

**BLOCK**

**2**

**HUMAN-ENVIRONMENT RELATIONSHIP**

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**UNIT 4  
EQUATORIAL REGIONS**

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**UNIT 5  
DESERT REGIONS**

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**UNIT 6  
MOUNTAINOUS REGIONS**

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**UNIT 7  
COASTAL REGIONS**

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**GLOSSARY**

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# **BGGCT- 135**

## **Environmental Geography**

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### **BLOCK 1 INTRODUCTION TO ENVIRONMENTAL GEOGRAPHY**

- Unit 1 Concepts and Scope of Environmental Geography
  - Unit 2 Ecology and Ecosystems
  - Unit 3 Biogeography
- 

### **BLOCK 2 HUMAN-ENVIRONMENT RELATIONSHIPS**

- Unit 4 Equatorial Regions
  - Unit 5 Desert Regions
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- 

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- Unit 15 Environmental Issues
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  - Unit 17 Environmental Policies with Special Reference to India
-

## BLOCK 2: HUMAN-ENVIRONMENT RELATIONSHIP

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Major focus of the present block is to understand various ways of human interaction with their environment. There are four units in the block that describe and explain human environment relationship in four distinct geographical regions namely equatorial, desert, mountainous and coastal. Let us discuss briefly about each unit.

**Unit 4: Equatorial Regions:** As the title of the unit suggests we will describe and explain human-environment relationship in the equatorial region. You will learn about the location and extension of the equatorial region. This understanding would help you to analyse the soil and climatic conditions of this region. You will also get an insight into flora and fauna of the region. Based on all these understanding about bio-physical environment an attempt has been made to critically analyse human-environment interaction in the equatorial region. The interaction between human beings and their environment is such that the environment influences humans and, at the same time, human beings also get influenced by the environment.

**Unit 5: Desert Regions:** In this unit you will learn about the human-environment relationship in the desert region, where conditions seem most unfavourable to human habitation. This unit begins with a brief description of the location, extent of deserts around the world and physical conditions in a desert. Thereafter, you will learn about how human beings adapted to adverse conditions in a desert, developing relationships with the environment that allowed them to survive there for centuries. The traditional human-environment relationship has undergone a major change with the rapid growth of population and the advent of modern technology. Today this region has been confronted with various challenges, and you will also learn about these challenges.

**Unit 6: Mountainous Regions:** This unit deals with different physical and human aspects of the mountainous regions of the world. You will study about the geographical location and distribution of the mountain region. You will also get an idea about the climate and soil conditions prevailing in the mountain region. This insight will greatly help you to understand the floral and faunal diversity of the mountain regions. The study of locational aspects along with physical parameters would also help you to envisage the kind of human-environment relationship and comprehend the nature and types of opportunities, challenges and constraints of mountain regions. You will also learn about various factors which are responsible for generating major environmental problems being faced by the mountain communities and societies. You will also be able to learn about the set of opportunities, specificities and constraints which characterizes the interplay between humans and its environment in mountain regions of the world.

**Unit 7: Coastal Regions:** Like other three units, this unit has also discussed about various aspects related to human-environment relationship in the coastal regions. The unit begins with a discussion on the importance of coastal regions. This will be followed by a description of some important landform features found in this region, as well as the importance of these features. Some prominent ecosystems and their ecological significance have also been discussed in section 7.4. Subsequent sections discuss some coastal hazards and environmental problems that affect this region, together with measures that can be taken to reduce the risk from them.

We hope after studying this block, you will better understand the basic concepts of cartography, what are maps and their types, usage of maps, and map scales in particular. Our best wishes are with you in this endeavour.

## EQUATORIAL REGIONS

### Structure

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- |  |  |
|--|--|
| 4.1 Introduction<br>Expected Learning Outcomes | 4.6 Human-environment<br>relationships       |
| 4.2 Geographical Location and<br>distribution  | 4.7 Summary                                  |
| 4.3 Climate                                    | 4.8 Terminal Questions                       |
| 4.4 Soil                                       | 4.9 Answers                                  |
| 4.5 Flora and Fauna                            | 4.10 References/Suggested Further<br>Reading |

### 4.1 INTRODUCTION

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In Block 1, you have learnt about the bio-geographical regions of the world. You now know that there are various bio-geographic regions on the earth, and each has its distinct characteristics or features. You might be knowing that the environment of a region has a direct influence upon the human beings residing in that region. Human try to adapt to their environment in numerous ways. You have already read about human adaptation to the environment in Block 1, Unit 4 of the course on Human Geography. The focus of the present block shall be to understand the ways of the interaction of human beings and their environment. In this process, we shall first be dealing with the relationship between humans and their environment in the equatorial region. Hence, the focus of the present unit is the study of the equatorial region.

In Sec. 4.2 you will study about the location and distribution of the equatorial region. The understanding gained in this section shall help you to analyse the soil and climatic conditions of this region, which will be dealt with in greater detail in Sec. 4.3 and 4.4. Further, in Sec. 4.5, you will get insight into flora and fauna of the region. Based on all these understanding Sec 4.6 shall deal with the human-environment interaction in the equatorial region. The interaction between human

and environment is such that the environment influences humans and, at the same time, human influences the environment.

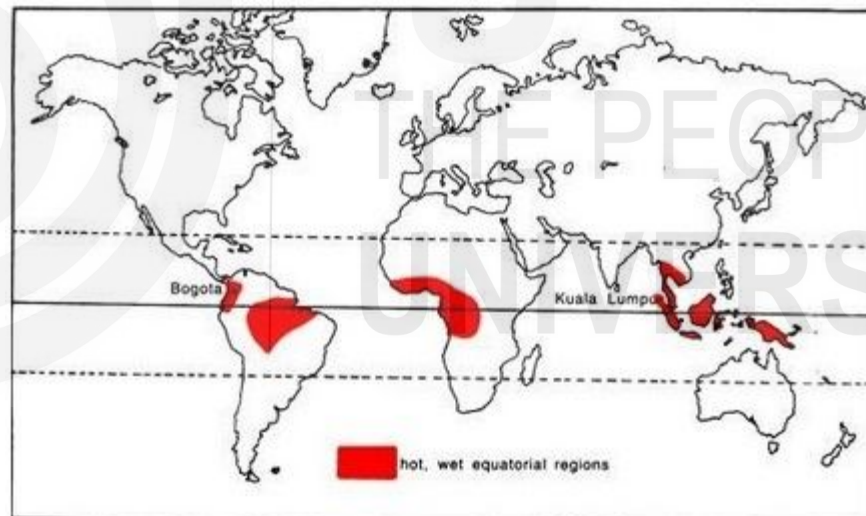
## Expected Learning Outcomes

After completing the study of this unit, you should be able to:

- State the geographical location and distribution of the equatorial region in the world;
- Explain the climatic conditions and soil associated with the equatorial region;
- Describe the flora and fauna of the region; and
- Analyse human-environment relationship in the region.

## 4.2 GEOGRAPHICAL LOCATION AND DISTRIBUTION

Before discussing about human-environment relationship of any region, the first and foremost requirement is to know about their location on the earth surface. This would help us to understand physical conditions and socio-economic activities in a better manner. Therefore let us know about the location and situation of equatorial region with the help of world map given below.



**Fig. 4.1: Location and Distribution of the Equatorial Region in the World**

As the name suggests, this region is located in and around the equator in both the hemisphere. As depicted in the Fig. 4.1, the equatorial region is located between  $0^{\circ}$  and  $10^{\circ}$  latitude on either side of the equator. It stretches in the Amazon lowlands in South America, Congo basin in Africa and the East Indies, from Sumatra to New Guinea in Asia. In other words, this region spread across the continents of South America, Africa and Asia. The location and distribution of the equatorial region is clearly shown in Fig 4.1.

This region covers about 6% area of the earth surface. Though this region covers a small stretch of earth surface, it has ecological and economic significance for the entire earth. We will discuss about its significance in the following section.

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### **SAQ 1**

Explain the location and distribution of the equatorial region?

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## **4.3 CLIMATE**

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The location of a place gives insights about the climate of that region. Considering this, can you now analyze the climatic conditions prevalent in the equatorial region? As the name suggests, this region is located near the equator. You might have read in the school that the sun's rays falls perpendicular/straight throughout the year on the equatorial region. Therefore, it is characterized by high sunshine throughout the year. The high sunshine leads to high temperature throughout the year. This is the reason for which, the region does not have the presence of winters. In fact, the seasonal and diurnal variation in temperature is not considerable. Temperatures are uniform throughout the year. The mean monthly and mean annual temperature of the region is close to 27° C.

The mornings in the region are bright and sunny. The high amount of evaporation in the region results in heavy convectional rainfall in the afternoons. You have already read about the convectional rainfall in Block 3 titled Climatology in course on Physical Geography. Thus, the region is characterized by high precipitation. The rainfall reaches as high as 2500mm annually.

Till now you might have understood the climate of equatorial region. If we summarise the climate of equatorial region then it can be expressed as hot and wet climatic condition.

### **SAQ 2**

Why is there no winter season in the climate in the equatorial region.

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## **4.4 FLORA AND FAUNA**

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You have already learnt about the climatic conditions in the equatorial region in the previous section. The high temperature and high rainfall in the region supports a rich and profuse vegetation. As mentioned in the initial section of this unit that it plays a very significant role in terms of global ecology and economy. Let us discuss both flora and fauna of this region briefly.

### 4.4.1 Flora

The characteristic feature of the vegetation of this area can be summarized as:

- (a) **Diverse vegetation:** The equatorial region supports diverse vegetation owing to its climatic condition. The climatic conditions support the growth of numerous types of vegetation. The region is said to be a genetic reservoir of numerous species. The region contains as many as 3000 species of trees within a few square kilometres. The diversity of vegetation ranges from evergreen trees to climbing plants like lianas as well as epiphytic and parasitic plants.
- (b) **Arrangement in layers:** The struggle for sunlight among the vegetation of the region results in a distinctive layered arrangement. The top most layer consists of the scattered 'emergent' crowns that have been able to protrude from the closed canopy below. Such trees often reach up to the height of 40 m. Below this layer is the continuous layer. This layer consists of trees which are around 15 to 30 m in height. The lowermost layer consists of the vegetation which can tolerate shade. This layer, which is close to the ground consists of ferns and herbaceous plants. Most of the sunlight is stopped by the upper layers of the trees, and hence, the lowest layer is not too dense (Refer Fig. 4.2).

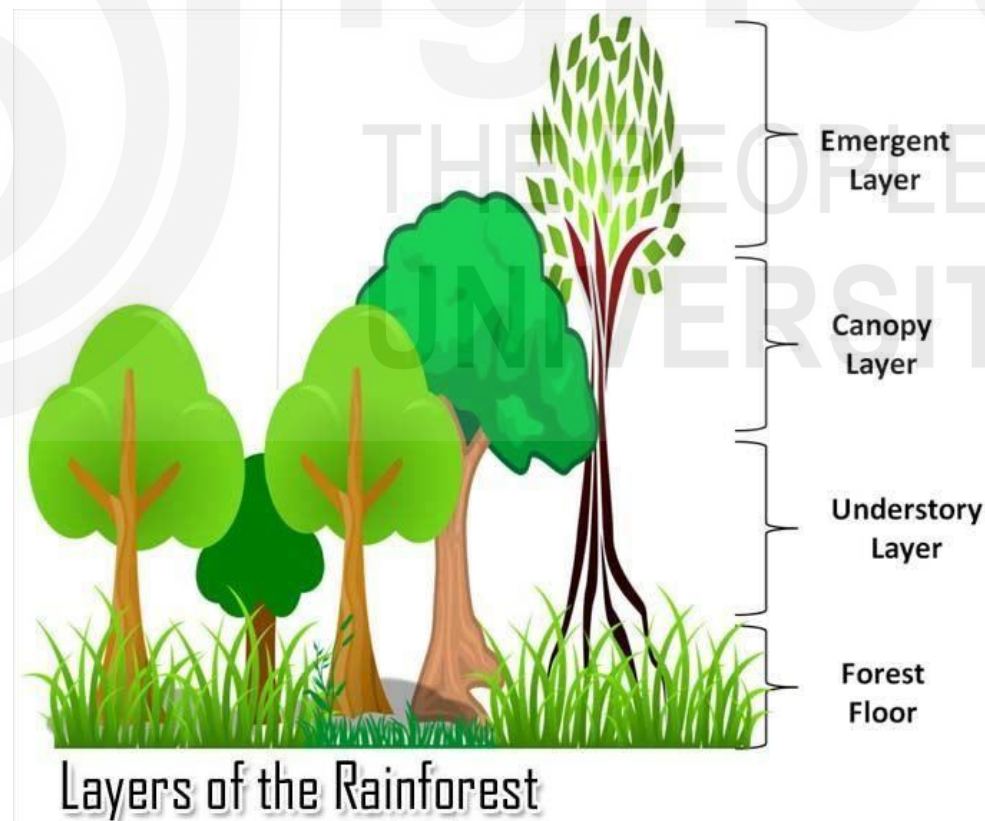


Fig. 4.2: Layered Arrangements of Vegetation in the Equatorial Region



### **4.4.2 Fauna**

The equatorial region not only supports abundant and diverse vegetation but is also home to diverse fauna. The African elephant, jaguar, are some of the animals of this region. The Congo basin is home to the mountain gorilla, lowland gorillas, chimpanzees as well as thousand species of birds. The poison dart frog, margay, collard anteater are some of the other animals.

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#### **SAQ 3**

Why are plants arranged in distinct layers in equatorial region?

#### **SAQ 4**

Name any four animal species of equatorial region.

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### **4.5 SOIL**

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While you might be thinking that the profuse vegetation in the region is an indication of soil highly rich in nutrients, but it is not so. Can you guess why this is not so. This is because of the high temperature and rainfall. It accelerate the process of weathering in the equatorial region. That is why most of the soils of the tropical regions are clays which have little soluble mineral content in them. The soils are moderate to highly acidic, which restrict the ability of the roots to take up the nutrients of the soil. The high rainfall in the region also washes the top layer of the soil more easily compared to any other region; thus making it devoid of the nutrients. The soils of these regions recycle and reuse almost everything that falls on it i.e. decayed species of animals, leaves and flowers etc. This supports the luxuriant growth of vegetation in the soil, despite the soil being so poor in the nutrients.

Till now, you might have realized location plays a vital role in determining climate and soil condition. Similarly, climate and soil plays a vital role in the growth of vegetation. In the following section, we will discuss about flora and fauna in the equatorial region.

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#### **SAQ 5**

Why is soil devoid of nutrients in equatorial region?

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### **4.6 HUMAN-ENVIRONMENT RELATIONSHIPS**

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Till now you might have got an idea about the physical characteristics of the region. As you have read in the Human Geography that humans adapted to their

environment by adjusting their day to day activities or by modifying their environment according to their suitability. The relationship between humans and their environment has been important, yet a complex one. The environment of a region bears influences on humans, and at the same time, the environment also gets influenced by humans. There is a two-way interaction between the two. Both of the two cannot remain in isolation. Here we shall try to understand this relationship from both the dimensions with particular reference to the equatorial region.

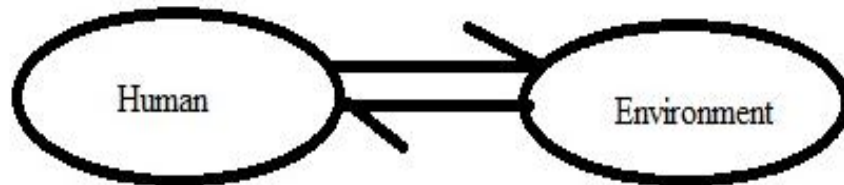


Fig. 4.3: Two-way Processes in Human-environment Relationship

#### 4.6.1 Impact of Environment On Humans

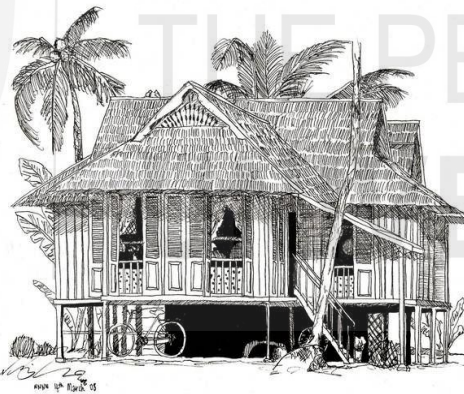
The environment of a region has a direct influence upon the human beings residing in that region. Humans try to adapt themselves to their environment in numerous ways. Some of these are as follows:

- (i) **The Native Inhabitants:** The equatorial region is inhabited by the indigenous people which comprise of the Pygmies of Africa, Indian tribes in Amazon Basin. They have adapted to the environment in numerous ways. The Pygmies are small in stature. It is believed that their small stature enables them to move in the forests more easily compared to the taller people.
- (ii) **Agriculture:** Different forms of agriculture are practiced in the equatorial regions. Traditionally the most common form of agriculture has been the migratory agriculture, which is the slash and burns form of agriculture.

