Understanding Environment

A Textbook in Geography for Class IX

N. ANANTAPADMANABHAN

राष्ट्रीय शैक्षिक अनुसंधान और प्रशिक्षण परिषद्
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Foreword

UNDERSTANDING ENVIRONMENT is a textbook of General World Geography for secondary classes. As is evident from this title, the interrelationship marked between humans and environment in different parts of the world has been emphasized throughout this book.

Keeping in view the requirements of the general education under 10+2+3—national system of education, specific topical themes have been drawn from physical, human, economic and applied branches of geography for discussion in the book. This textbook is expected to be a companion volume of the *India: Economic Geography*. The facts have been used only as means to understand certain concepts and not as an end in themselves. An attempt has been made to employ the factual information to highlight the meaningful ideas and socially relevant values. The wider promotion of an attitude of international understanding among students has been given its well-deserved place. The book has been profusely illustrated by maps and diagrams in order to make geographic learning easy and full of interest. Those contexts and the key points of the New Education Policy 1986 have been given fullest attention which have become necessary for preparing the Geography textbook for this stage.

The Council is thankful to the ex-senior Principal and Director of Collegiate Education, Tamil Nadu, Professor N. Anantapadmanabhan for preparing this book. It was rather difficult to bring it out in its present form without his devotion to the task of authoring the textbook.

Thanks are also due to Shri Yash Pal Singh, Incharge, Geography programmes in the School Television Branch, Education Department, Delhi for preparing the Hindi version of the book. It was not possible in such a short time but for the pains taken by him for its completion.

The development of a geography textbook has always been a challenging task involving much labour and many precautions. For this I am thankful to Dr K.L. Joshi and Shri D.P. Gupta of the Department of Education in Social Sciences and Humanities who looked to all related tasks besides taking the responsibility of planning the exercises, appendices, glossary, maps and diagrams. I am also grateful to all those teachers, teacher-educators and subject specialists from different universities who helped in the serious work of reviewing the manuscript for seeing to its finalization in the workshop group meetings. My special thanks are due to the Vice-Chancellor and other authorities of the Kamaraj University, Madurai who provided various facilities in organising the workshop in their campus. I thank all the members of the Publication Team for bringing out this publication on time.

We shall thankfully welcome any suggestions for bringing about further improvements in the book.

P.L. MALHOTRA
Director
National Council of Educational
Research and Training

New Delhi
March 1989

Preface

This book has been prepared in accordance with the revised syllabus for secondary classes. The first half of the book deals with the study of the Physical and Biological aspects of the environment. The latter part of the book covers man's impact on the environment with reference to his growing numbers and increasing demand for resources. There is also a chapter on the use of Maps as Aid to Understanding Environment. The last chapter includes two case studies to bring out the relation between man and environment in two diverse regions. The main objective of the book is to enable pupils to understand the components and processes of the environment so that they may learn to live in harmony with the environment.

Though the manuscript was prepared while I was working as the Director of Collegiate Education, Madras, this book has nothing to do with my official responsibilities. Most of the writing was done in the early morning hours of the day. The manuscript was finalised at a workshop organised by the Department of Education in Social Sciences and Humanities of the NCERT at the Madurai Kamaraj University, Madurai. I wish to thank all the participants of the workshop for their valuable suggestions for revision of the manuscript including the illustrations. Dr K.L. Joshi of the NCERT has got the maps and illustrations prepared in final form and has also provided captions to the illustrations. I wish to place on record my sincere thanks to Dr K.L. Joshi for his assistance in many ways. I thank the Director, NCERT for giving me yet another opportunity for preparing a textbook.

I welcome suggestions for improvement of the book.

N. ANANTAPADMANABHAN

Contents

THE CONSTITUTION OF INDIA

PREAMBLE

WE, THE PEOPLE OF INDIA, having solemnly resolved to constitute India into a [1][SOVEREIGN SOCIALIST SECULAR DEMOCRATIC REPUBLIC] and to secure to all its citizens:

JUSTICE, social, economic and political;

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

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

FRATERNITY assuring the dignity of the individual and the [2][unity and integrity of the Nation];

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

1. Subs. by the Constitution (Forty-second Amendment) Act, 1976, Sec.2, for "Sovereign Democratic Republic" (w.e.f. 3.1.1977)
2. Subs. by the Constitution (Forty-second Amendment) Act, 1976, Sec.2, for "Unity of the Nation" (w.e.f. 3.1.1977)

Part IV A
Fundamental Duties

ARTICLE 51A

Fundamental Duties – It shall be the duty of every citizen of India–

(a) to abide by the Constitution and respect its ideals and institutions, the National Flag and the National Anthem;

(b) to cherish and follow the noble ideals which inspired our national struggle for freedom;

(c) to uphold and protect the sovereignty, unity and integrity of India;

(d) to defend the country and render national service when called upon to do so;

(e) to promote harmony and the spirit of common brotherhood amongst all the people of India transcending religious, linguistic and regional or sectional diversities; to renounce practices derogatory to the dignity of women;

(f) to value and preserve the rich heritage of our composite culture;

(g) to protect and improve the natural environment including forests, lakes, rivers, wild life and to have compassion for living creatures;

(h) to develop the scientific temper, humanism and the spirit of inquiry and reform;

(i) to safeguard public property and to abjure violence;

(j) to strive towards excellence in all spheres of individual and collective activity so that the nation constantly rises to higher levels of endeavour and achievement.

