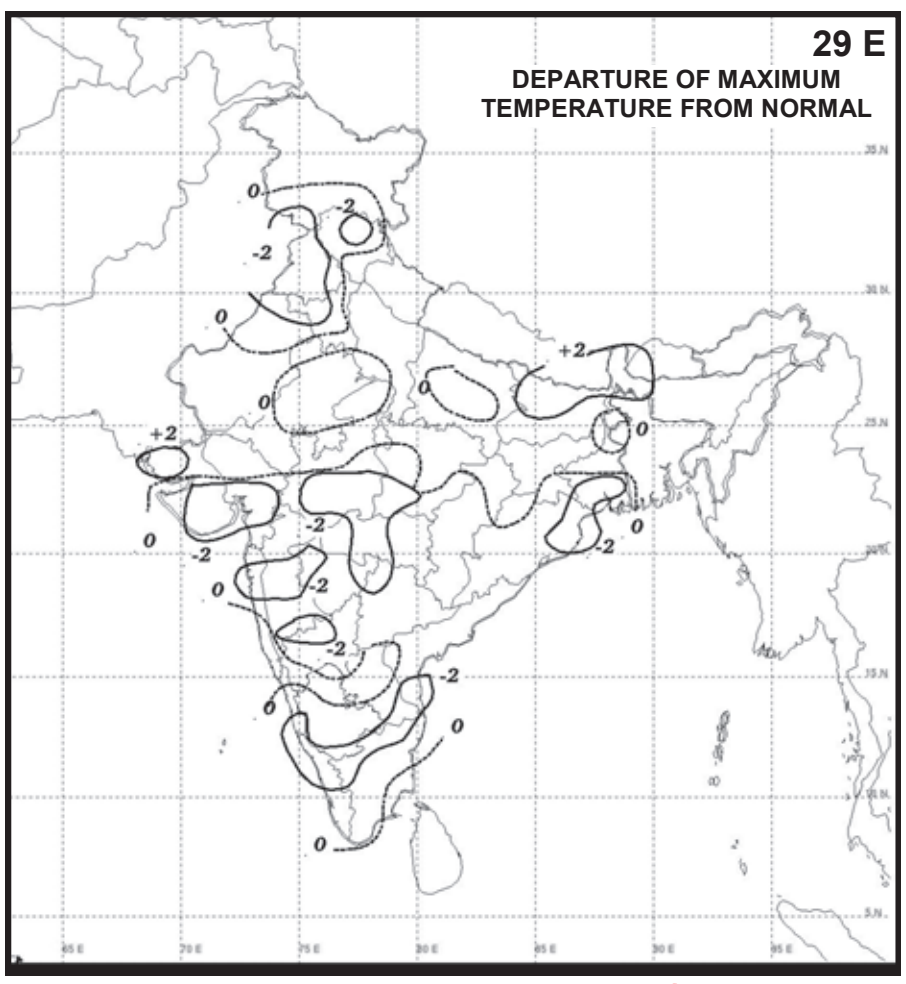
# INDIAN DAILY WEATHER REPORT

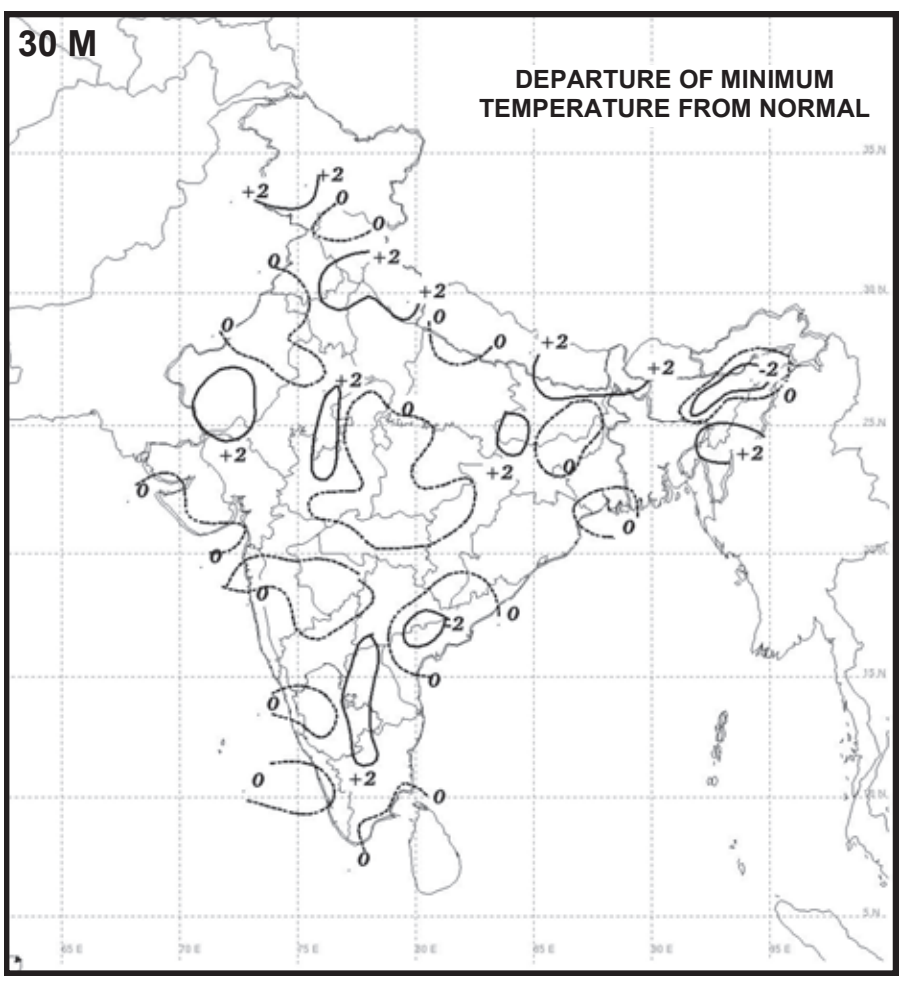
## WEATHER MAP AT 0830 hrs. I.S.T. (0300 hrs. U.T.C.)