**(a) Migratory Agriculture/Slash and Burn Agriculture:** The people of this region are mostly nomadic. They practice different activities in groups like hunting and fishing. The most common method of agriculture practiced in the equatorial rainforests is the slash and burn agriculture method. In this type of agriculture, vast tracts of land are cleared for cultivation and then abandoned for a new land until the old one regains its fertility. This practice is, however, ecologically unsound. Do you know this type of agriculture is known by different names in different countries? In the equatorial African countries, this form of agriculture is known as Fang, Masole in the Zaire river valley, Comile and Milya in Mexico and Central America, Roka in Brazil, Ladang in Java nad Indonesia, Caingin in Philippines and Ray in Vietnam.

**(b) Commercial farming:** The commercial farming is carried on a small scale in the equatorial region, but generally sizeable single cash crops like rice, citrus, opium, tea, soyabeans are cultivated. In the Amazon basin, the people grow crops like manioc or cassava. The commercial agriculture is also practiced in the form of large plantations of coffee, rubber and banana, palm oil etc.

**(iii) Settlements:** Do you know that the environment influences the settlements as well? The thick forests have an impact over the type of houses that can be built and the type of settlement that is possible in the equatorial regions. The people of the equatorial region are mostly nomadic and move from place to place. However, in some regions, a special type of houses are found. In the Amazon, people live in special type of house called Maloca. These houses have steep, slant roofs and apartment like in shape. People also reside in houses with thatched roofs over them. In Malaysia, the villages are called 'kampongs'. The houses in Malaysia are mainly raised on timber stilts. The stilts enable the building to be better suited for the natural terrain. The materials used for constructing the houses comprise of the easily available materials from the forests which comprise of the timber, bamboo and leaves. Moreover, the wood and bamboo that are used also have insulating properties, and they conduct or retain little heat into the building. Thus, it may be observed that the houses and the building material in the region are influenced by the environment of that region (Refer Fig. 4.4).



**Fig. 4.4: Types of Houses in a. Amazon Basin b. Malaysia**

**(iv) Climate and Human Health:** The climate of a region has a profound impact on the health of human beings. The excess heat and humidity have negative impacts on the health of the people. Climate change has made the people of the region more vulnerable.

**Prevalence of Diseases:** While the hot and humid climate supports the growth of vegetation, it also leads to the growth of bacteria and pests. These, in turn, are responsible for the large scale prevalence of diseases in the equatorial region. There is large scale prevalence of vector borne

diseases in this area such as malaria, lymphatic filariasis, dengue. The insects and animals of the forests serve as host and vectors to several other diseases like yellow fever, leishmaniasis and Chagas disease. The prevalence of such types of diseases makes life difficult for the people of the region. The handling as well as consumption of bushmeat increases the exposure to many viruses and may be the underlying causes of the emergence of diseases including HIV and Ebola.

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## SAQ 6

How have human beings adapted themselves in the equatorial regions?

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### **4.6.2 Impact of Humans on The Equatorial Region**

The equatorial rainforests are very important for human beings. They stabilize the world climate and hydrologic cycle and are essential in providing numerous ecosystem services. Its importance can hardly be undermined. The interaction of humans with the environment has been beneficial to humans, but, at the same time, the region has been afflicted with several problems due to the influence of human beings in the area. The loss of equatorial rainforests is not just harmful to the local environment. It is loss of numerous species inhabiting the earth- a loss of millions of years of evolution and its consequent repercussions on the earth as a whole.

- (i) **Deforestation:** Do you know that the rainforest basins of Amazon, Congo and Southeast Asia comprise of huge forest area? These cover over 1.3 billion hectares and roughly corresponds to one-third of the total forest area of the world. That is huge- Isn't it? The problem, however, lies in the fact that even these forests are affected by the problem of deforestation. During the decade 2000-2010, the three basins reported a net loss of forest area of 5.4 million hectares per year. The loss in the amazon basin was the highest and amounted to around 3.6 million hectares per year in the decade. Now that is something to worry about because while the deforestation is mainly human induced, its repercussions shall also be faced by the humans to a great extent. This is because these forests play a great role in regulating the climate of the world and they are a storehouse of a range of products and services that are vital in providing local livelihood and in the national development.

Deforestation is a significant threat to the equatorial forests caused due to human beings. In the Amazon forests, the deforestation is mainly due to the expansion of agriculture. Other important factors driving deforestation are cattle ranching, expansion of infrastructures like dams and roads. Deforestation as a problem cannot be viewed as a single impact in the region. It triggers a chain of other negative impacts in the region, which

include soil erosion, altered hydrology, loss of biodiversity. While the problem is initiated by human beings in the path of development, the combined effect of all these negative impacts takes a toll on human beings.

- (ii) Logging:** Logging also leads to significant forest degradation. It opens up the opportunity for conversion of the land to different land use, which even forest clearances. This is prevalent in tropical rainforests. In South east Asia, the *Dipterocarpaceae* family of trees are predominant and are very important for the timber industry. This is because the trees produce long, straight and knot free (no branches) logs which are ideal for plywood and sawn timber. As of 2012, the Southeast Asia region has become the world's leading log producing region owing to its dense commercial stocking of forests. Out of the three regions, Southeast Asia produced around 56% of the three regions' logs, 36% of the sawn timber and around 85% of the plywood in the year 2008-2012.
- (iii) Cattle Ranching:** One of the dominant causes of deforestation in the tropical areas is the expansion of cattle pasture and cattle ranching, which is specifically from the gate beef and dairy. The Amazon Brazil is home to approximately 200 million head of cattle and is the largest exporter in the world. Ranching is an important and attractive economic activity due to the low input cost and the easy transportation in the rural areas, and hence, it is one of the leading causes of deforestation in the area.
- (iv) Mining:** Mining is also one of the other human induced activity, which negatively influences the environment in tropical regions. Mining has an impact on the environment in two ways; the first being the direct deforestation. While the extent of deforestation caused by mining is lesser than agriculture, it is a regionally important factor for the deforestation in the area. The second impact of mining is the direct impact in the riverine structures due to mining and the associated pollution from the sedimentation in rivers and the release of toxic materials. In Amazon forest, gold mining leads to deforestation, and the mercury used in processing leads to contamination of fish, water as well as the air. The mercury in the air is highly injurious to human health, and this has led to countries like Ecuador adopting the zero mercury plan. It is important that countries too, ratify the Minamata Convention.
- (v) Dams and Hydropower Expansion:** Construction of dams and hydropower expansion has become a threat to the equatorial region. In the Amazon forests, construction of dams has threatened the flow of the Amazon rivers and their tributaries. It has threatened aquatic and terrestrial ecosystems. It is already known that dam construction leads to forest loss, encourages settlements and leads to deforestation. Thus, as a result of this the indigenous people are displaced; both as a result of the construction of dams as well as flooding.

**(vi) Transport Infrastructure:** The increase in transport infrastructures like roads, railway and water transport are transforming the equatorial regions. For such activities, forests are cleared, and the local inhabitants are displaced. Moreover, the increase in transport infrastructure also results in access to remote areas. This also brings a change in the cultural composition in the areas.

**(vii) Major Towns in the Tropical Rainforest:** Reading about the dense forests in the tropical area, you may find it hard to believe that the area also has some important towns among which are also beautiful tourist spots. Some of the cities are truly places for adventure and bewildering excitement, while others are important centres of finance, economy and education.

Some of the major cities in the Amazon areas are Iquitos City and Puerto Maldonado in Peru, Manaus City, Sanatrem and Belem in Brazil. These are important tourist centres. The capital of Ecuador; Quito, is one of the important cities in the country. In Colombia, Bagota and Leticia are important centres in terms of the economy and port, respectively, in the country. In the SE Asian region, Singapore is one of the leading cities in several amenities like high quality education, technology, innovation, healthcare and tourism. In Indonesia, Jakarta and Bandung are important centres. The Congo basin has comparatively lesser number of cities because of the impenetrable forests and the political instability in the region. However, some of the important ones are Brazzaville in the Congo, Kinshasha and Lubumbashi in the Democratic Republic of Congo.

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### SAQ 7

What are the negative impacts of human beings in the equatorial regions?

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## 4.7 SUMMARY

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In this unit you have studied:

- Each region has its own physical and associated cultural landscape.
- The equatorial region is located between 5° and 10° latitude on either side of the equator. It stretches in the Amazon lowlands in South America, Congo basin in Africa and the East Indies, from Sumatra to New Guinea.
- Being located near the equator, it is characterized by high sunshine throughout the year. The soil is poor in nutrients. Still, the region supports luxuriant and diverse vegetation. The region is also home to diverse fauna.
- The human-environment relationship is a two-way process. The environment has an impact on humans, and humans also affect the environment.

- The people inhabiting these areas adjust to the environment in numerous ways by constructing houses suiting to the climate, practicing agriculture in accordance with the environment.
- Deforestation, logging, mining activities, dams and hydropower projects are some of the ways in which human affect the environment. While humans alter the environment on the path of development, but in the process, they negatively affect the environment.

## 4.8 TERMINAL QUESTIONS

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1. Explain the climatic Characteristics of the equatorial region
2. Describe the characteristics of vegetation of the equatorial region
3. “The relationship between humans and their environment is two-way”. Explain the statement in light of the interaction between humans and their environment in the equatorial region.
4. The equatorial region is inaccessible, despite this there is a growth of urbanization in the region. Discuss the growth and emergence of the towns and cities in this area.

## 4.9 ANSWERS

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### Self-Assessment Questions (SAQ)

1. The equatorial region is located between 5° and 10° latitude on either side of the equator. It stretches in the Amazon lowlands in South America, Congo basin in Africa and the East Indies, from Sumatra to New Guinea.
2. The sun’s rays falls perpendicular throughout the year on the equatorial region. Therefore, it is characterized by high sunshine throughout the year. The high sunshine leads to high temperature throughout the year. This is the reason for which, the region does not have the presence of winters.
3. The struggle for sunlight among the vegetation of the region results in a distinctive layered arrangement.
4. The African elephant, Jaguar, the mountain gorilla, lowland gorillas, chimpanzees.
5. This is because of the high temperature and rainfall. It accelerate the process of weathering in the equatorial region. The high rainfall in the region also washes the top layer of the soil more easily compared to any other region; thus making it devoid of the nutrients.

6. The human beings of the equatorial region have adapted themselves to the climatic conditions of the area in numerous ways.
- (i) In the equatorial regions, people have modified their settlements according to the environment. In the Amazon, people live in special type of house called Maloca. These houses have steep, slant roofs and apartment like in shape. People also reside in houses with thatched roofs over them. In Malaysia, the villages are called 'kampongs'. The houses in Malaysia are mainly raised on timber stilts. The stilts enable the building to be better suited for the natural terrain. The wood and bamboo that are used are construction material has insulating properties, and they conduct or retain little heat into the building.
  - (ii) The people practice numerous types of agriculture, which suits the environment.
7. The humans affect the environment of equatorial regions negatively in numerous ways; deforestation and its associated chain of events being the primary one. Deforestation is mainly due to the expansion of agriculture. Other important factors driving deforestation are cattle ranching, expansion of infrastructures like dams and roads. Deforestation as a problem cannot be viewed as a single impact in the region. It triggers a chain of other negative impacts in the region, which include soil erosion, altered hydrology, loss of biodiversity. In Amazon forest, gold mining leads to deforestation, and the mercury used in processing leads to contamination of fish, water as well as the air.

### **Terminal Questions**

1. Refer to Section 4.3
2. The characteristic feature of the vegetation of the equatorial area is; diverse vegetation and arrangement in layers.
  - (i) **Diverse vegetation:** The equatorial region supports diverse vegetation. The region is said to be a genetic reservoir of numerous species. The region contains as many as 3000 species of trees within a few square kilometres. The diversity of vegetation ranges from evergreen trees to climbing plants like lianas as well as epiphytic and parasitic plants.
  - (ii) **Arrangement in layers:** The vegetation of the region is arranged in layers. The top most layer consists of the scattered 'emergent' crowns that have been able to protrude from the closed canopy below. Such trees often reach up to the height of 40 m. Below this layer is the continuous layer. This layer consists of trees which are around 15 to 30 m in height. The lowermost layer consists of the vegetation which can tolerate shade. This layer, which is close to the ground consists of ferns and herbaceous plants. For details please refer to Section 4.4



3. Refer to Section 4.6

4. Refer to Section 4.6.2 (vii)

## **4.10 REFERENCES/SUGGESTED FURTHER READING**

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## DESERT REGIONS

### Structure

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|---|---|
| 5.1 Introduction                            | Settled cultivators                       |
| Expected Learning Outcomes                  | Mining settlers                           |
| 5.2 What is a Desert?                       | Urban dwellers                            |
| Location and causes                         | 5.6 Environmental Problems in the Region  |
| 5.3 The Biophysical Environment of a Desert | Desertification                           |
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### 5.1 INTRODUCTION

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You have already learnt that human beings derive all the resources they need from their environment. The environment provides them with food and clothing, and the space as well as material for construction of shelters. You also know that resources are not uniformly distributed across the surface of the earth. Over a period of time, through experimentation, observation and exchange of ideas, people living in different parts of the earth evolved practices that allowed them to utilise local resources to obtain food, clothing and shelter. They developed economic and social systems that sustained over long periods of time. However, in some places, these systems proved to be unsustainable, and became a cause of environmental decline.

The process by which living organisms, including human beings, adjust themselves to their surroundings is called adaptation. Adaptation to the environment is vital to the survival of any species. Plants and animals adapt to the environment in various ways. The shape, size and colour of their body parts may be modified to suit environmental conditions (morphological

adaptation). In other organisms, the functioning of organs may be tailored to deal with certain environmental constraints (physiological adaptation). Some animals take to habits such as migration and hibernation to avoid extreme conditions (behavioural adaptation). In the case of human beings, however, physical adaptation is not very evident. Human beings adapt to their environment by altering their cultural and economic organisation. At the same time, they modify their environment with the use of technology. Thus the human-environment relationship in any region is a reflection of how the environment influences human activity, as well as how human activities in turn affect the environment.

In this unit you will learn about the human-environment relationship in the desert region, where conditions seem most unfavourable to human habitation. The unit begins with a brief description of the physical conditions in a desert. Thereafter, you will learn about how human beings adapted to conditions in a desert, developing relationships with the environment that allowed them to survive there for centuries. The traditional human-environment relationship has undergone a major change with the rapid growth of population and the advent of modern technology. New challenges confront these areas today, and you will learn about these too.

## **Expected Learning Outcomes**

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After completing the study of this unit, you should be able to:

- Explain how the environment influences, not determines, human action and behaviour;
- Describe the biophysical conditions in a desert;
- Describe how human beings adapt to this environment;
- Explain how technology, culture and politics have changed the dynamics of the human-environment relationship in deserts; and
- Analyse new challenges emerging due to these changes.