UNIT I

Our Environment

WE LIVE on the earth which is a unique planet in the solar system. Its uniqueness lies in that its environment is favourable for all forms of life, including humans. Our environment thus consists of both the physical environment and the biological environment. The physical environment includes the non-living elements of the environment such as land, water and air. The biological environment refers to plants, animals and micro-organisms. Both these elements of environment interact with one another, exchanging matter and energy.

Our environment is dynamic in nature. Both the physical and biological elements of the environment change in course of time. The sun is the main source of energy which causes changes in the environment. We are familiar with the day to day changes in weather and seasonal changes in climate. These changes are the result of differences brought in the heating of the earth and its atmosphere by the sun. Similarly, circulation of water in the ocean and between the oceans, the atmosphere and the land masses is caused by solar energy. The plants depend on solar energy for their growth. As animals feed on plants, all living beings are dependent on the sun. A field of wheat, a herd of cattle, a crowd of people and a shoal of fish represent examples of solar energy stored in various forms.

Though we are aware of changes in other elements of the environment, we do not consider land to be subject to such changes. While occasionally earthquakes and volcanoes may bring about sudden changes, the land surface is being continuously modified by the agents of gradation such as rivers, glaciers, winds and waves leading to the formation of a variety of landforms.

Circulation of matter and energy between the physical elements of the environment such as land, sea and air is responsible for creating an environment favourable for all forms of life. All forms of life are found in the narrow zones of contact between land, sea and air. How would you explain the wide variety in plant and animal life?

CHAPTER ONE

Our Environment — Components and Processes

ENVIRONMENT LITERALLY means the *surroundings* of an object. For example, the environment of a plant refers to the conditions which favour the growth of the particular plant. While the environmental conditions in Punjab are suitable for cultivation of wheat, they are not so in the Kaveri delta in Tamil Nadu. Thus, the environmental conditions vary from place to place.

Our immediate concern is the environment in which humans live. The earth is the habitat of humans but they do not live in isolation from other life forms on ther earth, as they depend on them for food and other necessities. Thus, in a broader sense, we must study the environment of all forms of life on the earth as a whole.

Elements of Environment

The earth is a unique planet of the solar system as it has conditions favourable for the evolution and survival of various forms of life. This is possible partly because of optimum distance of the earth from the sun. Temperature on the earth is neither too high as on Venus or Mercury nor too low as on Jupiter and other distant planets. The layer of air which surrounds the earth contains oxygen which is essential for all forms of life. The air envelope also moderates the temperature on the earth's surface. So the variations of temperature between day and night or between summer and winter are not very high as on other planets. The moderate temperature conditions enable water to be present in large quantities on the earth. The temperature variations enable water to be present in solid and gaseous states also enabling its circulation. The presence of water favours growth and evolution of various species of plant and animal life, including humans. Thus, the earth is unique in having a life - bearing layer or *biosphere*.

The types of plants and animals living in a particular region depend on the physical environment in that region. Thus, the environment in which humans live consists of *physical or non-living environment* and *biological or living environment*. The physical environment comprises the land, water and air while the biological environment includes the plants, animals and other organisms. The physical and biological environment interact with one another. A change in physical environment brings about a change in biological environment, or the vice versa

Dynamic Environment

The physical and biological elements in the environment are dynamic in nature. Changes take place slowly or suddenly in the nature of landforms. The circulation of air and water brings about changes in the climatic conditions in different seasons. Long-term changes also occur in the physical environ-

ment leading to extinction of certain species of plants and animals and evolution of new species adapted to the physical environment. The last mass extinction of a large number of plant and animal species took place about 65 million years ago. Evidence of such extinct species are preserved in the form of fossils in layers of rocks. Changes in environment are responsible for the evolution of humans about one million years ago.

The distribution of continents and oceans has also varied during the long history of the earth. There is growing evidence indicating that the continents have drifted from their initial positions before assuming the present pattern of distribution. The major landforms have also changed owing to movements of the earth's crust. Even the Himalayan peaks exceeding 8000 metres contain deposits of sedimentary rocks once laid down in a shallow sea in that region. Changes in the physical environment and corresponding variations in the biological environment have been occurring as normal phenomena during the long history of the earth. While some of the changes are due to natural processes, others are caused by human activities.