### Wednesday, 30 August 2017 (08 Bhadrapada 1939 Saka)

**PLATE - 7**



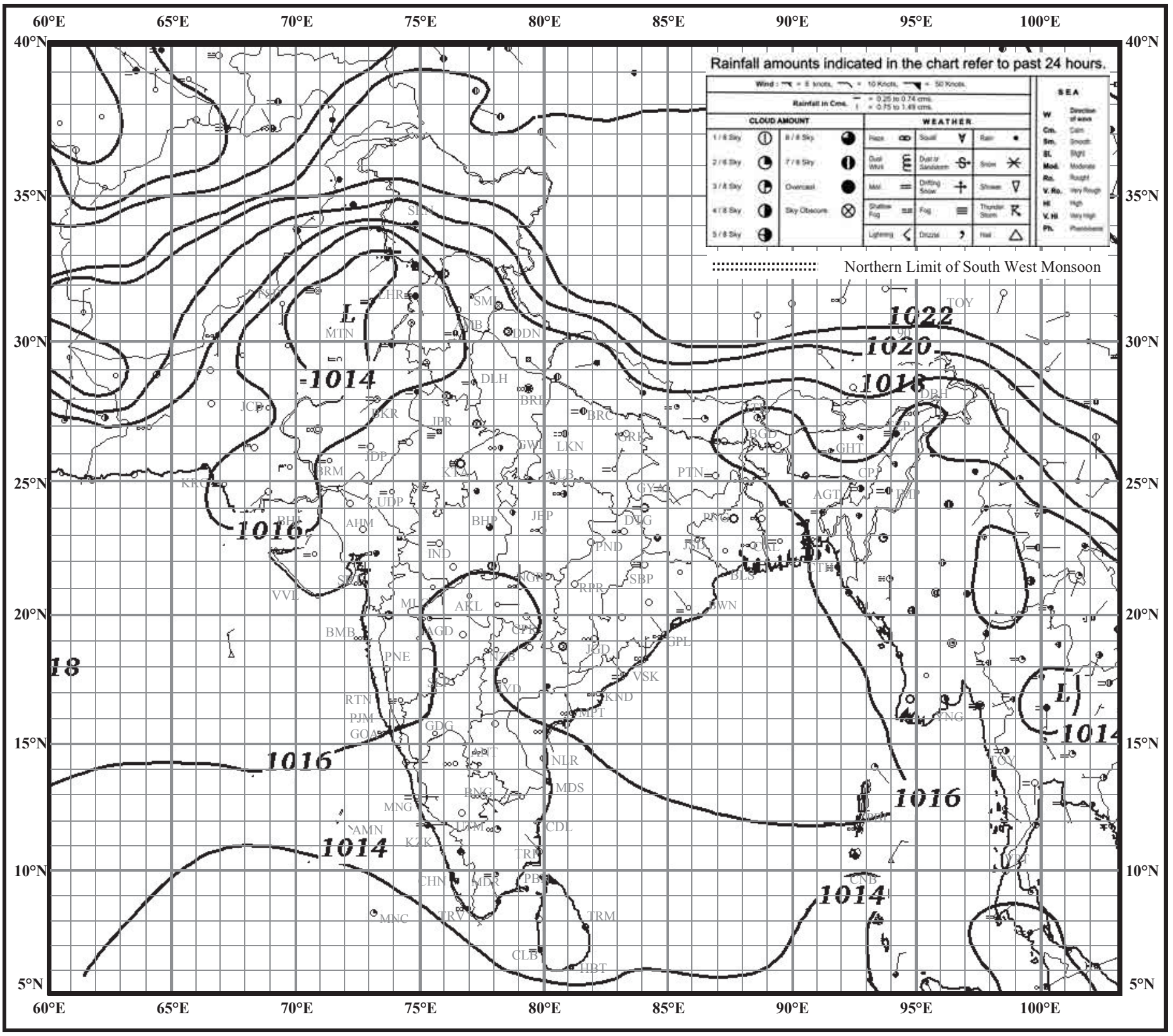



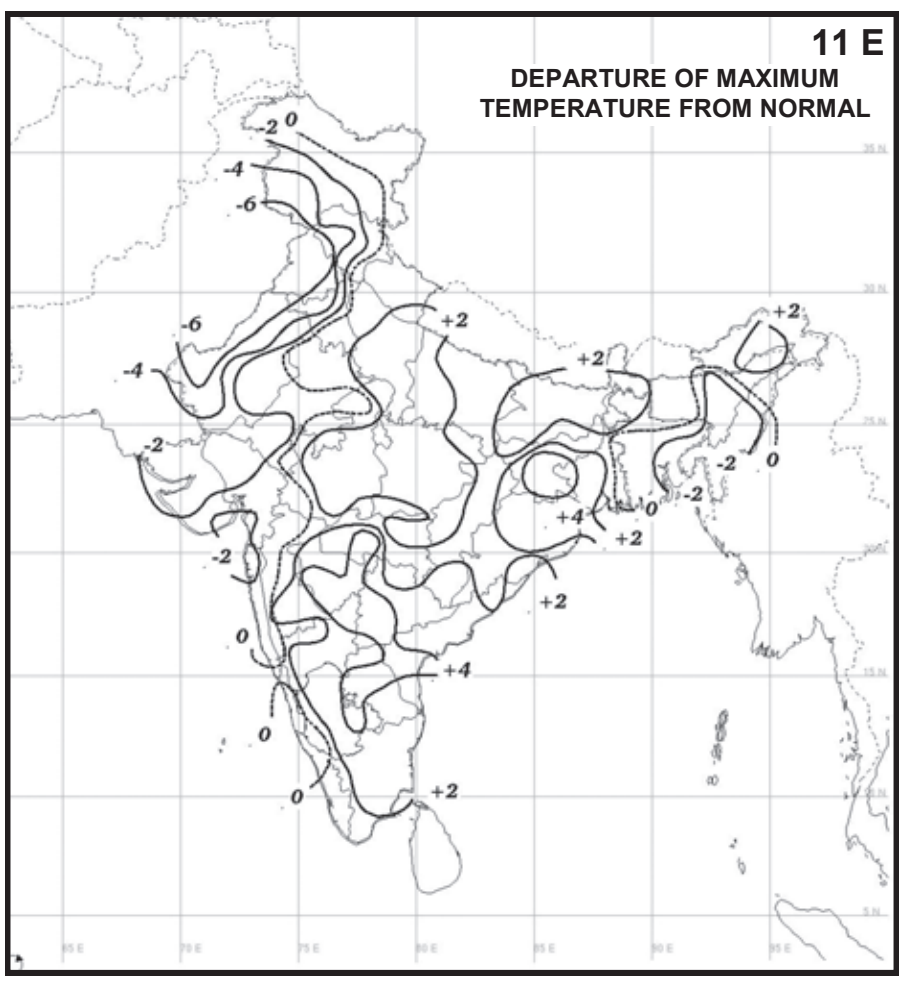
# INDIAN DAILY WEATHER REPORT

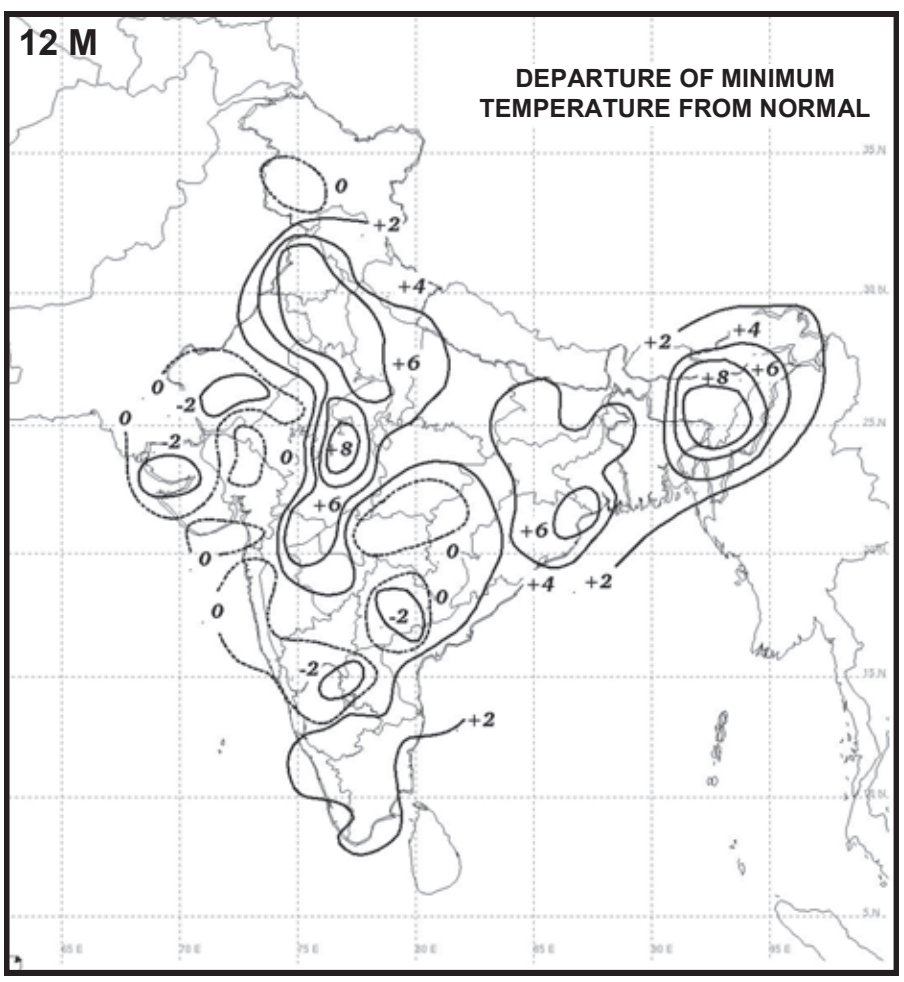