## **5.2 WHAT IS A DESERT?**

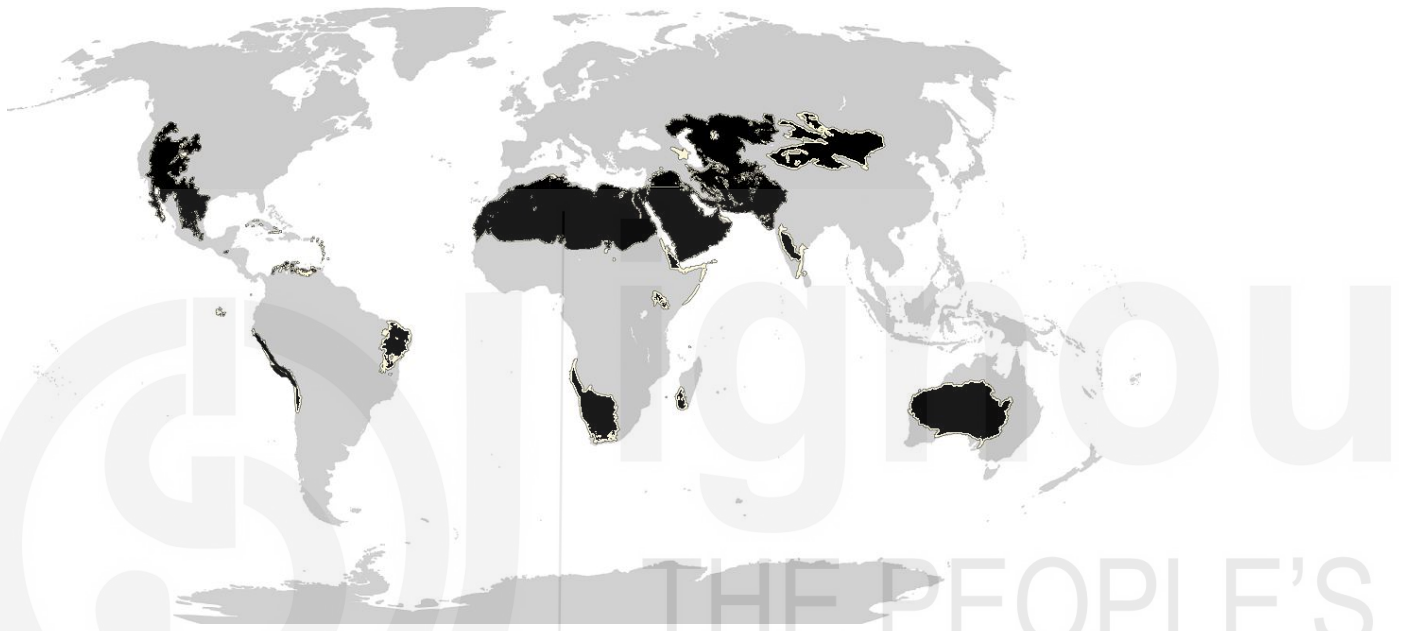
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When we talk about a desert what comes to your mind immediately? I am sure the word desert conjures up images of vast expanses of sand under a scorching sun. However, not all deserts fit this description. Therefore before discussing about human-environment relationship we should have clarity about the definition or meaning of a desert. There is no precise definition of a desert. It is generally accepted that a desert is a biome in which evaporation exceeds precipitation. The rate of evaporation varies with temperature. So it is not easy to define a desert merely on the basis of precipitation. But a desert is likely to develop where the annual precipitation is less than 250 mm. It is important to remember that aridity (or the absence of moisture) is the common characteristic of all deserts, while temperature varies from desert to desert.

Deserts may be classified into hot and dry deserts, semi deserts, coastal deserts and cold deserts, based on the amount and distribution of

temperature and precipitation. This unit will focus only on hot and dry deserts and semi deserts. Similarly, while sand is commonly found in deserts, all desert landscapes are not dominated by sand. Deserts in which sand is in abundance, completely covering the ground and leading to the formation of dunes that resemble wave-like ridges of the ocean surface, are called erg, meaning a sand sea. In other deserts, the wind may blow away all the sand, leaving behind closely packed, interlocking angular rock fragments. Such a stony desert is known as **reg**. In some deserts the landscape is dominated by boulders and exposed bedrock. **Hamada** is the name given to such deserts.

### **5.2.1 Location and Formation of Deserts**



**Fig. 5.1: Major Hot Deserts of the world (source: Wikipedia)**

Various factors are responsible for the location of deserts in certain areas. The largest hot deserts, like the Sahara and Arabian deserts, are located in the trade wind belt near the sub-tropical high pressure belts in both hemispheres. These are places located under the descending limb of the Hadley Cell that dominates the atmospheric circulation in tropical areas. As the air subsides, it warms adiabatically, inhibiting condensation and precipitation.

Do you find some patterns in the location of desert in the world (Refer Fig. 5.1)? Some deserts are located on the leeward side of mountains and the rain shadow effect is responsible for their formation. The Sonoran Desert in North America is located to the east of the coastal ranges. While moisture bearing winds arising from the ocean bring precipitation to the western flanks of the ranges, places to the east receive no precipitation from them as they have already shed their moisture before reaching here.

Deserts are also located in the interior of continents. Their interior location prevents them from receiving moisture from the oceans. The Gobi Desert has been formed due to the inland location as well as the rain shadow effect.

The presence of cold ocean currents also favours the formation of deserts. Air in contact with cold ocean waters is cooled from below and this leads to suppression of rainfall. The formation of the Kalahari Desert in Africa and the Atacama Desert in South America is aided by the effects of the Benguela and Humboldt currents respectively.

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## SAQ 1

What is a desert? Where are the major deserts of the world located?

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## 5.3 THE BIOPHYSICAL ENVIRONMENT OF DESERT

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You might have got fair amount of idea about environmental conditions prevalent in the desert from the previous section. However, you need to have a thorough understanding of bio-physical environment of desert so that you can relate easily with the human-environment relationship and prevalent environmental issues in the desert region. Therefore, in this section, we have described and also explained elements of bio-physical environment in detail. It includes climate, soil, flora and fauna.

### 5.3.1 Climate

Desert climate is one of extremes. As you have already learnt, aridity is the defining characteristic of a desert and some places can be extremely arid, receiving precipitation as an exception rather than as a rule. Highest maximum temperatures too are recorded in deserts, as the sun shines strongly in the cloudless skies during the day. However, the lack of moisture also allows terrestrial radiation to escape quickly, so that it can get quite cold soon after the sun sets.

Hot deserts are generally warm throughout the year. Mean annual temperatures are above 20°C. They are extremely hot in summer, with daytime temperatures well in excess of 40°C. Places such as Jacobabad (Pakistan), Death Valley (California, USA) and Azizia (Libya) have recorded temperatures higher than 50°C. The clear skies and low humidity also allow for high diurnal and annual ranges of temperature. This is more so in sandy deserts than rocky deserts. Hot, dry winds, such as the *khamsin* in Egypt and the *sirocco* in northern Africa, blow sand across the desert, making conditions even more difficult.

As already mentioned, a desert is characterised by low humidity and precipitation. Coastal areas may have higher humidity, but in the inland parts of the desert relative humidity is around 25% during the day. Humidity may be further reduced when dry winds begin to blow.

Precipitation is not only low, it is also erratic. Average precipitation figures have little meaning as several years of no rainfall may be suddenly followed by heavy rain in one year. Rain, when it comes, is in the form of short, violent showers, which may result in flash floods. Lighter showers are ineffective, as

the moisture they bring evaporates in no time. The Atacama Desert in northern Chile in South America is the driest place in the world. Some weather stations in this desert have never recorded any rain.

Mists are common in the coastal parts of deserts like the Atacama and the Kalahari. The fog that forms over the ocean is blown inland by the wind. Moisture from fog drip is sufficient to support a vegetation cover on the coastal hills.

### **5.3.2 Soil**

Desert soils form under arid conditions. In the absence of water, leaching plays a limited role in soil formation. As a result, soils are rich in soluble mineral nutrients, sometimes excessively so. Soil horizons too are poorly developed. Soils are deficient in organic matter owing to the lack of vegetation. The absence of organic matter makes the soils pale in colour, pale grey and pale red being common colours. Sometimes a layer of calcium carbonate, or some other soluble salt, forms on or close to the surface.

Despite this, soils are quite fertile and a range of crops are produced wherever irrigation is available. The Nile Valley in Egypt, the Imperial Valley in USA, and the Indus Valley in Pakistan are agriculturally productive but the soils need careful management as they are vulnerable to salt build-up and water logging.

### **5.3.3 Flora and Fauna**

Harsh conditions notwithstanding, most parts of the desert show an amazing capacity to support life. Deserts display an unexpectedly large amount of biodiversity, with plants and animals showing interesting ways of adapting to lack of water and extreme temperatures. The amount and type of vegetation varies from desert to desert, with North American deserts supporting more vegetation than Asian deserts.

The only parts of the desert that are devoid of life are the areas of shifting sand dunes. A continuous vegetation cover is absent, plants are scattered, and shrubs are the dominant form of vegetation, especially in Asia and Africa. Plants are usually low in height, although the Saguaro cactus in the Sonoran Desert is almost tree-like in height. Most plants are **xerophytes** that can survive with very little water and can withstand long periods of drought. There are some **halophytes** (salt tolerant plants) too. Some xerophytes have deep tap roots that allow them to make use of groundwater reserves. Others develop a network of lateral roots that spread horizontally to make use of soil moisture from a large area. Some body parts, like the stems and roots, of some plants are modified to store water, while others have thick bark, small and waxy leaves to reduce losses from evapotranspiration. Plants may bear sharp spines, or may be strongly scented to protect themselves from grazers. Others camouflage themselves to resemble stones or dung in order to avoid being eaten by animals. In the very dry parts of the desert seeds can lie dormant for years and then suddenly spring to life after a shower of rain. These ephemeral plants can complete their life cycles at incredible speeds.

Below given figure depicts various types of plant species found in the desert (Fig. 5.2).

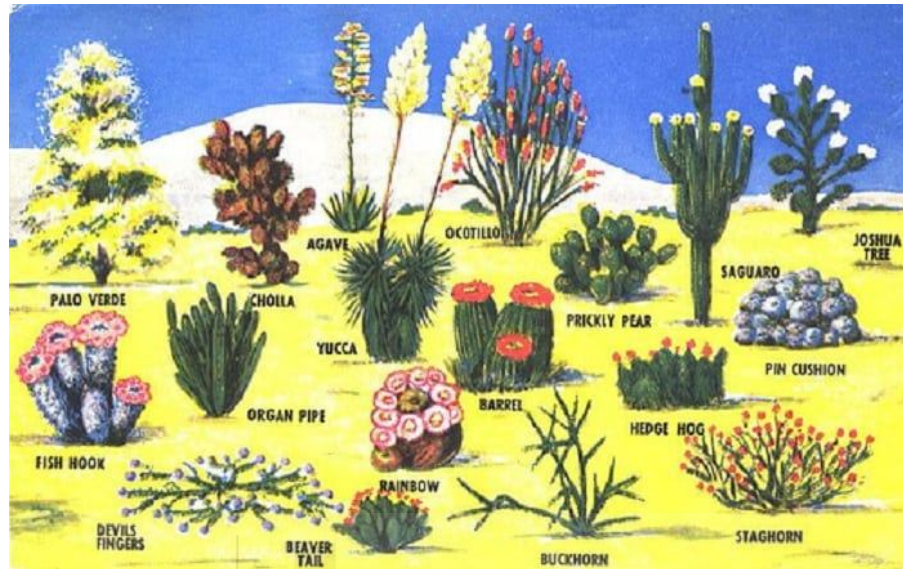


Fig. 5.2: Major Plant species found in the Hot Deserts of the world

Animals living in the desert show a similar range of adaptation. Only a few large animals, such as the ibex, oryx, foxes, jackals, wild asses and the camel, are found here. Most of them live in the margins of the desert. The camel is a large mammal very well adapted to survive in deserts. Famous as the 'ship of the desert', it was vital to the survival of several desert dwelling communities, as we shall see later. The other animals are mostly smaller in size. They include rats, lizards, snakes, spiders and scorpions. Most of them are nocturnal, which enables them to avoid the high daytime temperatures. Animals like the kangaroo rat and pocket mouse can survive without drinking water as they can meet their water requirements from the food they eat. The light coloured bodies of animals in the desert reflect sunlight. Moisture loss is reduced by the absence of sweat glands in the body, and dry excrement. Multitudes of insects can be found in the brief period of plant growth.

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## SAQ 2

What are the major characteristics of the climate of a desert?

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## 5.4 SOURCES OF WATER IN A DESERT

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As discussed in the section 5.2, loss of water from evapotranspiration in a desert is more than the amount of water received in the form of precipitation. As a result of which there is no surplus water. Without a moisture surplus, the desert itself cannot support perennial rivers. Yet there are other possible sources of water. A permanent source of water in a desert and the vegetated area around it is known as an **oasis**. An **exotic river** has its source in a rainy area beyond the margins of the desert. The volume of water that flows in them is so large that they can carry it across the desert. Examples of such

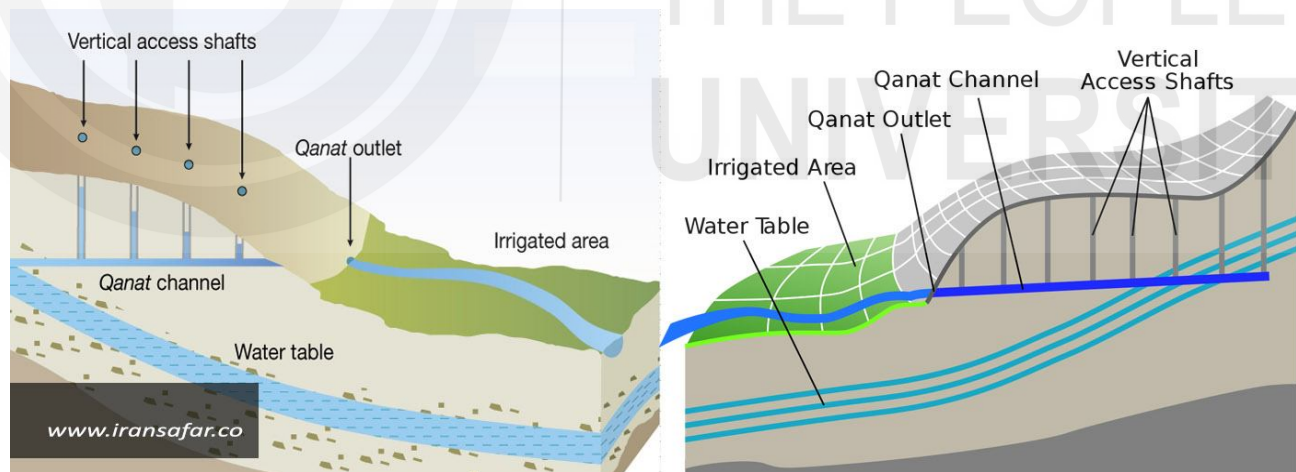


rivers are the Nile in Egypt, the Tigris and the Euphrates in Iraq, the Indus in Pakistan and the Colorado in the Imperial Valley in the USA. These are very large rivers but there are many smaller rivers that flow through deserts in other parts of the world. People living in the desert have utilised their water from ancient times. For example, the Nile supported the Egyptian civilisation while the Indus supported the Harappan civilisation. Can you name some other similar kind of civilizations and associated rivers?

Also found in the desert are channels that are dry except in the rainy season. Such channels are called **wadis** in Arabic speaking countries. Although the channel is dry on the surface, water is available below the surface. This water can be accessed with the help of wells. In some places **natural springs** may provide water. As in the case of exotic rivers, the source of water in natural springs too lies outside the desert.

In certain geological formations, water may be available from **artesian wells**. This happens when a layer of pervious rock lies between two layers of impervious rock. If the pervious layer is exposed in an area which receives enough rainfall, it may be filled with water. Natural pressure may force the water to rise up in a well bored into it at a lower level.

Apart from these natural sources of water, communities living in deserts have devised various innovative means of obtaining a permanent supply of water. The **qanat** or **kariz** is an example of an indigenous system of transporting water common in South West Asia, especially Iran (Refer Fig. 5.3). In this system water is transported by gravity through underground tunnels from alluvial aquifers to an agricultural settlement. The water thus brought to the villages is shared through a system of community management which ensures that the distribution is equitable and its use is sustainable.



**Fig. 5.3: Structure of a Qanat or Kariz**

Today, many countries in the region are obtaining a part of their supply of water from the sea. For example, nearly all of Dubai's water supply comes from desalination plants that remove salt from seawater and make it fit for domestic and commercial use.



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### SAQ 3

1. Fill in the blanks with suitable words.

- (i) A permanent source of water in a desert and the vegetated area around it is known as an \_\_\_\_\_.
  - (ii) Channels that are dry except in the rainy season are called \_\_\_\_\_ in Arabic speaking countries.
  - (iii) \_\_\_\_\_ is an example of an indigenous system of transporting water common in South West Asia, especially Iran
- 

## 5.5 HUMAN-ENVIRONMENT RELATIONSHIPS IN THE DESERT

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Deserts are sparsely populated for reasons that are not hard to understand. There are extensive stretches where there are no permanent settlements. Yet human beings have lived in other parts of the desert for centuries. As noted earlier, ancient civilisations flourished in the desert and large settlements developed around oases. Where permanent sources of water were not available, humans adopted a nomadic lifestyle. Even today, communities living in the desert show varying forms of social and economic organisation and live in different stages of technological development.

### 5.5.1 Nomadic Hunters

The simplest forms of social and cultural organisation are found among the nomadic hunters. They are the oldest inhabitants of the lands they occupy. Very few examples of these communities survive today, and those that do have been pushed to the most inhospitable parts by people belonging to more powerful groups.

The **San** are an excellent example of one such group. Also known as Bushmen (a term considered derogatory today) the San are the indigenous people of southern Africa, having lived here for thousands of years. They are found in Botswana, Namibia and South Africa, and are around 100000 in number. They live in migratory groups, each of which has about 50 members. They have an excellent understanding of the flora and fauna of the land they live in. They are aware of the nutritional, medical, recreational and lethal properties of local plants. They are also skilled trackers and hunters, trapping and hunting animals for food. They dig pitfalls near waterholes and cover them carefully in order to trap animals that come to drink water. More commonly, they hunt animals using poison-tipped reed arrows and wooden clubs. They also eat lizards, snakes, frogs, worms and ant eggs. Wooden sticks are used to dig holes in the sand to find water. Sometimes they also squeeze water from succulent roots. While moving from place to place in pursuit of animals, they carry water in ostrich egg shells. Since it is not possible to store food they eat well when food is available and starve when it is not.