The Atmosphere

The air envelope that surrounds the earth is called the atmosphere. Among the four major elements of environment, the atmosphere is the most dynamic as changes take place in it not only from one season to another but also over shorter periods of a few hours. Of the total mass of the atmosphere, 99 per cent is within a height of 32 km from the earth's surface. It is to be noted that most of the atmospheric changes occur within this layer. The atmosphere is held to the earth by the force of gravity.

Composition

The atmosphere consists of a mixture of gases having a relatively uniform composition in the lower layers. An average sample of pure dry air consists of nitrogen (78 per cent), oxygen (21 per cent) and argon (0.9 per cent). Other gases, such as carbon dioxide, hydrogen, helium and ozone are present in minute quantities. The lower layers of the atmosphere also contain water vapour in variable quantities. Water vapour is added to the atmosphere by evaporation from oceans, lakes and other water bodies. Though water vapour may not exceed 4 per cent of the total volume of air at any given place, it plays an important role in the atmospheric processes. Apart from these gases, solid particles like dust, carbon, salt, pollen grains, etc., are also found in the lower layers of the atmosphere.

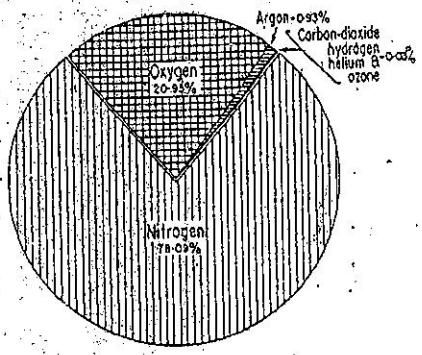


Fig. 1.1 Composition of Atmosphere
A number of gases are present in the atmosphere, some in large and others in small quantities. Why carbon dioxide is less over forests than over oceans ? Why the composition changes near factories and in big cities ?

Structure

The density of the atmosphere decreases with height. Four layers may be identified. The lowest layer is called the *troposphere*. In this layer, the temperature of air decreases with height at an average rate of 1°C for 165 metres. The troposphere extends up to a height of 18 kilometres along the equator and about 8 kilometres along the poles. The upper limit of the troposphere is called the *tropopause*. Most of the weather phenomena take place in this layer.

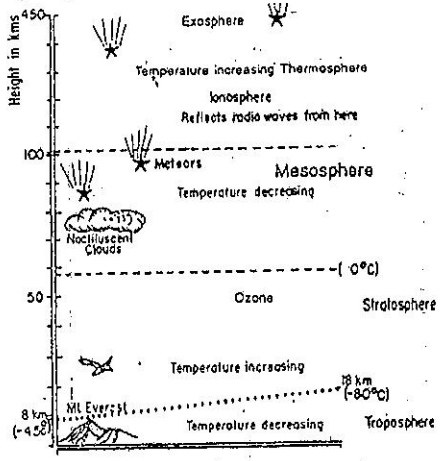


Fig. 1.2 Structure of the Atmosphere

Examine the four layers of air and their characteristics. Inter-planetary space extends beyond 1000 km. Which layer of the atmosphere is ideal for flying jet aircraft and why ?

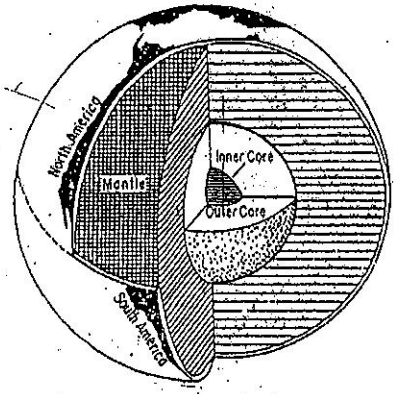
Above the troposphere is another layer called the *stratosphere*. The thickness of the stratosphere is about 40-45 kilometres. In this layer, the temperature remains constant and then increases with height. As the stratosphere is free from clouds and associated weather phenomena, conditions are ideal for flying of jet aircraft. The ozone in this layer absorbs harmful ultra-violet radiation from the sun.

The *mesosphere* extends above the stratosphere. The fourth layer is called the *thermosphere*. Its lower part, called the *ionosphere* contains electrically charged particles called ions. These particles reflect radio waves back to the earth's surface and enable wireless communication. The upper portion of this layer is called the *exosphere*. There is no distinct upper limit to the exosphere and this gives way to the inter-planetary space.

The atmosphere is an important element of the environment. The layer of air acts as a blanket protecting the earth from ultra-violet radiation and extremes of temperature. The differential heating of the atmosphere by the sun's rays produces circulation of air leading to winds, clouds and precipitation. The variation in climatic conditions on the earth is responsible for diversity in the distribution of plant and animal life.