## WEATHER MAP AT 0830 hrs. I.S.T. (0300 hrs. U.T.C.)

### Tuesday, 12 December 2017 (21 Agrahayana 1939 Saka)

**PLATE - 8**



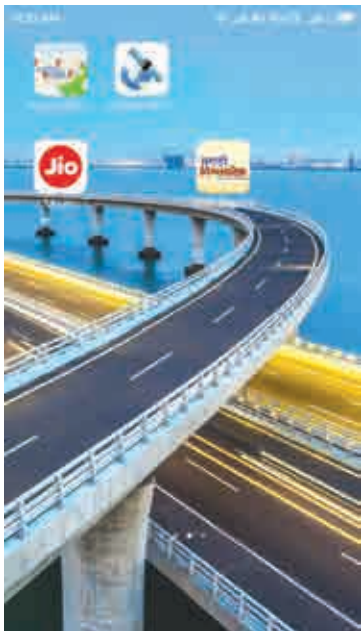


Fig. 11.2

2) After you click the icon of the App, following screen will appear. Let's see what each of these means. Follow the figure to understand the components shown on the screen. Fig. 11.3.

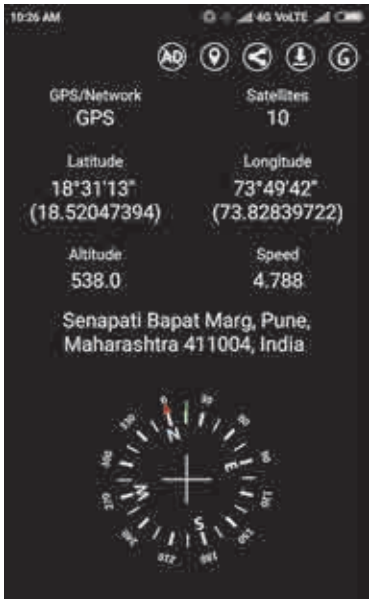



Fig. 11.3

(Note: Take reading only when 4 or more satellites are visible. At least 4 satellites are needed to work out your position accurately.)