Being constantly on the move, they do not have many possessions, nor do they build elaborate shelters. They live in caves, under rocky overhangs or in crude huts made by sticking a few branches in the ground and covering them with animal skin and grass. Their clothing is similarly made from animal skin. Domestication of animals and cultivation of plants are not practised by them.

Contact with other cultural groups, both African and European, has played havoc with their way of life. Their traditional weapons were useless against these groups and they were soon driven away from their land. New diseases led to a decline in their population. European hunters destroyed the herds of animals which were the source of their food.

The traditional lifestyle of the San is looked down upon and they are encouraged to take up farming, a skill that they do not possess. Governments have relocated them under the pretext of preserving wildlife and ecosystems. However, many suspect that the real reason for the relocation may be the mineral resources of the land that they lived in.

The **Bindibus** living in the Australian desert have a similar lifestyle. They do not cultivate land or raise animals. The only animal they have domesticated is the Dingo, a wild dog. The Bindibus are hunters and gatherers, and the Dingo assists them in tracking and running down animals like kangaroos and rabbits. They use few implements like digging sticks, grinding stones, spears and the boomerang. Their tools and weapons are made of stone and wood as metallurgy and pottery making are unknown to them.

### **5.5.2 Nomadic Herders**

Pastoral nomadism emerged soon after humans learnt to domesticate animals, and is common in the deserts of North Africa and West Asia, where the rainfall produces wild fodder scattered in patches that can temporarily support small groups of herders. A livestock economy revolves around the care of animals, and is a little more advanced than that of the hunters and gatherers. Herders move from one waterhole to the next with their flocks of sheep and goats and herds of asses and camels. Camels largely serve as beasts of burden. They live on the margins of the desert which are wetter, venturing into the desert only when conditions are favourable. They follow well-defined routes along which pastures and sources of water are known to be available. Regular routes also help in avoiding clashes between different nomadic groups. Some herders practice transhumance, migrating from lower elevations in winter to uplands in summer. The wealthier among them may own agricultural land along the route. The animals graze on the stubble in autumn, adding manure to the fields. In keeping with their nomadic lifestyles, they have few possessions, which are easily portable. Their thick, loose garments protect them from heat and cold, as well as from the strong, dust-laden winds.

Animals provide herders with milk, cheese and meat for food. The hide and leather obtained from their skin are used to make items of clothing, tents, footwear and water bags. The hair and wool become raw material for cloth, mats, ropes, rugs and carpets. Surplus products are traded with merchants and cultivators to obtain food grains, dates, medicines and manufactured

products like utensils and weapons. In order to minimise risk, nomadic herders also hunt and gather, and whenever possible, grow crops and work for wages. Examples of nomadic herders are the **Bedouins** of Arabia, the **Tuaregs** of Western Sahara, the **Bishari** of north east Africa and the **Kurds** of Iraq, Iran, Turkey and Syria.

For thousands of years these lands have been able to support nomadic communities as the seasonal rotation of pastures allowed them to maintain their fertility and resilience. In the past few decades however, rising human and animal populations, and pressure from competing land use has led to the degradation of land and threatened the nomadic lifestyles that they supported. Governments too are encouraging the sedentarisation of nomadic groups and generally neglect pastoral communities. As a result, their traditional importance is being lost and meat is now being imported from other countries, like Australia. Migration along traditional routes has been disrupted by the creation of international boundaries, many of them imposed without regard for the traditional culture of the area.

### **5.5.3 Caravan Traders**

Caravan traders constitute another nomadic group in the desert. They are merchants who travel across the desert, carrying a range of goods for sale or exchange. Needless to say, their business involves a huge amount of risk. Traditionally, they relied heavily on the camel, known as the “ship of the desert”, as it is extremely well adapted to surviving in the desert. It can carry large loads and cover long distances and go without food and water for long stretches of time. Not only that, it can also provide milk and meat, while its hair can be woven into rugs and carpets. These rugs and carpets can be traded, along with articles made from camel hide. However, the development of modern means of mechanised transport has reduced the role of the camel.

### **5.5.4 Settled Cultivators**

Settled agriculture is possible only where a permanent source of water is available. Farmers have practised agriculture along the Nile valley in Egypt for more than 5000 years. They devised a system of using floodwaters for irrigation by storing the overflow from the Nile in shallow basins that were bounded by raised banks. This water could be stored for more than a month and was lifted into narrow canals with the help of water-lifting devices, such as the **shaduf** and the **noria**, that were powered by animals and human beings. The canals directed the water to the fields where rice and cotton were grown in summer, and wheat, barley, beans and other crops were produced in winter. Palm trees were also grown, and almost every part of these trees was used in one way or another. Farmers also kept a few domestic animals, mostly cattle, oxen, mules and donkeys. They provided food, while also helping in agriculture and transportation. However, the number of farm animals was small, as little land could be spared for growing fodder. The floodwaters also enriched the soil with nutrients, so that the fertility of the soils was maintained.

Irrigated agriculture was also carried out along other rivers such as the Tigris and the Euphrates. In the absence of rivers irrigation was provided with the

help of underground tunnels, or qanats, described in an earlier section. Oases also provided water for irrigation, but the effort required to raise water was so great that their use was limited in the past. The availability of pumps in recent times has greatly facilitated its use.

The construction of dams and extensive networks of canals has changed the desert landscape in many areas. Better control over the supply of water has enabled modern farmers to cultivate two, and even three, crops every year, instead of just a single one. The Aswan dam on the Nile in Egypt has brought more than 400000 hectares of desert land under cultivation. Dams on the Indus in Pakistan, the Tigris and the Euphrates in Iraq, Syria and Turkey, and the Colorado in the USA have similarly transformed life in many parts of the desert. However, the development of canal irrigation has brought along its own set of problems. The natural fertilisation provided by the floodwaters along the Nile is no longer available, as the Aswan Dam has controlled floods. More than a hundred million dollars have to be spent in adding chemical fertilisers to the soil. Salts also build up in the soil as the rate of evaporation is very high, and additional costs are incurred in flushing them out. Water logging and increased moisture in the soil has also brought in diseases like schistosomiasis.

### **5.5.5 Mining Settlers**

Mineral wealth has attracted people to the harshest of environments. In the desert too, settlements have come up wherever minerals have been found. The discovery of gold brought settlers to Karlgoolie and Coolgardie, located on the edge of the Australian desert, in the late nineteenth century. Similarly, the presence of diamonds and copper has led to a rush of miners into the Kalahari desert (to the detriment of its San inhabitants). The discovery of silver in Mexico, uranium in Utah in the USA, has changed the ecology and landscape of the desert. The biggest transformation, however, came with the discovery of oil in the Arabian and Saharan desert. New cities have emerged in the area to cater to the needs of the oil industry, from drilling, to refining and transporting.

### **5.5.6 Urban Dwellers**

Cities began to emerge in the desert regions of Asia and Africa more than 5000 years ago. Most of them were located on the margins of deserts rather than in the centre of them. Cities such as Cairo, Damascus and Baghdad served as centres of administration, education, religion, commercial activity and transportation, and continue to do so even today. Mecca and Medina are Islam's holiest cities. City dwellers provided valuable goods and services to fellow residents and other inhabitants of the desert, namely the nomads and the rural folk. The cities had beautiful palaces and other impressive structures that inspired awe. The structure of the old cities changed under the influence of colonialism. In the past few decades, oil wealth in West Asia and North Africa has led to the founding of new cities and the transformation of older ones. Dubai, for instance, is a desert city known for its glitz and glamour, attracting tourists from all over the world. Tourists also flock to cities like Las Vegas in the USA, a city famous for its casinos and golf courses.

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## SAQ 4

- a. Name some groups of nomadic hunters and briefly discuss their lifestyle.
  - b. Discuss how agriculture was traditionally carried out in the desert.
- 

## 5.6 ENVIRONMENTAL PROBLEMS IN THE REGION

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As we have seen in the previous section, people have lived in the deserts from the oldest times. They adopted various lifestyles for survival, depending on the specific conditions of the area they inhabited. The human-environment relationship has not always been harmonious in all parts, and there is evidence of settlements having to be abandoned due to drying up of water sources. In fact the decline of certain civilisations is attributed to decline in land productivity due to both natural and human factors. Desert ecosystems are extremely fragile, and even the smallest disturbances can cause irreversible damage. Recovery time is long as the vegetation grows at an extremely slow rate. Increase in human and animal population in the region, coupled with a rise in living standards and change in technology, is creating tremendous pressure on resources and resulting in several environmental problems. The construction of large dams and the introduction of canal irrigation, for instance has caused problems of water logging, and the introduction of new diseases. Some of the major problems are discussed in this section. Certain other problems, like the impact of oil and gas production, the dumping of nuclear waste in deserts and their use as nuclear testing grounds and damage to the thin topsoil by the movement of heavy vehicles, are also serious, but they have been left out of this discussion.

### 5.6.1 Desertification

The term desertification was at one time used to refer to the march of the desert into neighbouring areas. Today it is used more broadly to include a number of processes which lead to a decline in the productive potential of land in arid and semi-arid areas. This happens largely as a result of human activity, although natural factors like climate change may also be responsible for it. Desertification is said to be moderate if reduction in productivity is between 10% and 25%, severe if it is between 25% and 50%, and very severe if it is more than 50%. Gullies and sand dunes may become visible in the case of very severe desertification. Desertification is a serious global problem that affects more than a billion people across the world, especially in the cattle rearing areas in semi arid and arid parts of sub-Saharan Africa, Middle East and West Asia. It usually begins when the natural vegetation in an area is partially or completely removed (to make way for agriculture or to find fuel wood), increasing the proportion of bare ground. This leads to several changes in soil, like reduction in organic content, decline in capacity for water retention, and loss of structure, which lower its fertility. Reduced fertility results in a further reduction in vegetative cover, increasing vulnerability to erosion by wind and water. Eventually the character of the land may change to such an extent that the local climate is changed due to changes in the albedo and energy budget. Overgrazing, over-cultivation, deforestation,

surface mining without land reclamation, faulty irrigation techniques, and use of heavy farm machinery are some of the human activities that contribute to desertification.

Desertification affects a large number of people, and a lot of research is being done to find ways of halting, and even reversing the process. Monitoring to detect early signs, creating awareness and educating and training people in more sustainable ways of resource utilisation are important steps being undertaken. It may interest you to know that a **Great Green Wall** movement was started in the Sahel region along the southern edge of the Sahara to combat the problem of desertification. Initiated in 2007, this movement plans an 8000 km line of trees bordering the Sahara in the south. It is hoped that this will not only check the southward march of the desert, but also transform lives in one of the poorest region of the world.

### **5.6.2 Salinisation**

All soils contain some salts and the salt content of the soil is known as its salinity. An increase in the concentration of salts in soil is called salinisation. Salinisation is a problem faced in many irrigated areas, especially where evaporation rates are high. All the water applied to the fields is not absorbed by plants. Much of the water evaporates directly from the soil, leaving the salts behind. Accumulation of soluble salts of sodium, magnesium and calcium in soil takes place to such an extent that soil fertility is adversely affected. The presence of salty ground water may also contribute to the problem. When the fields are flooded by irrigation water without proper drainage, the water table is raised and the salty underground water reaches the upper layers of the soil. When it evaporates, it leaves a deposit of salt in the surface layer of soil, which is sometimes visible as a white crust. More scientific methods of irrigation can go a long way in checking this problem, while helping in conserving water at the same time.

### **5.6.3 Problems Related to Climate Change**

There is now sufficient evidence to indicate that global climate change will lead to rise in temperatures and irregular precipitation in all parts of the world. Higher temperatures will in turn lead to higher rates of evapotranspiration, and therefore, drier conditions, which can prove disastrous in the already water-stressed arid regions. Droughts are a regular feature of dry land climates, and their intensity and frequency are predicted to increase. This will severely impact food security, ecosystem and human health and economic growth in these regions. The sub-Saharan region, where about 23% of the people are already undernourished, is likely to be the worst affected as the nexus between climate change, agriculture and poverty makes conditions even worse.

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## **SAQ 5**

What are the major reasons for the emergence of environmental problems in these regions?

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## 5.7 SUMMARY

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In this unit you have studied:

- How human beings adapt to their environment, particularly in hot desert regions?
- The common characteristic of all deserts is the scanty precipitation, which may be due to their location in high pressure belts, in inland areas, in rain shadow areas, or their proximity to cold ocean currents.
- The climate is characterised by high temperatures, clear skies, dust laden winds, and low rainfall.
- Plants and animals living in the area show amazing adaptation to these harsh conditions.
- Human beings too have lived in deserts for centuries, displaying a range of food habits, clothing and economic activity suited to the specific environmental conditions in the parts they inhabit.
- However, increase in population and the introduction of new technology have created pressure on the scarce resources of the region, and several environmental problems have emerged in recent decades.

## 5.8 TERMINAL QUESTIONS

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1. Describe in brief bio-physical environment of desert.
2. Explain how human beings have adapted to the physical conditions found in deserts.
3. Discuss the major problems resulting from the human-environment interaction in deserts.

## 5.9 ANSWERS

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### Self-Assessment Questions (SAQ)

1. A desert is an arid area where evapotranspiration is higher than precipitation. Deserts are located in the trade wind belt, in high pressure belts where air tends to descend, on the lee side of mountains, in the interiors of continents, and in coastal areas adjacent to cold currents.
2. Desserts are characterised by high daytime temperatures, low humidity, and clear skies. They experience great range of temperature, low and erratic precipitation, and hot and dry winds.
3. (i) oasis; (ii) wadis; (iii) Qanat or Kariz
4. a. The San of the Kalahari and the Bindibus of Australia are examples of nomadic hunters in the desert. They live in small migratory groups and

are skilled hunters. They have few possessions and live in simple shelters.

b. Floodwater was traditionally practiced along rivers, especially the Nile. In other places farmers used oasis water or diverted water using qanats. They produced crops like rice, wheat, cotton and barley. They also kept a few animals.

5. Environmental problems in this region are mainly because of the increase in human and animal population, and the introduction of new technology.

### **Terminal Questions**

1. Your answer should include brief description about physical conditions namely climate and soil and biological features namely plants and animals. For detail please refer to section 5.3.
2. You must discuss how hunters, herders, agriculturists, traders and city dwellers have adapted to life in the desert. For details refer to section 5.4.
3. Your answer must discuss how increase in population and the introduction of new technology have created environmental problems in the region. Discuss problems related to salination, desertification and threats from climate change. For details refer to section 5.6.

### **5.10 REFERENCES/SUGGESTED FURTHER READING**

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# MOUNTAINOUS REGIONS

## Structure

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|--|---|
| 6.1 Introduction<br>Expected Learning Outcomes | 6.7 Human-environment<br>relationships in the mountain<br>regions |
| 6.2 Geographical Location and<br>Distribution  | 6.8 Environmental Problems in the<br>Mountainous Region           |
| 6.3 Climate                                    | 6.9 Summary   |
| 6.4 Soil                                       | 6.10 Terminal Questions   |
| 6.5 Flora                                      | 6.11 Answers  |
| 6.6 Fauna                                      | 6.12 References/Suggested Further<br>Reading                      |

## 6.1 INTRODUCTION

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In previous units 4 and 5, you have learnt about the equatorial and desert regions of the world. You came to know about the important features of these two major geographical regions along with their an exposure on the type of juxtaposition of human-environment relationships and their spatial variations across the different regions of the planet earth. These two units of Block 2 made you learn that the environment of a region exerts a dominant impact on the human beings and their range of economic activities. In this Unit 6, you will explore that mountainous regions are high altitude areas above the mean sea level on the surface of the earth. The physical element of elevation manifests into the localized interferences with the elements of weather and climate, drainage, soil, flora and fauna. Mountainous areas of the world constitute very important second order landforms while the continents are the first order landforms. Mountains make up nearly one-fifth land area of the entire world and support millions of people living there in relative isolation in dispersed settlements. Nearly half of the world's population depends on mountainous areas for their basic needs. It includes the availability of water, food, fuel wood and timber, grazing grounds, mineral resources, herbs and

medicinal plants, hydroelectricity, recreational activities and tourism. All over the world, these mountainous regions are known for their complex environments and unique bio-geographical niches. Usually, mountainous regions are characterized by undulating terrain, specific set of natural and cultural resources, diversified ecological zones showing the effect of altitude, and greater degree of biological diversity and human cultural ingenuity to cope with the forces of nature in a harmonious manner. Mountainous regions entail one more specific characteristic as they are also unique entities on multiple aspects such as social, cultural, economic and political as well. Mountains are considered identical to borderlands all across the world. Other than mountains, another physical entity which is taken as a natural point for political divisions is river to demarcate the boundary between two political entities. A mountain serves as boundary between different cultural groups but also houses certain distinctive cultural groups which are known for preserving their centuries old cultural values and norms.