The Lithosphere

The word 'lithosphere' refers to the solid layers of rock material on the earth's surface, both on the continents and ocean floors. The lithosphere is composed of the crust and the upper mantle. The average thickness of lithosphere is about 100 km. The crust is thicker in the continents than on the ocean floors. The crustal layer is of



1.3 The Layered Structure of Earth's Interior
It is the thin and solidified crust of the earth which supports all life. The experience from mines indicate that heat increases as we move downwards into the earth.

lighter density compared to the interior layers. As the crustal layer comprises of rocks rich in silica and aluminium, it is called the *sial* layer.

Below the sial layer lies the *mantle* which extends up to a depth of 2900 km. The mantle consists of (a) *Inner silicate* or *sima* layer having materials rich in silica and magnesium; and (b) transitional zone of mixed metals and silicates.

The *core* of the earth consists of metals in liquid or plastic state because of high temperature and pressure. The core of the earth has a radius of about 3400 km. As nickel and iron are dominant in the core, it is called *Nife*. This accounts for earth's magnetism.

Rock Types

The crust of the earth consists of various types of rocks. Rocks are made up of minerals which are naturally occurring solid materials having definite chemical composition.

Silicates are the most abundant minerals in the crust. Silicates are formed by combination of two elements—silicon and oxygen. Feldspar, quartz and mica are the most abundant silicate minerals found in rocks.

Rocks are classified into three major types on the basis of their mode of origin. Rocks which are formed by solidification from a liquid state are called *igneous rocks*. Such rocks are formed by gradual cooling of molten rock called magma which gets erupted by volcanoes. As the earth cooled to a solid crust, the original crust of the earth consisted of igneous rocks. Igneous rocks are, therefore, known as *primary rocks*. Basalt and Granite are examples of igneous rocks.

Sedimentary rocks are made up of sediments deposited usually on the floor of seas and lakes. Sediments may consists of particles of gravel, sand, silt or clay. The loose sediments get compacted into rocks by pressure of overlying sediments and presence of cementing materials such as lime. Limestone and sandstone are sedimentary rocks. Sedimentary rocks are also called *stratified rocks* as they occur in the form of layers or strata of sediments deposited one above the other. Sedimentary rocks are the most widespread on the surface of the earth. Sedimentary rocks contain remains of plant and animal organisms called fossils, which got deposited with sediments.

Metamorphic rocks are those formed by change of form of pre-existing igneous or sedimentary rocks, when they were subjected to extreme heat or pressure, or both. The minerals present in rocks get metamorphosed or altered owing to high temperature or pressure and new minerals are formed. The process is somewhat similar to that of making hard bricks form soft clay blocks. Limestone gets converted to marble, a metamorphic rock. Sandstone gets metamorphosed to to quartzite.

The lithosphere is a source of various mineral resources and fuels such as coal and oil. The soil cover on the land surface is indispensable for the growth of plants. The surface of the land is carved into a variety of landforms, such as mountains, plateaus, valleys and plains. The landforms are subjected to gradual changes by rivers and other agents acting on the earth's surface. Sudden changes may be brought about by earth movements or volcanic action.

The nature of the landforms in an area sets certain limitations to its use by men. For example, a hill slope can be cultivated only when it is terraced at considerable expense. Construction of houses and highways has to be in conformity with the topography of the region. Thus, the pattern of land use in a region depends on the nature of landforms, besides economic and cultural factors. An understanding of the processes at work in shaping

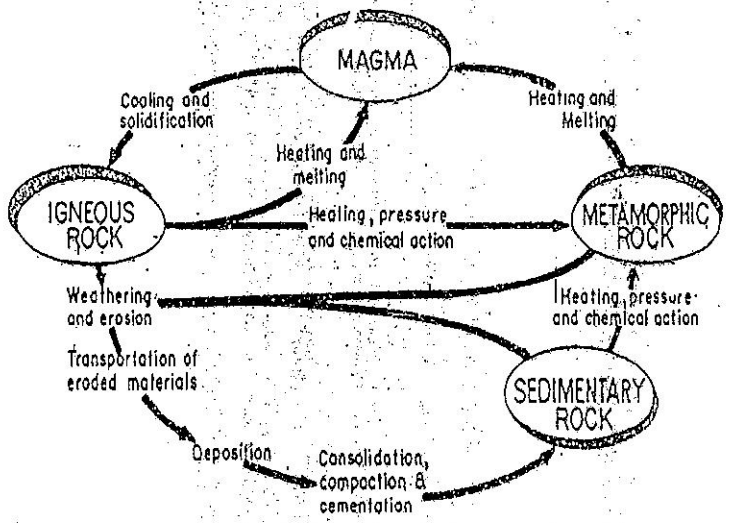


Fig. 1.4 Rock Types and their formation
Mark the three rock types on the earth's surface. Note how magma changes into igneous rock which changes into sedimentary and the metamorphic rocks.

the landforms in a region is essential for planning proper use of the land.