3) Take a screenshot of the information.

4) Complete your observations here :

1) Number of coverage (visible) Satellites - .....
2) Absolute location - Latitude .....° .....' ....."and Longitude .....° .....' ....." .
3) Altitude of place from mean sea level (MSL) - ..... metres
4) Address or relative location - .....
5) Repeat the process for 2 more points not in the same location

**Learnings :**

Write a small paragraph on the learnings from this practical.

**PART II :** Measure area of a plot.

**STEP 1 -** Now install Gps Area Measurement and Calculator App from Google Play Store Following screen will appear. Fig. 11.4.


Fig. 11.4

**STEP 2 -** After you click the icon of the App, following screen will appear. Fig. 11.5.


Fig. 11.5

**STEP 3 -** Click on the icon 'Area'. Following screen will appear. Fig. 11.6.

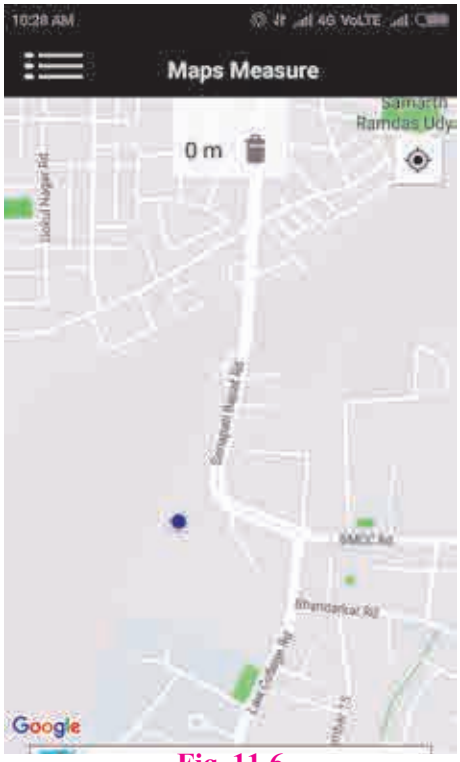



Fig. 11.6

**STEP 4 -** Click on the menu on the left and select Distance. This will help in measuring perimeter. For measuring area, click on Area. Following screen will appear. Fig. 11.7.

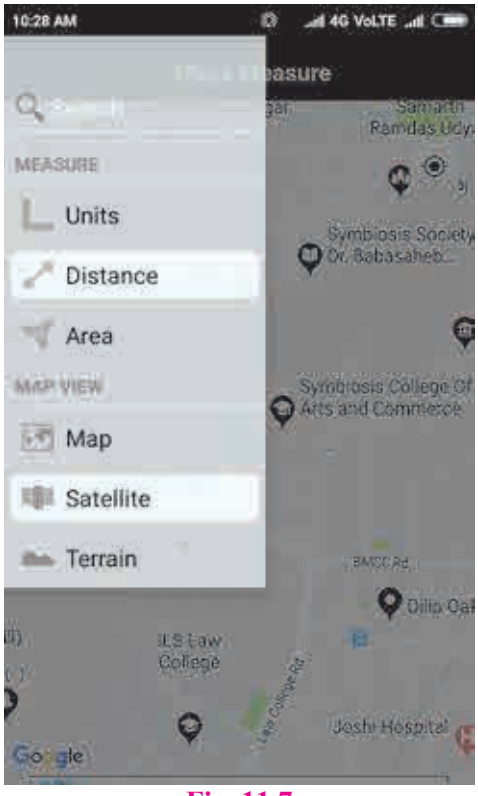



Fig. 11.7

**STEP 5 -** You can choose Terrain/Satellite option for viewing the area where you are.

**STEP 6 -** Now you can select the points to make a plot. Choose 3 or more points to measure the area of the plot. Teachers should make sure that the points are not close enough, atleast 25m away.

**STEP 7 -** Go to the first point and click on the blue point on the screen. This will be your first point. Fig. 11.8.


Fig. 11.8

**STEP 8 -** Go to other three points and repeat the process. Then come back to the first point. This will enclose your plot. Following screenshots will appear. Fig. 11.9 to 11.12. On the top of the screens, you can see the distance between points as you move forward. At the end, you get the perimeter of the plot. (Four points) . See the screenshot.