Besides serene, scenic, natural and cultural landscapes harmoniously juxtaposed on one another, you also know that mountainous regions of the world are considered as a natural repository of freshwater stored in innumerable glaciers and reservoirs, mineral resources, herbs and medicinal plants, natural vegetation and faunal diversities. Many human societies worship the mountains all across the mountainous countries of the world. Some prominent mountain groups are American Indians, Himalayan tribes of India, Chinese and Incas etc. Two of the important natural factors namely altitude and latitude together invariably control the life and livelihood of the people and the nature of their environment. You will further learn the way life of human beings are closely interwoven with their environment keeping in mind the opportunities and challenges, its specificities and constraints etc. which mountainous regions offer to its inhabitants. A mountain is simply defined as any natural elevation existing on the earth's surface having a summit smaller in proportion to its base, which may rise more or less abruptly from the surrounding level. There are several criteria for delimiting a mountainous region in different countries of the world. You will study the manifestation of environment on human beings in their all walks of life like socio-cultural, religious, economic and political etc. in the mountainous regions of the world.

This unit is organized into various sections dealing with different physical and human aspects of the mountainous regions of the world. You will study about the geographical location and distribution of the mountain region from Section 6.2. This will enable you to find, identify and locate the distribution of mountain regions on a world map. In the next Sections 6.3 and 6.4, you will get an idea about the climate and soil conditions prevailing in the mountain regions of the world. This insight will greatly help you to understand the floral and faunal diversity of the mountain regions discussed in Sections 6.5 and 6.6. The study of locational aspects along with physical parameters will definitely help you to envisage the kind of human-environment relationship and comprehend the nature and types of opportunities, challenges and constraints of mountain regions in

Sec. 6.7. In Sec. 6.8, you will learn about the spatial and non-spatial factors which are responsible for generating major environmental problems being faced by the mountain communities and societies coinciding with the rise and spread of global economic forces. You will be able to learn about the set of opportunities, specificities and constraints which characterizes the interplay between humans and its environment in mountain regions of the world.

## Expected Learning Outcomes

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After completing the study of this unit, you should be able to:

- state the geographical distribution and location of the mountain regions;
- describe the climatic conditions and nature of soil of the mountain regions;
- describe the floral and faunal characteristics of the mountain regions;
- highlight the nature of human-environment relationship in the mountain regions; and
- explain major environmental problems of the mountainous regions of the world.

## 6.2 GEOGRAPHICAL LOCATION AND DISTRIBUTION

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The mountainous regions of the World are one of the major geomorphological units found on continents on the face of the planet Earth, other being the oceans. The continents can be grouped into two diverse classes; first one is the extensive, flat and relatively stable piece of landmass which have been eroded close to sea level and second one covers the uplifted portions owing to tectonic activity typically characterized with deformation of crustal rocks which led to the development of mountain belts as it exists in present-day world. The characteristic feature of a mountain region is its altitude above the mean sea level. Generally, mountainous regions are situated in the margins and interior parts of the continents across the globe on both sides of the equator. Within the continents where mountainous regions are situated, one of the most characteristic topographic features is the linear arrangements of its mountain belts. We may surmise that the mountainous regions may be randomly distributed on the face of the planet earth. However, in reality, such is not the case. These are mainly located in two major zones as far as their age (having less than 100 million years old) is concerned. First major zone extends into the circum-pacific belt comprising the region surrounded by the Pacific Ocean. It includes the mountainous regions of western Americas and further extends into the western Pacific Ocean emerging in the form of volcanic island arcs. These are of volcanic origin having largely made up of volcanic rocks as well as deformed sedimentary rocks of volcanic origin. Some of the prominent examples are Aleutian Islands, New Guinea, Japan, Andaman and Nicobar Islands and Philippines etc. Second major mountainous zone extends eastwards from the

European Alp Mountain ranges running through Iran and then extends further east into the Himalayas in Asia. From here, it eventually dips towards the south and culminates into the island nation of Indonesia. This mountainous zone is made up as a result of mountain building process where thick sequence of rock strata were intensely squeezed and got highly deformed characterized by the sequence of faulting and folding activities. Besides, older mountain chains can also be found in the first major landforms i.e., continents. The major examples are Appalachians in the eastern parts of United States and Urals mountain in Russia. Their summits are now worn down by the twin processes of weathering and erosion over a long span of time. In many places, the way spatial interaction takes place between humans and their environment is closely determined by the knowledge, attitude and given level of resources and technology etc. In the world, the largest and highest area of mountain land is found in the Himalayan-Tibetan Massif region. And, the longest approximately continuous series of mountain range is found along the west coast of the Americas. It spans from Alaska in the North America to Chile in the South America. Some more prominent mountain regions encompass European mountain chains (Alps, Pyrenees), Asian mountain chains (Caucasus, Urals), and New Guinea, New Zealand, and East African mountain chains besides many other lesser significant mountain chains found on the earth's surface. You may visualize the geographical location and distribution of the mountain regions depicted in Fig 6.1 below.



**Fig. 6.1: Map showing the geographical location and distribution of the mountain regions of the world.**

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### **SAQ 1**

Describe the geographical location and distribution of the mountain regions of the world?

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## 6.3 CLIMATE

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Many of you are aware of the fact that location of a given place on globe invariably governs and determines the climate or weather conditions of that region. The climate is considered as a fundamental natural constituent that helps to sustain and nurture any kind of natural environment be it mountain, desert, coastal or plain environment. Owing to the factors of diverse terrain and variable nature of energy and available moisture content, mountain areas are generally characterized by climatic contrasts within a span of one kilometer or even lesser distance. If you have had done a trekking in a mountainous area, you might have experienced such contrasts while ascending and descending a mountain or a summit. On this basis, will you be able to tell us and highlight the climatic conditions that prevail in the mountain regions of the world? Is it identical or are there spatial variations across the mountain regions in different latitudes and altitudes? Are there any other factors which govern the climate of a region in such places etc.? Such kind of questions along with many other queries may crawl into your cognitive faculty. Mountain regions are magnificent features on the face of the earth characterized by the sharp rise from the surrounding territory, generally taken as 300 metres above mean sea level globally with some variations depending upon the location of a particular mountain region. The geographic regions having a lesser elevations than this are known as hills. Such enormously high rising arrangement of mountains not only influences the climate of a surrounding area but also affects the wind patterns and distribution of precipitation. From this discussion, we can guess that the height of the mountain ranges may have led to striking alterations in the climate of a region. Such changes have not only led to the significant transformations of the surrounding physical landscape but also vastly influenced the type as well as suitability of natural habitats for their living organisms .

As the mountain regions which are situated far away from the equator experience moderate sunshine hours. It gives birth to the prevalence of moderate temperature conditions during short summer months and low to very low temperature conditions in winter months. You know that temperature decreases at a rate of approximately 6.5 degree Celsius per 1000 metres of elevation.. Other factors which govern the temperature values are sun-drenched and shady portions in the mountain slopes. The southern parts of the mountain slopes receive ample amount of sun's energy as compared to northern parts in the northern hemisphere. The amount of solar radiation received on the face of the earth's surface increases directly in proportion to the altitude of the mountains. The diurnal range of temperature also remains high due to the differential heating and cooling effect of the mountains. The values of temperature as well as crop growing season in one agricultural year consequently declines with rising altitude. In higher climates of the Himalayan Mountains, the farmers are able to grow and reap only a single crop in one agricultural year due to harsh environmental conditions. Mountains receive more precipitation as opposed to lowlands in the form of snow during the winter months. This stored water is used during the brief

summer months to grow the crops channelized through gravity channels known as 'Kuhls' in Kullu and Lahaul area of western Himalayas. Further, mountain regions are characterized by the seasonal and diurnal variation in temperature to a considerable extent. Temperature values seldom exceed 30 degree Celsius during peak summer months in different locations of the Himalayan ranges and it plummets below minus 30 degree Celsius in some parts of the mountain regions in a year. The mean monthly and mean annual temperature of the mountain region remains approximately 15° C.

The mornings in the mountainous regions remains cool and moderate. Due to its location, orographic rainfall is common. Thus, the region experiences precipitation mainly in the form of snowfall during long winter months. The annual precipitation is around 989 milimetres in some parts of the mountainous regions in Himalayas.

## **6.4 SOIL**

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The soil of mountain regions is characterized by typical conditions unlike other geographical regions. The rugged topography, cold climatic conditions and other factors puts serious impediments on the proper development of soil horizon. The soil profile is not fully developed except on the river terraces or in similar geomorphological units like that of a plateau or plain region. Here, the soil profile is often characterized by skeletal soil cover, stony character, thinness and immature mountain soil. It further varies with the altitudinal variations across the different segments of mountain regions. It is characterized by stony clay with thin soil cover. There is a difference in the soil cover between low lying portions near the river terraces and higher areas in the mountain uplands or highlands. The prevalence of near sub-zero temperature values for a significant portion of the year coupled with heavy snowfall often triggers the process of mechanical weathering in the mountainous regions. The soils of the mountain regions are stony clay having very poor mineral content. The soils are highly acidic in nature, which retards the growth of plants as roots cannot absorb the required nutrients from the soil. The intense and heavy snowfall in the region also damages the top soil layer more prominently as opposed to other geographical region. In this manner, the soil profile generally remains devoid of the much required soil nutrients for the plant growth.

You may be well aware about the fact that the good soil cover or soil profile offers the most suitably required ideal conditions for any growth and sustenance of vegetation cover in any geographical region across the globe. You will study the flora or vegetation cover in the next section.

## **6.5 FLORA**

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In the preceding section, you have already learnt about the climatic conditions of the mountainous regions. The low temperature and scanty to moderate rainfall in

the mountainous region allows the growth of rich and varied vegetative cover and few of which are medicinally valuable. The characteristic feature of the flora of this area can be summarized as under:

### **Natural Vegetation**

One of most common and conspicuous feature that characterizes the natural vegetation is altitudinal zonation in the mountain regions. A clearly striking feature is the change in the type of vegetation with the increasing altitude. However, initially, the vegetation cover may resemble with that of a low-lying surrounding regions. The vegetation and climate belt changes with increasing altitude in a similar way as it changes from equator towards poles on a globe in mountainous regions of the world. The altitude of both snowline and treeline often shows an increase towards the mountainous regions of the equatorial areas. However, the location of mountains near the equatorial regions are greatly influenced and affected by the many physical and other factors comprising wind system, exposure to sun shine, moisture content, evaporation rate and snow depth etc. The mountain areas found in the temperate latitudes are commonly grass producing regions having two distinct zones. First one is located near the village boundaries mostly at valley bottoms and second one is located at the higher reaches as alpine pastures particularly in Alps and Himalayans and similar mountainous regions. If you happen to be a mountain resident or have visited the mountainous regions, then you may have noticed the diverse types of natural vegetation changing with the increasing altitude. In the higher altitudinal areas, especially in the cold desert regions like in some Himalayan valleys (Ladakh, Zanskar, Lahaul-Spiti, Manas and Malari etc. of India), the vegetation cover virtually starts disappearing as you keep ascending away from the foothills barring few xerophytic plants like juniper and very few resilient varieties of shrubs having medicinal values. Owing to altitudinal gradient and prevalence of varied climatic conditions, the mountainous region supports diverse types of natural vegetation. The types of natural vegetation vary with altitude, slope aspects, amount of sunshine and topographical characteristics. The mountainous region is considered as a storehouse of medicinal herbs and plants along with numerous plant species. The diversity of vegetation ranges from xerophytic coniferous forests to temperate evergreen forests. Some of the prominent plant species are pine, cedar, junipers and shrubs such as seabuckthorn (with medicinal properties) etc.

## **6.6 FAUNA**

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The mountainous regions do not only contains diverse variety of natural vegetation but also are home to many faunal species including a few endangered species. The snow leopard, ibex, yak, llama are few large animals which are native to diverse mountainous regions of the world. Mostly, two broad types of faunal life exist in the mountainous regions of the world. First category covers the animals living in the elevation of the natural forests. Second category covers the alpine animals living in the uplands in the mountainous regions with most of the

animals being herbivores. These animals tend to migrate during the onset of winters at the time when grasses dry up due to cold and low temperature to the lower and slightly warmer elevations as like that of transhumance activity in which the Gaddis (Shepherd community), Gujjar of lower shivalik Himalayas and Bakerwals of Jammu region tend to migrate with their animal flocks. The major mountainous ranges of the world are home to many animal species as well as thousands of species of birds.

These animals and birds are of paramount importance both from the sustainability of ecosystem services and well being of the human communities and societies. Hence, all of you will certainly agree with us that the faunal diversities must be preserved.

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## **SAQ 2**

Discuss the major characteristics of climate in mountainous regions of the world.

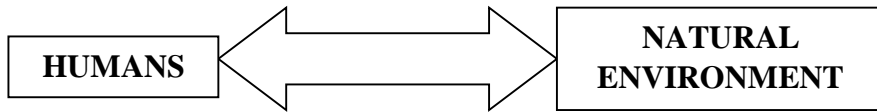
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## **6.7 HUMAN-ENVIRONMENT RELATIONSHIPS IN MOUNTAIN REGION**

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It is of utmost importance the way humans develop their relationships with its immediate environment through a chain of spatial economic activities. Because mountain regions are characterized by fragile and complex topographical or physical characteristics, unlike other regions. It is understood that while deriving a host of services, humans also try to influence the environment and in turn the environment also influences the activities of humans. It is a two-way interaction that takes place between the humans and their environment. Such interaction is determined by the interplay between three factors like knowledge, skill level and set of available technological inputs etc. If we see these factors in plain regions as opposed to that of mountain regions, then we may observe that first two factors may not create a hindrance in both the regions to a considerable extent. However, as far as third factor of technological inputs are concerned, then due to its high altitudinal location, it may create considerable hindrances in the operation at the ground level. Quite often, besides these three factors, the mountain people may also seem to be lagging behind as far as capital input is concerned. Therefore, the human-environment relationships in mountain regions are more complex as compared to other geographical regions. Here, the humans try to modify the environmental constraints with the help of available knowledge, skill and technological inputs and at the same time adapts to the dictates of the environment greatly. It also varies across the altitudinal gradient as well as human communities in the mountain regions as it may vary from one region to another greatly.





**Fig. 6.2: The schematic diagram highlighting the two-way process between humans and their physical environment.**

It is needless to mention that the physical environment of a particular geographical region not only governs but also exerts a direct influence upon the human beings living in that region. In order to survive and carry out spatial economic avocations, the people of that particular geographical region not only try to modify the bounties of nature within the dictates of natural forces, but, also at the same time, try to adapt themselves to the forces of physical environment in one or other ways. One of the classic ways is to suitably modify their agricultural practices. This fact holds more relevance in case of mountainous regions which are characterized by specific resource sets and environmental constraints alike..

### **Agriculture and allied activities**

The pursuit of agriculture and allied activities in its various forms has long been remained one of the major source of livelihood in mountainous regions. In most of the mountainous areas of the World, the different forms of agriculture are still practiced mainly characterized by traditional or indigenous subsistence farming, sedentary and mixed agriculture, pastoralism and agro-forestry etc. However, with the passage of time, at present, it has been gradually transformed into modern forms of agriculture barring few insular locations particularly in parts of developing and underdeveloped countries largely devoid of the inputs of technology and capital with some exceptions. It is notable that due to lack of ample amount of arable land on account of rugged topography, skeletal mountain soil cover, soil erosions, lack of proper irrigation facilities and transportation, the agriculture sector is not well developed in many mountainous regions. However, some notable exceptions can be seen in the few cold desert valleys of Ladakh and Lahaul in India where agriculture is well developed. On the gently sloping areas of mountains, terrace farming is practiced. In some lowland river terraces with milder climate and relatively thicker soil cover, besides growing food grains, temperate fruits (like apple, pear, and plum) and European vegetables and the rajmash (pulse) are also grown both for subsistence as well as commercial purposes. With the passage of time, mechanization of farming techniques is also evident particularly in some lowland areas having relatively flat arable land in localized pockets of agriculturally prosperous valleys in western Himalayas.

Animal husbandry is an integral component of the agriculture in the highlands of mountainous regions of the world. It is an important substitute economic activity other than cultivation of crops, fruits and off-seasonal vegetables. Different kinds of domesticated animals are taken for grazing in the high alpine mountain pasture with the onset of summer months and are grazed on lower valley slopes with the onset of winter months. Two of the most homogenously reared animals

are sheep and goats in the highlands whereas cattle's are mostly reared in the lower areas of the mountainous regions. The rhythm of human life typically revolves with the change in seasons across the mountainous regions of the world.