The Hydrosphere

The hydrosphere refers to the layer of water on the surface of the earth in the form of oceans, lakes, rivers and other waterbodies. Water covers 71 per cent of the total surface area of the earth. Therefore, the earth is sometimes called a 'watery planet'. Continents may be considered as large islands rising from the vast oceans. Water occurs on the land in the form of ice-sheets in polar regions and on high mountains. Water also occurs below surface of the land in the form of underground water. Water occurs in the form of water vapour in the lower layers of the atmosphere. Even plants and animals, including man are predominantly made up of water. Of the total volume of water available, 97 per cent is in the vast oceans, 2 per cent is stored in the form of ice-sheets and less than 1 per cent is available as fresh water.

Differential heating by the sun is responsible for the circulation of water in the hydrosphere, similar to the circulation of air in the atmosphere. When the surface water in the oceans, lakes, etc., gets heated by the sun's rays, *evaporation* takes place and water vapour is added on to the lower layers of the atmosphere. We know that water vapour in the atmosphere may get cooled leading to *condensation* of water into tiny droplets which form clouds. Such clouds may cause *precipitation* of water in the form of rainfall or snowfall on the surface of the earth. Rainfall on the land leads to surface *run-off* in the form of rivers which reach the oceans ultimately. In this process of circulation, water is consumed by plants and animals in the biosphere. Water may get

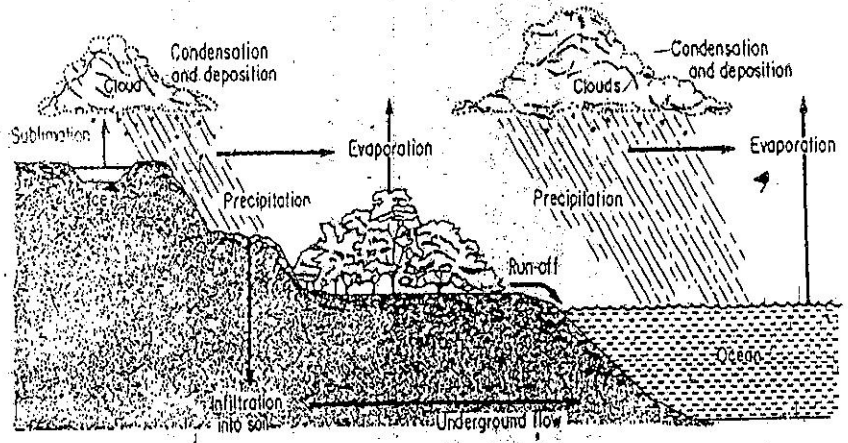


Fig. 1.5 Hydrological Cycle
Water is constantly moving round from ocean to air, from air to land and from land to ocean again. Can you tell what force is responsible for this hydrological cycle?

temporarily stored on the land in the form of lakes, ice-sheets or as underground water below the land surface. This circulation of water between hydrosphere, atmosphere and lithosphere is called the *'hydrological cycle'*.

Water circulates both horizontally and vertically in the oceans. When wind blows on the surface of the oceans, it drags the water in its direction resulting in the formation of *waves* and *currents*. The general pattern of ocean currents in the surface water is related to the prevailing winds. Movement of ocean water also takes place owing to gravitational force of the moon and the sun. Such movements are called *tides*. Normally tides occur twice a day at regular intervals.

Oceans are important as they provide link between the land masses by modern shipping. Oceans have a moderating influence on the climate of coastal regions. Oceans are teeming with plant and animal life. These marine organisms provide large reserves of food for man. Valuable reserves of oil have been tapped in the off-shore regions. There are valuable mineral deposits on the ocean floor. In addition to the resources on the land, humans have to turn their attention to the oceans for food and other needs.

The Biosphere

We have seen that the biosphere is a unique element of the earth. The organisms comprising the biosphere are mostly found in the relatively narrow zones of contact between the atmosphere, lithosphere and hydrosphere. The plants and animals living on the land are found in the zone of contact between the lithosphere and atmosphere. Similarly, the zone of contact between land and sea is teeming with organisms living on the shore and in the shallow sea water near the shore. In the open ocean, most of the living organisms occur in the shallow surface waters exposed to the atmosphere and sunlight.

The biological process depends on sunlight for their energy. Matter is derived from the minerals present in soil, water on the land and in oceans, and oxygen and carbon dioxide present in the lower layers of the atmosphere. The energy from the sun enables conversion of inorganic materials into organic matter leading to a variety of life forms varying in size from minute bacteria to huge trees, elephants or large whales. The growth and survival of the biosphere is made possible by the transfer of energy and matter between elements of the environment.

Each organism in the biosphere has certain limiting physical conditions for its survival and growth. This means that the types of plants and animals found in a region are related to the prevailing physical environment. Each organism prefers a certain *habitat*. All organisms living in a particular habitat are dependent on one another. Thus, all organisms in the biosphere not only interact with the physical environment but also with one another. A study of these inter-relationships between the various life forms and their environment is the major concern of the science of *ecology*.