**STEP 9 -** Select Area from the menu and you will get the screen showing the area of your plot. Fig. 11.13. You will see the area as shown in fig 11.14.

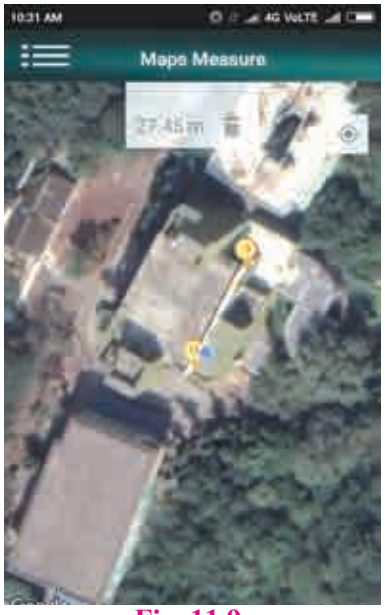


Fig. 11.9

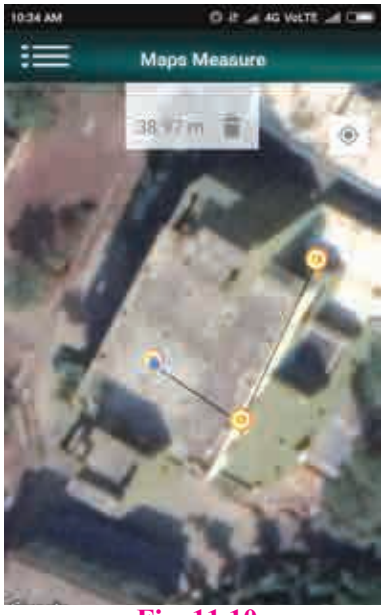


Fig. 11.10

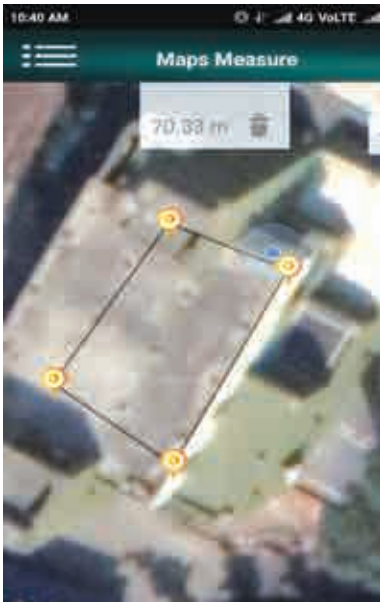


Fig. 11.11

Fig. 11.12

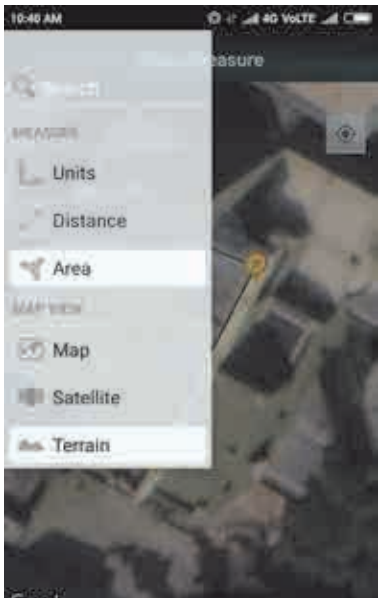


Fig. 11.13

Fig. 11.14

**Observations and conclusions :**

Fill in the table as given below in your field book.

| Points | Distance from 1st point | Distance between two points |
|---|---|---|
| 1 | - | - |
| 2 | 27.45 m | 27.45 m |
| 3 | 38.97 m | 11.52 m |
| 4 | 57.93 m | 18.96 m |
| 5 | 70.33 m | 31.36 m |
| **Total perimeter -** | | 70.33 m |
| **Total Area** | | 289 $m^2$ |

**Further Suggestions for practicals :**

1) Make a map of your school's play ground and measure area with the help of mobile GPS.
2) Measure the area of your farm with the help of mobile GPS.
3) Measure distance between your home and your school with the help of mobile GPS.