**Fig. 6.3: Nomadic Herders.**

### **Settlements**

By now, it is certainly a well known fact to all of you that the natural environment of any geographical region influences the human habitation or settlements, economic activities, health and many other socio-cultural pursuits. It is commonly believed that mountains are not suitable geographical locations for human habitation. However, it is not true in reality. Besides harsh environmental constraints and adversities, many of the mountainous regions are suitably inhabited across the globe. Mountains offer variety of natural resources, scenic natural and cultural attractions like snow-clad mountain ranges, waterfalls, temples, forests, alpine pastures and recreational avenues etc. to boost tourism activities. The Ural mountains situated in Eastern Europe is the repository of metallic minerals like iron ore. Cement is extracted from the sedimentary rock strata from some parts of lower Himalayan Mountains. In the Rockies mountain of North America, many economically valuable minerals such as gold, zinc, copper and silver etc. are commercially extracted. Some of the mountain regions are settled as administrative units like that of Shimla in Himachal Pradesh by the Britishers to avoid the intense heat of plains. Many mountains have also provided a refuge to the people who were driven out and rendered homeless during the period of wars, struggles and conflicts. Mountains are known for their closed societies, self-centeredness who likes to preserve their cultural norms and values.

The proximity to mountains not only influences but also has a direct impact on the house types built in different parts of the mountainous regions. The houses

generally used to be built with the locally available natural resources including rocks, sand, soil, timber and wood etc. However, with the passage of time, modern type of houses has now become a common and popular trend. In many areas, an amalgamation or fusion may also be evident in the types of houses built. In the mountainous area of western Himalayas particularly in Kullu valley, a special type of earthquake resistant houses known as '**Katkuni House Structures**' were used to be built completely on the basis of locally available construction materials, which has now almost started vanishing from the region due to the popularity of modern style of architecture brought from the plain regions. Such houses can still be seen in the remote villages of kullu valley and other portions of Himachal Pradesh. This is a special kind of architectural style which is known to withstand the shocks of earthquake (as evident from the devastating massive Kangra Earthquake of 1905), but also offers a unique architecture vista of style superimposed on the cultural landscape to the outside visitors. All across the mountainous regions of the world, houses are generally built on the basis of locally available materials with minor variations therein and natural environment particularly precipitation and temperature exert a direct influence on the same.



**Fig. 6.4: Types of Houses in the Mountainous region.**

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### **SAQ 3**

Highlight the major features of human-environment relationship in the mountain regions?

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## 6.8 ENVIRONMENTAL PROBLEMS IN THE MOUNTAINOUS REGION

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There are many kinds of environmental problems which have cropped up in the recent past directly as a result of the indiscriminate use of natural resources fuelled by the accelerated rate of economic activities. We will broadly try to highlight some of the pertinent issues and problems here in order to sensitize you about these ever-mounting problems of these regions. As you have studied in the previous sections that people are living in the mountainous regions from the time immemorial, people have evolved a suitable mechanisms and adopted standard non-consumerist lifestyles for their survival keeping in mind the specific natural environmental conditions of the area which they inhabited. Initially, before the advent of industrial revolution, this relationship used to be harmonious whereby humans lived in close harmony with the forces of nature. However, soon after the industrial revolution particularly in the last one and half centuries, this symbiotic relationship has started taking a complete u-turn by inducing anthropocentric interferences in the environment. Such disturbances induced due to the global economic forces have completely altered the delicate balance and greatly disturbed the ecological balance of the mountainous regions. Such kind of unhealthy human-environment relationship has led to many problems related with the use, misuse and overuse of natural resources. You may have encountered the range of such problems being faced by the inhabitants of mountainous regions probably through news, social media or other mediums. You are well aware that a mountain ecosystem are tremendously delicate systems and provides range of ecosystem services to the people living in both mountains as well as surrounding low-lying territories. One of the most essential and tangible ecosystem services is the provision of potable water which mountains provide through an extensive network of perennial river systems. Nowadays, with the increase in economic activities like tourism, trade, reckless and haphazard urbanization, solid waste management, air and water pollution, overgrazing, unscientific agricultural practices in consonance with the rise in population growth are taming these river systems all across the world to generate hydro-electric power and irrigation. The morphology of mountain rivers have started suffering a huge toll both in its volume and quality of water. The activity of tourism is also seen to be changing the cultural landscape of the native region and resulting into negative cultural influences. You are well aware that mountain headwaters also form a part of the hydrological cycle which you have learnt in your first semester course. Because of the onslaught by various economic activities, this delicate balance has taken a serious jolt eventually seen to be manifesting into range of human-induced serious problems. Such vast and high intensity spatial changes may cause an irreversible damage to the harmony and fragile ecosystems of the mountain regions in future.

The mountainous regions are very important for human beings both in the mountainous as well as surrounding low-lying regions as it harbours and provides

a variety of natural resources. They greatly help to regulate the local, regional and global climate regime along with hydrological cycle. They provide a range of essential ecosystem services to the people in its different forms. Therefore, mountainous regions hold great importance not only to its inhabitants at local level, but also to many other stakeholders at regional levels. No doubt, the spatial interaction has greatly brought a plethora of modern benefits to the human beings. It has interfered in the natural harmony by inflicting a lot of problems also. Such benefits are not free from serious impediments. Some of the prominent ones are loss and destruction of natural vegetative cover, change in climatic regime, decrease in the amount of snowfall resulting into water shortage due to global warming, melting glaciers and receding snowline have affected the availability of surface water (both for agricultural and drinking purposes with spatial variations therein across the mountainous regions), rising air and water pollution, drying of natural sources of water, solid waste management etc. Such imbalances caused on account of spatial interaction aimed towards holistic development which takes place between man and his environment may eventually disturb the delicate ecological set-up of mountainous regions. This may result into the severe hiccups across a chain of ecological services which originates from the mountainous regions and benefits the populace both in the mountainous regions as well as surrounding plains and other geographical regions. One of the most significant and pressing challenges surrounding the management of the world's water resources are being confronted by the global community in general and mountain communities in particular. The production patterns necessitated by the consumerist behaviors have started endangering our most critical life-providing resources like water through water pollution and over-extraction without thinking about the sustainability in the long-run. Although, the factors of population growth and global climate change have definitely induced a major pressure on such crucial resource systems. However, the most important factors are driven by the social, economic and political forces that necessitate the unsustainable resource utilisation in an overall context in the name of so-called paradigm of modernization and development without judicious utilization of life providing ecosystem services. Some of the major environmental problems are dealt under major sub-heads as under:

**Deforestation:** With the domestication of plants and animals, human beings had started clearing the natural tracts of forests in bulk for meeting the different needs. You know that natural forests play a major role to control and regulate not only the local climatic pattern but also affect the climate of entire world in a cause and effect relationship. They not only provide various ecosystem related services but also harbor a range of natural products which provides a source of livelihood to encapsulated human societies thereby broadly contributing in the economic development of a nation.

The problem of deforestation has emerged as a significant threat to the mountainous regions on account of ever-increasing social, economic, and political needs of human beings in recent past. All across the mountainous

forests of the world, it is happening due to the expansion of agriculture land, overgrazing, expansion of infrastructural facilities like dams for hydroelectric generation, various types of roads and creation of tourist and recreational amenities. One of the key principles of ecology states that a minor disturbance in one part of nature may induce effect in its other parts as well. Sometimes, such disturbances are within the ecological limits (naturally reparable) and sometimes they may cross such limit especially when augmented by the human actions and may invoke a irreparable damage to the entire life providing systems of the planet earth. Similarly, deforestation has also led to the increase in the temperature decrease in the amount of precipitation (both rainfall during summers and snowfall during winters), shifted and pushed the tree line to the higher altitudes, led to glacier recession, water deficit, loss of biodiversity etc. to name a few prominent associated and triggered issues and problems.

**Mining:** This is one of the significant human induced issue in mountainous regions of the world. Mining activity is seen to be apparently inducing a negative impact into the hydrology and ecology of the natural environment. It leads to the damage and deterioration of environment in many ways. The most significant ones are deforestation, disturbance in the geohydrology which leads to the drying up of water sources and thereby acute water deficits both for drinking and agricultural pursuits in mountains (especially where sedimentary rock strata is mined for making cement in Himalayan region), and also the associated air and water pollution. Mining also leaves behind a permanent scar in the beautiful natural landscape which existed prior to the commencement of mining activities.

**Dams for Hydroelectric power generation:** Recently, it has emerged as a source of major environmental problem which is often seen to be triggered by the flash floods. You may remember the recent flash floods in the mountainous states of Uttarakhand, Himachal, Jammu and Kashmir etc. These flash floods have induced massive destruction both to the human lives and infrastructural amenities spanning both upstream and downstream localities in the course of a river. Besides, it has also washed down the fertile tracts of agricultural lands near the upstream sections of river valleys.

**Tourism induced Overcrowding and Traffic Congestion:** It has led to the growth of many associated environmental problems particularly in the hill stations of Himachal Himalayas like Shimla, Kullu-Manali, and Dharamsala etc. Traffic congestion, cultural deterioration, overcrowding during peak tourist seasons, air and water pollution, increasing incidence of littering etc. are some of the common environmental issues and problems cropped up due to the tourism activities. Such problems may also be prevailing in other mountainous states of India and elsewhere.

**Haphazard growth of towns:** Due to the increasing population, globalization induced affluence brought by the secondary and tertiary sectors, the rate of construction has also gone up manifold in the mountains regions. But, in many mountainous areas of the developing countries especially in India, the way towns

are expanding seems to be disastrous in the longer-run keeping in mind the fragile ecological set-up, climate and seismic sensitivity of that region etc. It is leading to the proliferation of many related environmental problems including water shortage, illegal felling of trees for timber, non-compliance of town and country planning norms especially related with the commercial units constructed for tourism purposes, lack of solid waste management practices etc. People are going for the modern ways of construction leaving aside the centuries old sustainable practices both from ecological as well as seismic perspectives.

**Climate Change:** With the advancement of civilizations supported by the scientific and technological prowesses, the rate of climate change has also started accelerating to a considerable extent. As you know that mountainous regions not only provides a range of ecosystem services and products to both the mountain communities and societies but also supports millions of population living in the surrounding territories downstream as well. The accelerated rate of economic activities such as construction of dams, road widening, tourism activities and increasing vehicular pollution etc. have led to the significant alterations in the temperature values and precipitation patterns. In turn, all of these together have induced and triggered a range of environmental issues directly related with the climate change. These are change in precipitation patterns, reduced availability of water both for drinking and agricultural purposes shift and switch over in agricultural and horticultural crops, shift in wildlife habitat towards higher altitude and latitudes etc. Some of the ski resort in Alps mountain ranges of Europe are facing the problem to carry out the skiing activities because of lack of adequate snow cover as a result of climate change processes. Besides, the incidence of flash floods has also emerged as a recent phenomenon causing immense destruction to both life and property.

In the light of above discussion, it is not a difficult proposition to assume that the better and greater knowledge and appreciation of mountain resources and their specificities as well as judicious utilization and not exploitation by the human race may have far reaching implications for the current and future generations alike. The ongoing economic slaughter in the name of so-called trajectories of development aimed towards the wanton devastation of natural resources be it water, forest, soil, minerals, precious floral and faunal species etc. have already reached an alarming stage at many parts of the mountainous regions. Some of the mistakes which humans have committed may be avoided in the near future for the upkeep and benefit of most complex and spectacular second order landform systems of the planet earth i.e. mountains which is a life providing systems to the thousand and millions of people all across the world. The current crisis of pandemic has made all of us more and more vulnerable than we would have had even imagined in our distant dreams. It has radically upset our mechanisms and capacities to appraise, administer and cope up with risks particularly related to human health, and pushed us to believe that in order to solve such colossal problems necessitates global cooperation in which the active assistance of all stakeholders at independent level is very much required in a

holistic way. We may compare this situation with the kind of environmental problems which has started threatening and crippling the life providing ecosystem services of the mountainous regions, thus besides disturbing the delicate ecological set-up, it may also jeopardize the aspirations of populace in the long-run.

Whenever you happen to visit a mountain region, try to observe some of the discussed points and make a list of unwanted activities that is causing destruction to the fragile ecological set-up.

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### **SAQ 4**

Illustrate the key impacts on environment generated by the human actions owing to human-nature interactions in the mountain regions of the world?

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## **6.9 SUMMARY**

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In this unit, you have learnt the following key things:

- Unlike other regions, you came to know that mountain regions have its own complex set of physical and cultural landscape..
- Mountain regions are located in the margins and interior parts of almost all the continents in two major zones.
- These are the storehouses of many resources like timber, water, fodder and fuelwood and variety of minerals etc.
- It spans across the greater mountain ranges, chains and belts of the world across the continents.
- The human-environment relationship used to be characterized by harmony in all the spheres of life in earlier times. But, presently it has started seen a sign of transformation being necessitated by the forces of globalization driven by social, economic and political forces.
- Some of the prominent issues confronted by the mountain regions of the world are deforestation, climate change, dwindling natural resources, pollution in its various forms.

## **6.10 TERMINAL QUESTIONS**

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1. Highlight the major characteristics of soil of the mountain regions.



2. Describe the two-way process that takes place in a variety of ways between the humans on one hand and their natural environment on the other hand in the context of mountain regions.

(Hint: You may discuss and include a case study of any one mountain region with which you are reasonably familiar).

3. Highlight some of the crucial and challenging environmental issues of mountain regions of the world.

## **6.11 ANSWERS**

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### **Self-Assessment Questions (SAQs)**

1. Mountainous regions are generally located in the margins and interior portions spanning almost all the continents. These are mainly found to be located in two major zones. First major zone extends into the circum-pacific belt comprising the region surrounded by the Pacific Ocean. Second major mountainous zone extends eastwards from the European Alps mountain ranges running through Iran and then extending further east into the Himalayas in Asia.
2. As the mountain regions are situated far away from the equator mainly concentrated towards the margins of continents, it is characterized by high altitudinal character and hence moderate sunshine hours. These are generally characterized by very severe cold conditions during winter months with heavy snowfall and moderately warm conditions with scanty rainfall during summer months depending on the side of a mountain range.
3. It is a two-way interaction that takes place between the human and their environment. Such interaction is determined by the interplay between three factors like knowledge, skill level and set of available technological inputs etc.
4. Some of the prominent ones are loss and destruction of natural vegetative cover, change in climatic regime, decrease in the amount of snowfall resulting into water shortage due to global warming, melting glaciers and receding snowline have affected the availability of surface water (both for agricultural and drinking purposes with spatial variations therein across the type of mountainous regions), rising air and water pollution, drying of natural sources of water, solid waste management etc. These issues and problems have started upsetting the entire range of ecosystem services in a major way.

## **Terminal Questions**

1. Your answer should cover the major features of the soil. You may refer to the Sec. 6.6.
2. While answering this question, you should cover the two-way processes between the humans and their natural environment in the mountainous regions of the world and highlight the major points and underlying peculiarities. You may refer to the Sec. 6.7.
3. Your answer should broadly include major crucial and challenging environmental issues with suitable examples and illustrations. You may refer to the Sec. 6.9.

## **6.12 REFERENCES/SUGGESTED FURTHER READING**

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## COASTAL REGIONS

### Structure

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|--|--|
| 7.1 Introduction                         | Mangroves                                |
| Expected Learning Outcomes               | Coral Reefs                              |
| 7.2 Coastal Regions and Their Importance | 7.5 Coastal Hazards                      |
| Sites for human settlements              | Cyclones                                 |
| Economic importance                      | Tsunamis                                 |
| Ecological importance                    | Rising Sea Level                         |
| 7.3 Coastal Landform Features            | Other Environmental Problems             |
| Beaches                                  | 7.6 Summary                              |
| Deltas                                   | 7.7 Terminal Questions                   |
| Estuaries                                | 7.8 Answers                              |
| 7.4 Coastal Ecosystems                   | 7.9 References/Suggested Further Reading |

### 7.1 INTRODUCTION

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The regions you have studied so far in this block are identified on the basis of a typical climate or vegetation type. They are also generally located in a particular latitudinal belt. Now we shall study a region that can be found in every part of the globe, from the hot and humid tropics to the icy cold poles. Coastal regions have no precise definition but they can broadly be said to be the regions of interaction between land and oceans (and also large inland seas). Among the most dynamic regions of the world, they are affected by physical, biological and cultural processes that operate on spatial scales ranging from local to global, and on time scales ranging from sudden to gradual.

As mentioned earlier, coastal regions are found in all parts of the world. Soil and vegetation vary just as much as the climate. These regions extend over land as well as over the oceans, and contain numerous landforms and ecosystems. They are densely populated and support a variety of economic activity. The intensity of human activity has created a number of problems that are now increasingly evident. These regions are also vulnerable to some hazards, such as cyclones and tsunamis and the impact of global climate change. These are some of the issues that will be discussed in this unit.