Human beings are part of the biosphere. In the early periods of human history, human beings were just like any other animal being entirely dependent on the environment. Food gathering, hunting and fishing could not sustain a large population. With the development of agriculture, food was available in abundance and permanent settlements came into existence. Mining of coal, iron and other minerals heralded the Industrial Revolution. These led to the

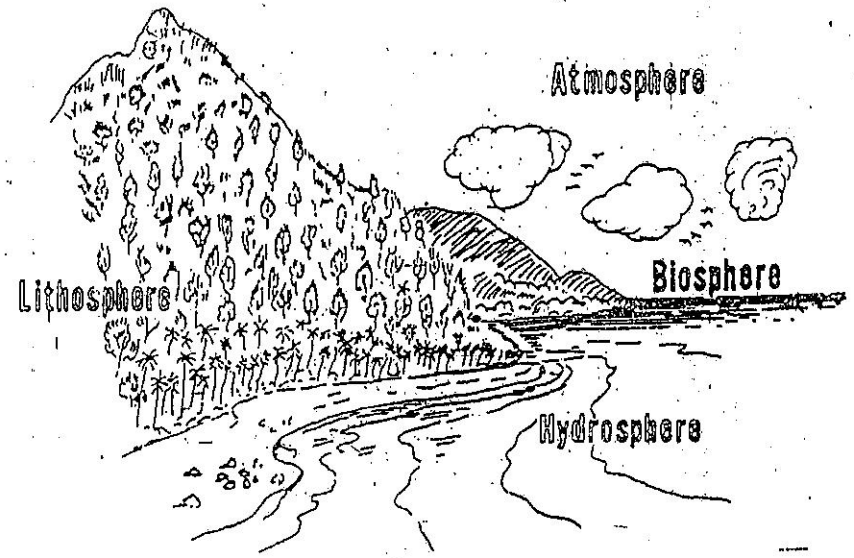


Fig. 1.6 The Biosphere
The life in all forms is confined to biosphere. It is a narrow zone extending to lithosphere, parts of hydrosphere and troposphere. The living organisms grow and reproduce in it.

increased production from fields and factories, and the colonisation of new landmasses like the Americas and Australia. With the tools at his command, man became a master of the environment. Human activities were aimed at satisfying their increasing needs from the environment. With rapid increase in human population during the last 100 years, their needs have increased enormously leading to an adverse impact on the physical and biological environment. Environmental pollution has taken place on a large scale in industrial and urban areas. These environmental changes pose a threat to survival of human on the earth.

There is an urgent need for protecting the environment from which humans derive their food and other resources. An understanding of the processes which take place in the environment is necessary so that human activities are reorganized in such a manner so as not to interfere with the environment. Human beings have to learn to live in perfect harmony with the physical and biological environment so that the earth continues to be habitable for future generations as well.

SELF-STUDY

1. Review Questions
   - (i) Why is the earth considered a unique planet?
   - (ii) Explain the term 'Dynamic Environment'.
   - (iii) Describe the composition of the atmosphere.
   - (iv) How are sedimentary rocks formed? Give two examples of such rocks.
   - (v) What processes cause circulation of water in the hydrosphere?
   - (vi) What do you mean by 'biosphere'?
   - (vii) How are oceans important to us?
2. Distinguish between
   - (i) Physical environment and Biological environment.
   - (ii) Troposphere and Stratosphere
   - (iii) Sial and Sima.
   - (iv) Igneous and Metamorphic rocks.
   - (v) Evaporation and Condensation.
3. Give a single technical term for each of the following :
   - (i) The lowest layer of the atmosphere where all weather phenomena take place.
   - (ii) The layer of rock materials on the earth's surface.
   - (iii) The circulation of water between sea, air and land.
   - (iv) The study of inter-relationships between the various life forms and their environment.
4. Discuss the significance of lithosphere to humans.

5. Describe the composition and structure of the atmosphere.
6. Examine the role of biosphere in the environment.

Do it yourself and find out

1. Study the environment in your area and make a list of four changes that you observe in the various elements of environment.
2. Examine the local area and list out the impact of human on the environment.
3. Collect specimens of rocks in your locality and name them.
4. Make a list of some important buildings or monuments of India and of the type of rocks used in their construction. Try to collect their pictures.

Books to Read

Goh Cheng Leong, *Certificate Physical and Human Geography*, New Delhi : Oxford University Press.
John F. Kolars and John D. Nystuen, *Physical Geography–Environment and Man*, New York : McGraw Hill.
Joseph M. Moran and others, *Introduction to Environmental Science*, San Fransisco : W.H. Freeman & Co.
Lake, P., *Physical Geography*, Calcutta: Macmillan & Co.
R.G. Barry and R.J. Chorely, *Atmosphere, Weather and Climate*, Britain : Methuen & Co.