***

## Practical No. 12 - Soil profile

**Aim :** To examine the soil profile of a place

**Introduction :**

In this practical, you will learn how to describe a **soil profile**. A profile is a vertical slice of soil from a site. A profile description uses a precise vocabulary to describe the **soil horizons**, from the top to the unaltered **parent material**. In a horizon profile description, you identify and describe each distinct layer. A new layer is identified when there is a noticeable change in **soil color, texture** or **structure**. In this practical, you will describe each horizon in terms of the following characteristics: colour, horizon, texture and depth.

**Materials required :** Munsell chart (download and print), scale, tape, notepad, pen, pencil, camera

**Method :**

- Visit a quarry or any place where there is open soil available to observe the horizons. You can also dig a pit within the school/ college premises.
- Make a preliminary differentiation of the soil horizons based on color of each horizon using the Munsell color chart record in the Table below.
- Measure the depth from the surface to the top and bottom of each horizon.
- Record presence or absence of roots in each horizon
- Use the texture by 'feel method' to determine the soil texture of each horizon and record in the table.
- Make a sketch of the soil horizons to scale and indicate the variability in depth that you see across the face of the profile
- Describe the landscape/topography in which the soil pit is found
- Determine the parent material of this soil
- Click photographs to paste in your journals.

**Make a table showing the readings as follows in your fieldbook :**

| Horizon | Depth (in cm) | Color | Roots ( present/Absent) | Texture (coarse /soft) | Notes |
|---|---|---|---|---|---|
| | | | | | |
| | | | | | |
| | | | | | |

**Observations and conclusions :**

## Practical No. 13 - Estimating the velocity of a river

**Aim :** To estimate the velocity of river

**Objectives :**

1) To understand the factors influencing the flow in the river.
2) To understand the effect of fluctuation in the flow on various bed forms in river channel.

**Materials required :** Stopwatch, piece of wood, metallic tape, whistle

**Method :**

- Select with the help of your teachers a stream in your locality which has straight course.
- Visit the site in the period when the flow is moderate. Ensure that there is some flow in the river
- On one bank of the river mark point A and measure a distance of 50m in downstream

direction of the flow.

- Measure 50 m distance and mark point B at the other end of the line.
- Two persons will be required to determine the velocity of the flow.
- The person at point A will hold the piece of wood and the whistle and stopwatch.
- He should throw the piece of wood in the flowing water and blow the whistle. Set the stop watch on.
- Person at point B will also have stop watch and the moment he hears the whistle, he starts the stopwatch keeping an eye on the stream. The piece of wood will flow in the downstream direction and the person at the point B and the moment he finds the piece of wood appearing in his frontline, he will stop the watch and blow the whistle.
- The time difference between the starting of the wood thrown and the wood sited at 50m distance is the time taken by the wood to cover the distance between A and B . Invariably, it is As wood is a floating load, it can be concluded that time taken by the wood is same as time taken by the water to cover the distance.
- Velocity of the river = Distance / time taken in seconds.

**Observations and conclusions :**

***

## Practical No. 14 - Determining location without the help of GPS

**Aim :** To Determine the geographical location of a place.

**Objectives :**

1) Understanding the relationship between specific celestial body and its position in the sky vis-a-vis location of the place
2) Understand the link between a longitude of a place and location of Standard Time Meridian in the region.
3) To estimate the geographical coordinates of a place without using any device

**Introduction :**

Generally, students or a layman find it difficult to know the location of a place with reference to geographical coordinates. Though geographical coordinate system depends on the imaginary lines assumed to be forming a graticule on the earth's surface, they are the only available system to know the coordinates of a place. As maps and other devices are available, one tends to forget their importance. Hence, it is necessary to make student understand how they can locate themselves on the planet.

At the same time, this method of locating yourself on the planet is very basic, simple and conventional. It uses the logic of defining the graticule. Explorers and travelers have used this method to locate themselves when the devices helping locating a place (like GPS or maps) were not available. This method is useful to locate a point in Northern Hemisphere. For Southern Hemisphere, a different method has to be used.

**Materials required :** A semi-circular protractor with a plumb- bob attached , paper pin, thread , a piece of stone , candle, a wrist watch and a stick of 5 feet length.

The method described below has two parts -one estimating the latitude and the other estimating the longitude.

**Procedure – to determine the latitude :**

**STEP 1 -** Take a semi-circular protractor available in your geometry box. You have to convert this protractor into a clinometer. (Instrument measuring an angle of slope)

**STEP 2 -** Take a paper pin and slightly heat it up with a candle. Be careful doing this so that you don't burn your fingers. Using the heated pin , make a small hole at the centre of the base of the protractor. Using a thread, a stone and make a plumb-bob , attach it to the protractor by inserting the thread through the hole you have made. Tie it properly. Hold the protractor with the base in your hand. The base will be at the top and the plumb will point the ground. You will realize the thread line will co-incide with the 90 0 mark.