The unit will begin with a discussion on the importance of coastal regions in section 7.2. This will be followed by a description of some important landform features found in this region, as well as the importance of these features in section 7.3. Some prominent ecosystems and their ecological significance will be discussed in section 7.4. Subsequent sections i.e. Section 7.5 will discuss some coastal hazards and environmental problems that affect this region, together with measures that can be taken to reduce the risk from them.

## **Expected Learning Outcomes**

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After completing the study of this unit, you should be able to:

- State the importance of coastal regions;
- Describe the characteristics and importance of some coastal features;
- Explain the importance of coastal ecosystems;
- Describe threats from coastal hazards; and
- Analyse how human activity threatens coastal regions.

## **7.2 COASTAL REGIONS AND THEIR IMPORTANCE**

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There is no consensus on what coastal regions are, and how their boundaries can be demarcated. Experts have variously placed their landward edges at 60 to 200 kilometres from the shoreline. The oceanward edge is just as fluidly defined. However, it is unanimously agreed that they extend in a continuum from coastal land, across intertidal areas, and into coastal waters. Intervening aquatic systems (the network of rivers and estuaries), salt marshes, wetlands, forests, tidal flats, beaches, dunes, coastal islands and coral reefs that are found at the interface of land and oceans, are included within them. This makes them highly dynamic, open systems which are marked by the interaction between terrestrial and marine environmental systems. Large scale exchange of matter and energy takes place between the two ecosystems, and each one greatly affects the other. Superimposed on the ecological and physical processes that operate here are the cultural forces introduced by the human element. Thus coastal regions are shaped equally by the energy of winds, waves, as well as the processes of social and economic development.

Coastal regions are very important as preferred spaces for human habitation, as well as for their immense economic and ecological value. However, the attraction these regions hold is proving to be self destructive as it has become the reason for many problems that contribute to their degradation. The importance of these regions is discussed in the following sections.

### **7.2.1 Sites for Human Settlements**

The highly dynamic coastal regions have always supported a large number of people. In the absence of a universally accepted definition of the region, it is difficult to say how many people live here. An estimate tells us that around 40 per cent of the world's population lives within 100 kilometres of the coast. This figure can be even higher for individual countries. For example, 80 per cent of

Australia's population dwells along the coast. This makes the coastal areas among the most densely populated parts of the world. What is more, the population here is growing faster than in non-coastal areas, so the share of world's population living here can be expected to increase in future. They are also the sites of many towns and cities. Of the world's 17 largest cities, 14 have coastal locations. A large proportion of medium-sized and smaller cities are also located along coasts.

There are many factors that make coastal regions attractive to human beings. Coastal plains are fertile areas, immensely suitable to agriculture. Fishing is another important economic activity. The salubrious climate adds to the attraction of the region. Although, as mentioned earlier, climate varies greatly with latitude, climate near the coast is less extreme and generally more humid, than climate in the interior locations along the same latitude.

While oceans separate land masses from each other, they also serve as waterways, a very important source of transport. Trade across the oceans has been carried on for centuries, leading to the emergence of several port cities which serve as gateways to international trade. Locations near the mouths of navigable rivers have the additional advantage of being connected to inland areas.

In addition to agriculture and fishing, people also find many employment opportunities in industry. Many manufacturing units are located in coastal areas because of the ease in importing raw material and exporting finished goods.

### **7.2.2 Economic Importance**

Carried out in coastal plains and in fertile river deltas, coastal **agriculture** makes a significant contribution to local and national economies. It produces not only food but also raw material for industry. Food is also easily available from the oceans in the form of **fish**. Unlike food supply from agriculture, which tends to be seasonal in nature, and has its dormant periods, food from the oceans is available throughout the year. Coastal waters account for a major share of the fish harvested from the world's oceans, which is an important source of animal protein. Protein sourced from fish provides a fifth of the per capita intake of animal protein to 3.3 billion people around the world. Its importance is even greater for coastal communities. Fishing and aquaculture provide livelihood to about 35 million people.

Despite the growing importance of air transport, shipping continues to be important. 90 per cent of international trade is carried out over maritime routes. The **shipping** industry contributes 5% to global GDP. Seaports are therefore very important as they serve as vital links between land and sea transport. Countries have invested heavily in creating ports and trade-related infrastructure.

The scenic beauty of coastal areas, the attraction of sunny beaches and the lure of water sports draws tourists to this region. It is estimated that 50% of international tourists travel to places near the sea. **Coastal tourism** makes a vital contribution to the economy of several nations, and is particularly

important in the case of small island states (like the Maldives), where more than 90% of the economy is organised around tourism.

Many **mineral and non mineral resources** are obtained from coastal lands and waters. These include sand, gravel, limestone, clay and salt. Nearly 30 per cent of the global output of crude oil comes from off shore drilling, notably in the North Sea and Gulf of Mexico.

Several critical inputs for **industry** are readily available here. Physical and financial infrastructure is well developed in the urban areas. The dense population provides plentiful supply of skilled and unskilled labour. Access to low-cost marine and inland transport ensures an easy supply of raw material from the hinterland as well as from overseas. It is equally easy to transport finished products to national and international markets. Use is made of sea water for the process of manufacture, as also for cooling, and unfortunately, even for dumping industrial wastes.

As the world is trying to break its reliance on fossil fuels, coastal regions offer a number of **alternative sources of energy** that are sustainable and non-polluting. Onshore, offshore, and now even floating wind farms catch prevailing winds and use their kinetic energy to generate electricity. Similarly, the energy of waves, tides and ocean currents is being harnessed, although this technology is still in its infancy and very few commercial projects have actually been initiated.

### **7.2.3 Ecological Importance**

Coastal **ecosystems are highly productive and biologically very diverse**. Of the more than 13000 species of marine fish, nearly 80 per cent live in coastal waters. Here they and many other kinds of marine organisms find food, shelter, breeding grounds and nurseries for young adults. Plant roots hold soil particles together, reduce the impact of raindrops and wave energy, thereby **reducing erosion**. Plants stabilise dunes by trapping windblown sand. Landforms and ecosystems along the coast serve as buffers that absorb the destructive power of coastal hazards like cyclones and tsunamis. Warm and cold currents that flow along the coast play a vital role in global **redistribution of energy** and stabilisation of climate. The ocean and atmospheric systems are intricately linked together, and any disturbance in one can lead to changes in the other. A warming of waters in the Pacific Ocean off the coast of South America, familiar to us as the El Nino, causes change in rainfall patterns across the globe. The importance of coastal areas is discussed in greater detail in subsequent sections.

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### **SAQ 1**

Why do people prefer to live in coastal regions?

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## 7.3 COASTAL LANDFORMS: BEACHES, DELTAS AND ESTUARIES

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A number of erosional and depositional features are found along the coast. They are controlled by geology (especially rock type and presence of weak zones) and the intensity of wave and wind action. Coastlines are classified into **erosional and depositional coastlines**, depending on whether erosion or deposition is the dominant process. The sea moves progressively inland in areas where erosion is dominant, producing cliffs, stacks, bays and inlets. The dominance of depositional processes causes land to extend into the sea. Beaches, dunes, bars and tombolos are common along depositional coastlines.

Coastlines are also classified into **coastlines of emergence, coastlines of submergence, and new coastlines built into oceans**. A fall in sea level or lifting of crust along the coast creates coastlines of emergence, exposing submarine landforms. Such coastlines are low lying, and slope gently into the sea. The eastern coastline of India is an example. On the other hand, a rise in sea level or a sinking of crust creates a coastline of submergence. Drowning of river and glacial valleys creates ria and fiord coastlines respectively. The western coastline of India is a coastline of submergence. New land is built into the oceans by volcanoes, growth of coral reefs and deltas. Some important coastal landforms will be discussed here.

### 7.3.1 Beaches

In popular perception, beaches are the landforms most commonly associated with coasts. A beach is a depositional feature, and is a strip of land covered with loose, water-borne sediments, located on the shores of a sea or lake. On sheltered coasts, the sediments comprise mainly sand and mud, while pebbles and even boulders accumulate on more exposed coasts. These sediments are produced by erosion and weathering carried out by wind and water. Longshore drifts are the agents that create most beaches. The upper limit of an active beach is the high-water mark. The lower limit is usually submerged under water. Beach sands are mostly composed of quartz. In tropical latitudes, skeletal remains of marine organisms may add a calcareous element to the sand.

Beaches are very important as recreation sites. In addition to this, they also play an important role in protecting coasts from erosion. They reduce the power of waves, winds and storm surges and stop them from destroying structures built along the coast. They are also the nesting grounds for many organisms. Beach sands sometimes contain valuable minerals like titanium, zirconium, tin, uranium and even gold, in concentrations large enough to make them economically significant.

Beaches are naturally destroyed by the process of coastal erosion. However, the increase in frequency and intensity of storms as a result of rise in sea surface temperatures is a major threat to beach stability. Rise in sea level also causes drowning of beaches. The construction of dams on rivers prevents river-borne sediments from nourishing beaches. Construction of

homes and setting up of businesses on or near beaches makes beaches narrower and causes problems of littering and pollution.

### **7.3.2 Deltas**

Most rivers eventually discharge their water into oceans or lakes. At the point of discharge, the velocity of the water is so low that it is unable to keep sediments in motion. As sediments are deposited at the mouth of the river, a delta is formed. Coarser sediments are deposited first while the finer clay particles are carried further into the ocean. The river channel itself is subdivided to form many distributaries. Although the name delta is derived from the triangular Greek alphabet of the same name, deltas have a variety of shapes. The **arcuate** Nile delta exhibits the classic triangular or fan-like shape, while the Mississippi delta resembles a **bird's foot**. **Cuspate** or V-shaped deltas form when the river flows into a sea with strong waves, as in the case of the Tiber River in Italy. The Ganga combines with the Brahmaputra to form the largest delta in the world. The width of this delta along the coast is about 350 kilometres. The mangrove forests found in this delta are known as the Sunderbans after the *sundri* tree found in them.

Deltas are densely populated and used intensively by humans. While they constitute just 1 per cent of all the land in the world, they house nearly half a billion people. The fertile soils and plentiful supply of water for irrigation make them the **food baskets** of many countries. Frequent floods replenish nutrients and add fertile silt to the land. Deltas also serve as nurseries for many species of fish, and both **subsistence and commercial fisheries** are practised here. The mangroves and marshes contained in them are home to **many unique species of plants and animals** and are especially important for several types of migratory birds.

**Climate change, land use change and river management schemes** affect the supply of water and sediments to deltaic areas, causing them to disappear at an alarming rate. Construction of dams has reduced the volume of water in most river systems as water and sediment are now discharged into reservoirs. This affects water temperature, sediment replenishment and prevents the migration of fish. Many wetlands are lost to development as land is 'reclaimed' to create new farmland and structures for flood protection. **Rise in sea level** adds to the loss as more and more land is submerged under water. Cyclones wash away muds and sand as new channels are cut into deltas. The Ganga-Brahmaputra delta, home to 150 million people, is sinking rapidly as human activity modifies the land. Decrease in the amount of sediment brought by rivers, and modification of delta channels to accommodate shrimp farming, are the primary reasons for this.

### **7.3.3 Estuaries**

A partially enclosed water body at the mouth of a river, through which water flows into the sea, is called an estuary. St. Lawrence River forms the largest estuary in the world. (Estuaries may also be created when a river flows into a freshwater lake. These are called freshwater estuaries.) Here freshwater from the river mixes with saltwater from the oceans to form brackish water. Many estuaries were formed when river valleys were drowned either as sea level



rose or land level fell. The effect of tides can be felt in estuaries, and sometimes a wall-like wave of water from the sea travels up the river in the form of a tidal bore. The rise and fall of tides affects the level of water and salinity. Salinity also changes with season, being higher in the dry season and lower in the rainy season when the flow of fresh water from the river increases.

Estuaries are important as **sites of ports and harbours**. Many important cities, like New York, Tokyo and Jakarta, have estuarine locations. The sheltered waters of estuaries are suitable for **recreational activities, aesthetic enjoyment** as well as for **scientific study**. Estuaries also serve as **critical natural habitats** for a variety of species, including birds, amphibians and fish. Waters are rich in plankton and bacteria, and nutrients are trapped between the outflowing river waters and the inflowing tides. The increase in salinity towards the mouth of the estuary allows for a gradual diversification of species.

Estuaries may support very productive ecosystems, but they are also very fragile. Human activity poses a threat to the survival of many estuaries. The discharge of untreated sewage and industrial wastewater, chemical-laden runoff from agriculture, and pollution from ships and oil spills, are adding toxicity to the estuarine environment. Land reclamation, dredging and overfishing also add to the damage.

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## SAQ 2

- i) How can coastlines be classified?
  - ii) Why are deltas important?
- 

## 7.4 COASTAL ECOSYSTEMS

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The meeting of land and sea in coastal areas creates a variety of environmental conditions that give rise to diverse ecosystems. These include estuaries, mangroves and coral reefs that are not only unique to these areas, but also of immense ecological importance. You have already learnt about estuaries in the previous section. Mangroves and coral reefs will be discussed in this section.

### 7.4.1 Mangroves

Salt marshes, estuaries, deltas and tidal flats in calm and shallow coastal areas support dense thickets or forests of **salt-tolerant trees and shrubs**. These are called mangroves and they are found along 8% of all coastlines. They are more common in tropical areas where they line nearly 25% of the coastlines. Root modifications, like pneumatophores and stilt and prop roots allow plants to breathe and remain erect even as they are periodically submerged in water. The dense network of interlacing roots traps sediments to help the growth of the mangrove further into the sea through coastal accretion.

As buffers between marine and terrestrial communities, mangroves provide many ecosystem services. They absorb the energy of winds, waves and storms and thus help in **stabilising shorelines** by reducing erosion more effectively than concrete structures built by human beings. They trap sediments and filter pollutants, thereby **improving water quality**. Aquatic and amphibious species find homes in mangroves while birds like pelicans and egrets nest in the branches. A variety of other animals, including large predators, also live in these forests. The Sunderban mangrove forest is famous as the largest home of the Royal Bengal Tiger, and it also houses many other rare and threatened species like the Estuarine Crocodile, Fishing Cat and Gangetic Dolphin (See Fig. 7.1).



**Fig. 7.1: The Sunderban Mangrove Forest.**

Mangroves are also very important for local communities as they provide them with valuable resources. Shrimp and many other commercially important species of fish and crustaceans are harvested from the water bodies located within them. Fish farms have been developed in many parts by locals for carrying out aquaculture and mariculture. They are important for methanol production; provide commercial timber, charcoal, and several plant products that are used by the pharmaceutical industry. The economic value of this ecosystem is estimated to be around US \$10000 per hectare per year.

Despite their great value, these fragile ecosystems are regarded by many as wastelands to be reclaimed for more productive use. Already about half the world's mangroves have been lost to human encroachment. The remaining areas face grave threats from overuse, and unplanned development. Large tracts have been cleared to make way for agriculture and aquaculture. The demand for fuelwood from a rapidly growing population also creates pressure on the vegetation. Cities and ports too have developed at the cost of mangroves.

### **7.4.2 Coral Reefs**

Coral reefs are perhaps the best known coastal ecosystems. Corals are **tiny, jelly-like animals** that live in colonies in warm, clear, shallow waters close to

the coast. They build hard external skeletons from carbonates dissolved in sea water and these hard calcium-rich shells accumulate to form rock-like structures called coral reefs. The Great Barrier Reef of Australia is the most famous coral reef in the world. Corals live symbiotically with photosynthetic algae, providing them shelter in return for food. Corals are abundant near submerged banks where nutrients are supplied by upwelling currents. In open oceans corals create circular or horse-shoe shaped islands known as atolls.

Corals are often called the **rain forests of the sea** as numerous other life forms subsist on them. They support more species per unit area than any other marine ecosystem. Covering less than one per cent of the ocean floor, these diverse ecosystems support 25% of marine life. They **support marine food chains** by supplying nitrogen and other nutrients. They act as **natural breakwaters** to protect coastlines from damage from waves and tropical storms. Corals are also of great interest to geologists and climate scientists as they contain in them a record of climatic events that occurred over a million years. Pharmaceutical companies too use marine extracts in drugs that treat cancer, arthritis and heart diseases. The fishing industry is supported by corals as they serve as spawning grounds and nurseries for many species of fish that are food for human beings. Corals also serve as magnets that attract tourists. **Reef adjacent tourism** accounts for around 70 million trips every year. Altogether, it is estimated that nearly 500 million people around the world depend on coral reefs for food, income and protection from hazards.