CHAPTER TWO

Face of the Land

THE SURFACE of the land is rarely uniform in height or appearance over large areas. Mountains, plateaus and plains are major landforms on the continents. Landforms vary in size and shape not only from place to place but also change with the passage of time. Such changes may occur suddenly or gradually. We are more aware of sudden changes caused by earthquakes or volcanic eruption or floods. Gradual changes are more widespread and take place continuously.

Landforms are caused by the action of two types of natural processes on the surface of the land. These natural processes may be divided into two major types—the external processes and the internal processes. The external processes are those which take place in the atmosphere and hydrosphere and affect the surface of the land. The internal processes take place in the interior of the earth and cause changes on the land surface. The external processes act slowly, wearing down the highland and depositing materials in the lowlands. The internal processes cause movements of the earth's crust leading to formation of mountains and plateaus. The nature of landforms at any place is the result of the interaction of these processes at a given period of time.

EXTERNAL PROCESSES

The crust of the earth consists of various types of rocks. Changes in weather conditions affect the rocks exposed on the surface and break them up into smaller particles. This process of breaking up of the rocks by changes in weather phenomena such as temperature, moisture and precipitation or by protrusion of plant roots, is called *weathering*. Weathering takes place in *situ*. This means that rocks break down in the places where they occur. Weathering may also be caused by chemical changes in the composition of minerals owing to seepage of water through joints and fissures in the rocks.

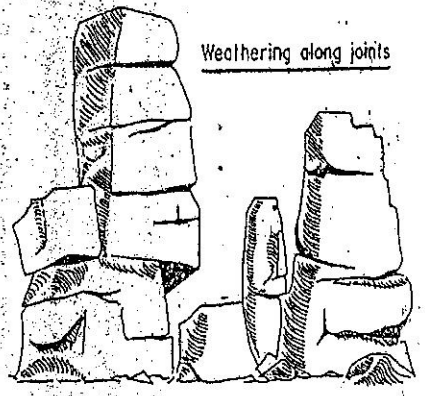


Fig. 2.1 (a) Weathering of Rocks
Water enters the rocks through their joints. In course of time they are split up.

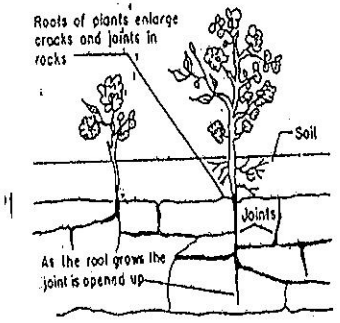


Fig 2.1 (b)
The plant roots penetrate the rocks through cracks and help in their breaking down at the place where they are standing.

The effect of weathering is to produce a layer of loose particles of rocks on the surface of the land. This layer of weathered particles protects the underlying rocks from further weathering. If the layer of weathered particles remains undisturbed over a long period of time, slow chemical and organic changes lead to the formation of *soils*. Thus, the process of weathering helps in the formation of soils. Differences in the intensity and type of weathering produce a number of minor landforms.

Soils are indispensable for the growth of all plants. The soil consists of mineral matter such as sand and clay as well as organic matter such as decayed leaves, flowers, dead tissues of organisms, minute bacteria and earthworms. Soils are formed by physical, chemical and organic changes which take place in the soil layer. Soil formation is mainly governed by factors such as the climate, nature of parent rock, topography of the area and the type of vegetation. Among these, the climate is the most important as it affects weathering of rocks, the quantity of moisture in the soil layer and the nature of vegetation. While soils are usually formed by the weathering of rocks, alluvial soil in river valleys and deltas is formed by deposition of materials by rivers.

The layer of weathered particles may get displaced down the slope by the action of gravity. Landslides occur owing to sudden movement of rock particles down a steep slope, especially during the rainy season. The rain-water seeps through weathered particles reducing friction and increasing their weight. Landslides block roads and railway lines and cause damage to houses and cultivated lands.

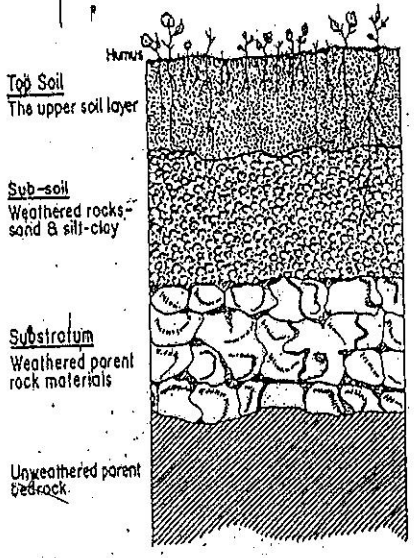


Fig. 2.2 Soil Formation
Note three main stages leading to the change of rock into soil particles.