**STEP 3 -** In the evening, wait for some time so that different stars will be visible in the sky. Locate the Pole Star under the guidance of your teacher or elderly persons with the help of either the Ursa Major ( Saptarishi- Group of seven major stars) or Cassiopeia ( Sharmishtha- group of five stars forming the letter W or M).Note that, you will definitely get either of the group of stars in the sky.

**STEP 4 -** Hold the protractor in your hand and look at the pole star along the line of the base of the protractor.Ask your friend to see the protractor and note the angle against the thread line. It will not be 90° as you saw in step 2. It will have some angle more than 90°. Find the difference between the observed angle and 90°. ($\phi - 90$) is the angle of elevation of the pole star above horizon. This is the angle of your latitude.

(Note: In Maharashtra, for any place the angle will be between 15° to 23°)

**Observations and learnings :**

Note your observations. Write a note on your experience and observations.

**PART II**

**Procedure – to determine the longitude :**

To do this activity, use the time at least 20 min before the mid-day. At a given location, place the stick in the ground. See that it is vertically standing.

**STEP 1 -** Observe the length of its shadow from 11 a.m. onwards. (Refer to Geography Textbook for Standard 8, Chapter 1 for a detailed experiment). After every ten minutes, measure the length of the shadow. Continue doing this till the shadow length is at its minimum. Note the time in your wrist watch, when it is the shortest. What do you think will be the time when the shadow is the shortest? Will it be before 12 o clock or after 12 o clock in Maharashtra?

**STEP 2 -** Your wrist watch is adjusted to IST. So, the minimal length of the shadow will be before 12 o clock in your wrist watch. (In Maharashtra, the time of minimum shadow length will be before 12 noon in your wrist watch. If you are in West Bengal or Assam, the minimum length of the shadow will be after 12 noon in your wrist watch.) Find the difference in the time of minimal shadow length and 12 noon in the wrist watch.

**STEP 3 -** Divide the difference by 4 and that will be the difference between your longitude and the IST.

**STEP 4 -** Subtract /Add the value to IST ( 82° 30' E) and that is the longitude of your place.

**Observations and learnings :**

Write a short note on your experience and observations. Find out the difference in the time between the minimum shadow length at easternmost and westernmost locations of Maharashtra.

***

# Practical No. 15 - Finding the slope of a road

**Aim :** To estimate the slope along a road.

**Objectives :**

1) To know why the roads are not always on flat surface
2) To know criteria for stability of a surface.

**Uses :**

1) Traffic safety and road construction.
2) Understanding mass movements.

**Materials required :** Ranging rods, foot scale, set squares (large size), activity to be carried out by 2 persons pieces of colored adhesive tape, measuring tape, scissors.

**Method :**

1) Select a stretch of road within your locality such that the points and the entire stretch of the road should be visible from both the points. Teachers should guide the students in selection of points in such a way that the rise is perceivable but not out of scope of observation.
2) One student can stand at the down slope end. He should stand with the ranging rod along the road. He should also hold the set square along the ranging rod. The set square should be such that the side of the set square will appear as the line of sight.
3) Another student will measure the height of the eyesight from the ground.
4) A student will stand with another ranging rod at point B. Before going to B , he will mark the point showing level of eyesight of the person at A on his ranging rod with a piece of coloured adhesive tape. The distance between A and B will be measured. From A, the student will look at the ranging rod at B. The person at point B will move his finger along the rod and person at A will ask him to stop at a point when his finger coincides with line of sight. He will mark that point by sticking a tape. Also, another student will measure the difference between the newly marked point and the line of sight marked earlier. Similarly, readings can be taken at points C, D, etc. Make sure you take at least 2 points after A.
5) Note the readings and fill the same in your field book in the following way.

| Points | Eyesight reading | Difference in height | Fall | Distance between successive points |
|---|---|---|---|---|
| A | 161 cm | | - | |
| B | 168 cm | +7 cm | - | 200 cm |
| C | 173 cm | +5 cm | - | 400 cm |
| **Total** | | | | 600 cm |

Similarly, rises / falls should also be added which will give us total rise along the road. Then the slope of the road will be

**Tan $\phi$ :** Total rise or drop / total distance between first point and last point.

**Note :** It is advisable during road surveys that the fall or rise should be measured in one and same direction.

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