An estimated 58% of the world's coral reefs are **threatened by a combination of natural and human factors**. Their proximity to the shore makes them vulnerable to damage by agriculture, urban development, industry and many other onshore human activities that increase the amount of sediments in water. Destructive fishing practices also cause damage to reefs. Damage is also caused by the movement of cruise ships. Local communities exploit corals to make articles for their own use and for sale to tourists. Corals are also lost due to environmental stress caused by factors like higher solar radiation, varying salinity, high water temperatures and changing sea levels. Rise in carbon dioxide in the atmosphere increases the acidity of surface waters in the oceans. This in turn changes the carbonate content of water, negatively affecting the growth of corals. At the same time, rising water temperatures inhibit photosynthesis by symbiotic algae, causing corals to expel them. Corals then lose their colour, in a process known as **coral bleaching**. Corals cannot survive without algae and they slowly die due to lack of food. Recovery is possible if water temperatures decrease, but in many cases the damage is permanent. Once corals are destroyed, the entire ecosystem is lost. We must therefore worry about the future of countries like Kiribati and Maldives that are built entirely on coral reefs.

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### SAQ 3

- i) What are mangroves and corals?
  - ii) Why are coral reefs important?
-

## 7.5 COASTAL HAZARDS

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The interaction of terrestrial, marine and atmospheric processes in coastal regions makes them highly vulnerable to a wide variety of natural hazards. Vulnerability is further increased by human activity that takes place with scant regard for the environment. This section will examine some of the major hazards that affect this region.

### 7.5.1 Cyclones

Tropical cyclones (also called hurricanes and typhoons) are giant storms that spin across the ocean waters and cause death and damage to property and environment when they make landfall. They form as **intense low pressure centres** over oceans where surface water temperature is greater than 26°C, allowing mass transfer of moisture from oceans to the atmosphere. The spinning motion is induced by the rotation of the earth. Low pressure at the centre of the system causes air to move inward and upward at speeds in excess of 118 kilometres per hour. These **strong winds** generate **waves** which can rise more than 7 metres above the surface of the ocean (which is already raised due to low atmospheric pressure). Towering **cumulonimbus clouds** arranged in spiral bands around the **eye** are a characteristic feature of these cyclones. **Torrential rain** falls from these clouds, causing rivers in the affected areas to overflow their banks.

Cyclones cause extensive damage over wide areas. Strong winds can uproot trees and hurl them against buildings. Electricity poles and telephone towers are knocked down, disrupting power supplies and telecommunications. Roofs may be blown off buildings, exposing the interiors to damage by rainwater. Damaging as these winds are, the maximum damage in a cyclone comes from the **storm surge** – a huge mass of water driven onshore by strong winds. As mentioned earlier, low pressure in the centre of the cyclone causes a rise in sea level. Winds push this bulging water towards land, flooding coastal areas under water several metres in depth. Heavy rain and overflowing rivers make the floods even worse. Several deaths are caused due to drowning. Bhola, a cyclone that struck Bangladesh (East Pakistan at that time) in 1970, killing more than 300,000 people, is the deadliest cyclone in history. Inundation by seawater damages fertile agricultural land and it takes many years and a lot of money and effort to restore its fertility. Beaches, lagoons, mangroves, coral reef and dune systems are also damaged by cyclones and they regain equilibrium only after a long time. Cyclones can damage valuable infrastructure in ports, harbours and cities, causing great economic loss. Hurricane Katrina, which affected the USA in 2005, and Hurricane Harvey, that affected the USA and some neighbouring countries in 2017, inflicted damages worth US \$ 125 billion each, and are believed to be the costliest cyclones yet. The IPCC predicts that global climate change will lead to an increase in the frequency and intensity of these storms. This will not only cause loss of life and property, but will also damage coastal ecosystems while simultaneously reducing their ability to recover.

Scientists have experimented, mostly unsuccessfully, in ways to suppress cyclones or divert them to areas where they would cause less damage. The

best strategy for protection against cyclones lies in **tracking, early warning and preparedness**. Weather scientists closely monitor the oceans and atmosphere for early signs of cyclone formation. Once detected, the development of a cyclone is closely monitored and appropriate warnings are issued from time to time to communities likely to be affected by it. People living in areas vulnerable to cyclones have been trained to respond to such warnings. In recent decades, timely evacuation of people into specially built shelters has helped in saving thousands of lives.

### **7.5.2 Tsunamis**

**Giant sea waves**, triggered by sudden movements of the sea floor due to submarine earthquakes, volcanic eruptions or landslides, are known as tsunamis. The name tsunami is of Japanese origin, and means a harbour wave. True to their name, they are hard to detect in the open oceans where they have a long wavelength and are less than a metre in height. They travel across oceans at speeds of up to 700 kilometres per hour (almost as fast as a jet plane), reaching places far removed from their place of origin. They lose speed once they reach shallower coastal waters, but register a huge increase in height, and unleash their destructive energy over a vast area. The height of a tsunami can be up to 30 metres, which makes it as high as a 10-storey building.



**Fig. 7.2: A Sight of Tsunamis.**

Tsunamis have the potential to cause large scale death and destruction. A massive underwater earthquake in the Banda Aceh region of Indonesia (known as the Sumatra-Andaman earthquake) in 2004 triggered tsunamis that affected coastal regions in South Asia and Africa. The death toll was more than 230000, and there was extensive damage to property. The incursion of seawater contaminated soil and groundwater as far as 3 kilometres from the shoreline. Coastal ecosystems like coral reefs were also severely damaged. In 2011, the Tohoku earthquake struck Japan. With a magnitude of 8.9, it was the strongest earthquake ever recorded in the country. It triggered a string of tsunamis, some of which affected locations on the other side of the Pacific Ocean. More than 15000 deaths occurred in Japan, a country among the best

prepared of all to face an earthquake and its aftermath. A 15 metre tsunami hit Japan and caused a severe humanitarian crisis. Apart from causing other damage, it disabled power supply and cooling to three reactors of the Fukushima Daiichi nuclear power station. The ensuing accident caused radioactive releases from the plant into the atmosphere and the ocean. Some workers lost their lives in trying to stabilise the reactors while others suffered harmful doses of radiation. Thousands of residents living around the plant had to be evacuated amidst fears of possible exposure.

Though tsunamis are extremely destructive, it is possible in most cases to detect them in advance and issue timely warnings in order to protect lives. On an average two destructive tsunamis are recorded per year and a major tsunami that causes ocean-wide devastation occurs once in 15 years. As most tsunamis are caused by earthquakes, scientists monitor underwater seismic activity with the help of sensors placed on the seafloor. Once a seismic disturbance is detected, they begin to look out for changes in sea level. Data is instantly conveyed to tsunami warning centres which analyse them and issue an alert whenever it is warranted. This warning is then conveyed through radio, television and text messages to people likely to be affected. **The Pacific Tsunami Warning System (PTWS)** functions from Hawaii. After the 2004 tsunami, India too has established an **Indian Tsunami Early Warning Centre (ITEWC)** that covers the entire Indian Ocean region.

The conventional approach to defence against tsunamis is to build **sea walls**. Japan has the most extensive defence system which covers nearly 40% of its coast. However, the failure of this system to protect the country against the tsunami in 2011 has provoked experts to reconsider this structural approach. It is found that building of walls provides a false sense of security to residents and prevents them from evacuating swiftly. They are also expensive to build and detrimental to fishing and tourism. Engineers and architects are now focusing on designing buildings that can withstand the force of these powerful waves. Plant-covered hills and well preserved mangroves and coral reefs are now being recommended as more effective, less expensive and aesthetically better alternatives to seawalls.

### **7.5.3 Rising Sea Level**

Sea level determines the boundary between land and sea. Anyone even slightly familiar with the sea knows that sea level is rarely constant. There are daily and seasonal variations in response to tidal patterns. Yet changes in sea level currently pose the biggest threat to coastal areas. Increasing emission of greenhouse gases induces global warming which is causing polar ice caps to melt. The added meltwater, as well as the increase in the volume of ocean waters due to thermal expansion, is causing inundation of coastal land. The fact that 10% of the world's population (more than 700 million people) live in low elevation coastal zones that are less than 10 metres above sea level, makes for a frightening scenario. Rehabilitating these **climate refugees** will be a great global challenge. The future of small island countries, which consist almost entirely of coastal land, is in grave danger. We have also seen that coastal areas contain fertile agricultural land and large cities which will be submerged as sea levels continue to rise. This is expected to cause a decline

or total loss of production in nearly a third of world's cropland and damage to valuable port and other infrastructure. Not only does rise in sea level pose a threat to human beings and their structures, it is also a cause of damage to coastal ecosystems like deltas, mangroves and coral reefs. Increased coastal erosion will lead to loss of beaches and dunes. Saltwater intrusion will increase the salinity of groundwater resources, thereby leading to a decline in water quality.

Coastal engineers and other experts are looking into protective and adaptive measures to cope with rising sea levels. Building walls and barriers to protect coastal areas from flooding are among the measures being suggested. Not only are these measures expensive, they also have their limitations. A detailed discussion on this issue is beyond the scope of this unit.

#### **7.5.4 Other Environmental Problems**

As we have seen, coastal areas are under great stress from human activities that take place not only within them but also far inland. Deforestation, unscientific management of soil and water resources, damming of rivers and indiscriminate use of fertilisers and pesticides are inland activities that can damage coastal ecosystems. Pollutants generated inland are carried to the coast by rivers. Within coastal areas, landscapes and habitats are destroyed and altered to meet the requirements of the growing population. Land is 'reclaimed' from the sea by draining wetlands and lagoons. We have already seen how mangroves have been cut down to create space for human activities. Increasing urbanisation, industrialisation and tourism create increasing pressure on land and water resources. Road building and other construction activity, port dredging, beach and reef mining and anchor damage are some other causes of stress. This section discusses the problems caused by fishing and pollution.

We have already seen the importance of **fishing** as an economic activity in coastal areas. Though fishing provides food and livelihood to coastal populations, overharvesting is fast depleting stocks of commercially important species and destroying food chains in many areas. Fish are sometimes harvested by destructive methods. Trawling disturbs worms, sponges and bottom-dwelling organisms. Non-target species that are not commercially important are also caught in fishing nets. Nets with very small mesh sizes catch juvenile fish which would have grown into adults. This has made fish stocks in many areas biologically unsustainable. Aquaculture, one of the fastest growing activities, is causing the destruction of mangroves, estuaries and off shore fisheries by modifying habitats, and introducing chemicals like antibiotics and pesticides.





**Fig. 7.3: Marine Pollution affecting Aquatic Life.**

**Marine pollution** is another environmental problem of coastal regions. 80% of this pollution has its origin over land while 20% comes from the atmosphere (as acid rain) and marine-based sources (such as oil spills). Oil spills, usually from tankers, can cover birds, mammals and other marine organisms with oil. Not many of them can survive this ordeal. Untreated sewage and industrial wastewater is dumped into the oceans. The resulting eutrophication is evident in the form of algal blooms which kill native organisms by depleting the supply of dissolved oxygen in water. Dumping of industrial waste can create tragedies like the one that occurred in Minamata Bay in the 1950s and 1960s when wastewater mixed with mercury was dumped into the sea. This poisoned the fish, which, when consumed by people, severely impaired their health.

It is clear that coastal regions are extremely important. However, they also face several grave threats and long term planning and large investments are needed for their protection. Strategies for coastal protection must consider entire coastlines and not focus on just large cities or vital installations.

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### SAQ 4

- i) What is a tsunami?
  - ii) What are the threats to coastal areas from rising sea levels?
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## 7.6 SUMMARY

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In this unit you have studied:

- Coastal regions are highly dynamic areas, shaped by terrestrial, atmospheric, marine and increasingly also by human forces.
- They are very important from the economic and ecological points of view.



- They support a dense and growing population, providing food and livelihood to millions of people.
- Several interesting landform features such as beaches, deltas and estuaries are found here. They also contain ecosystems like mangroves and coral reefs that are homes to thousands of species.
- Despite their great importance to human beings, these landforms and ecosystems are under great stress.
- Coastal areas are vulnerable to many hazards. Cyclones and tsunamis cause a lot of devastation, and several steps are taken to protect coastal areas from their impact.
- Rise in sea level is a major threat to coastal populations as it is going to result in largescale displacement of people from the area.
- Other problems like pollution and decline in coastal fisheries also afflict these areas. It is necessary to find ways of sustainably using the resources of these fragile regions.

## **7.7 TERMINAL QUESTIONS**

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1. Describe the major ecosystems found in coastal areas. Why are they important and how are they affected by human activity?
2. Identify major coastal hazards and their causes. What measures can be taken to protect life and property from their impact?
3. Discuss the causes and consequences of some environmental problems in coastal regions.

## **7.8 ANSWERS**

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### **Self Assessment Questions (SAQ)**

1. i) People like to live in coastal regions because of the climate, fertile land, livelihood opportunities in industry, fishing and tourism, and ease of transportation.
2. i) Coastlines are classified into erosional and depositional coastlines, depending on which of the two processes dominates. They are also classified into coastlines of emergence, of submergence and coastlines built into the ocean.  
  
ii) Deltas are important because they support a dense population, they support agriculture and fisheries, and they are home to many unique species.
3. i) Mangroves are thickets of salt-tolerant trees and shrubs in salt marshes, deltas and tidal flats. Corals are jelly-like animals that live in colonies in warm, clear water. Their hard skeletons build rock-like structures called reefs.

- ii) Coral reefs support many diverse species. They support marine food chains, offer coastal protection, scientific value, support fishing and attract tourists.
4. i) A tsunami is a giant sea wave generated by an earthquake, volcanic eruption or landslide that causes displacement of water on a large scale.
- ii) Rising sea levels will lead to submergence of agricultural land and large cities. They also threaten coastal ecosystems.

### **Terminal Questions**

1. Mangroves and coral reefs are the major ecosystems found in coastal regions. You must discuss the services provided by these. Humans are destroying them by overexploitation, encroaching into their areas, altering the properties of water and climate change.
2. Coastal areas are vulnerable to cyclones, tsunamis and the effects of rising sea level. Cyclones originate from low pressure centres over the oceans. Most tsunamis are caused by undersea earthquakes. Rise in sea level is a consequence of global warming because of the increase in the emission of greenhouse gases. Early warning systems and preparedness are the best defence against them. Preservation of coastal ecosystems and building of seawalls are some other measures.
3. You must discuss the role of human beings in creating environmental problems. These include construction, waste disposal and unplanned development. The consequences are pollution, loss of biodiversity, decline in fish production and diseases.

### **7.9 REFERENCES/SUGGESTED FURTHER READING**

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## GLOSSARY

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- Artesian wells** : This happens when a layer of pervious rock lies between two layers of impervious rock. If the pervious layer is exposed in an area which receives enough rainfall, it may be filled with water. Natural pressure may force the water to rise up in a well bored into it at a lower level.
- Environmental problems:** : The adverse effects generated due to the over-exploitation of natural resources such as deforestation, mining, construction of dams and climate change etc.
- Deforestation:** : It refers to the cutting and permanent removal of trees.
- Desertification:** : It refers to the march of the desert into neighboring areas. Today it is used more broadly to include a number of processes which lead to a decline in the productive potential of land in arid and semi-arid areas.
- Exotic river:** : An exotic river has its source in a rainy area beyond the margins of the desert. The volume of water that flows in them is so large that they can carry it across the desert.
- Estuary:** : A partially enclosed water body at the mouth of a river, through which water flows into the sea.
- Great green wall movement** : It was a movement started in the Sahel region along the southern edge of the Sahara to combat the problem of desertification. Initiated in 2007, this movement planted an 8000 km line of trees bordering the Sahara in the south.
- Halophytes** : Plants that are salt tolerant.
- Mountains** : Any significant elevation on the face of the earth's surface from the surrounding territory with impressive scale usually taken as 300 meters above the mean sea level.
- Oasis** : A permanent source of water in a desert and the vegetated area around it.
- Qanat or Kariz** : An indigenous system of transporting water common in South West Asia, especially Iran. In this system water is transported by gravity through underground tunnels from alluvial aquifers to an agricultural settlement.
- Salinisation** : An increase in the concentration of salts in soil.
- Slash and burn agriculture method** : In this type of agriculture, vast tracts of land are cleared for cultivation and then abandoned for a new land until the old one regains its fertility.
- Storm surge** : A huge mass of water driven onshore by strong winds.

- Transhumance** : A practice associated with the animal husbandry whereby the nomadic grazing communities move with their animal flocks for grazing with the change in seasons from lower parts to the high alpine mountain pastures.
- Tsunamis** : Giant sea waves triggered by sudden movements of the sea floor due to submarine earthquakes, volcanic eruptions or landslides.
- Wadis** : Channels those are dry except in the rainy season. Such channels are called wadis in Arabic speaking countries.
- Xerophytes** : Plants that can survive with very little water and can withstand long periods of drought.



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