Gradational Processes

Weathered particles are gradually transported

by moving agents such as rivers and winds and get deposited in the lowlands or on the sea floor. These processes are called *gradational processes* as they reduce the difference in height between highlands and lowlands. Gradational processes tend to produce a graded or level surface over a long period of time. The gradational processes comprise two components, namely degradation and aggradation. *Degradation* is the process by which material is removed from the highlands by erosion of the land. *Aggradation* is the process by which deposition takes place in the lowlands leading to a gradual increase in level. Both degradation and aggradation take place simultaneously over different areas.

Agents of Gradation

Rivers, glaciers, winds and waves are the main agents of gradation. These agents move on the surface of the land and they are assisted by the force of gravity in moving the materials down the slope. Winds may transport material even up the slope but such action is limited to fine particles of sand and dust. Each one of the agents of gradation plays an important role in certain regions only. The work of glaciers is limited to polar regions and ice-capped mountain tracts. Wind action is dominant in deserts, as the absence of vegetation cover helps removal of dry, loose particles of sand and dust by strong winds. Wave action plays an important role in the zone of contact between land and sea. The action of running water is the most widespread among all agents of gradation and it is, therefore, known as the *normal process of gradation*. A region may be subjected to more than one process of gradation in different seasons. For example, in a semi-arid region, work of running water is dominant in the short rainy season and wind action prevails in the dry season.

Rivers

Rivers originate in mountainous or hilly tracts, flow through a stretch of lowland and finally reach the sea. The volume of water flowing in a river varies according to season. The volume of water also varies depending on the quantity of water derived from other sources like melting of ice and springs. Rivers which maintain flow of water throughout the year are known as *perennial* rivers. Non-perennial rivers do not have flow of water during the dry season.

The course of a river from its source to its mouth is normally divided into three sections, namely, upper, middle and lower courses. In the upper course, as the water rushes down a steep slope, there is maximum erosive action along the river course. Such deepening of the river channel gives rise to gorges and canyons. The steep-valley slopes get weathered gradually to assume a V-shape. The valley gets deepened more rapidly and differential rates of erosion along the bed of the river leads to the formation of rapids and waterfalls. The occurrence of hard resistant rock across the path of the river may cause a waterfall owing to rapid erosion of less resistant rock downstream. Waterfalls are harnessed for the generation of hydro-electric power. In the upper course, many tributaries join the main river.

In the middle course, the path of the rivers is less steep than in the upper course. There is no further deepening of the valley. Here the volume of water is greater than in the upper course. The valley gets widened leading to the formation of a broad valley floor. The river channel occupies only a portion of the broad plain. The river channel develops broad sweeping curves in the level plains. Such curves in the river channel are called *meanders*. During floods, water overflows the channel and covers the entire plain

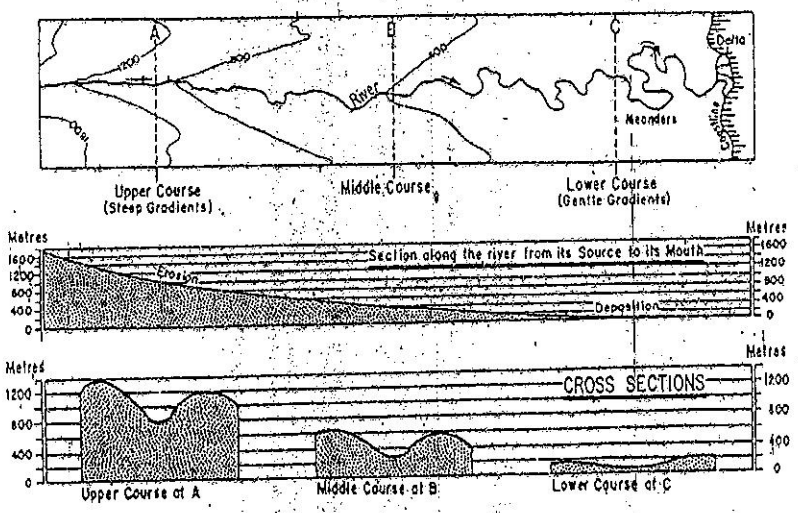
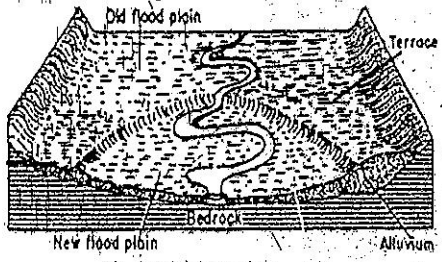


Fig. 2.3 Profile of a River Course
Note the upper, middle and lower courses of a river from its source to its mouth. What difference do you find in the slope and form of land in the three parts of its course.

submerging a vast area. When floods subside, sediments get deposited. These sediments are called alluvium. The plains on either side of the channel are called *flood plains* as they are liable to submergence during floods.

In the lower course of a river, the valley floor has extremely gentle slope. Hence, the river is unable to transport all the sediments in its channel. As deposition is the dominant process, the river channel gets obstructed and



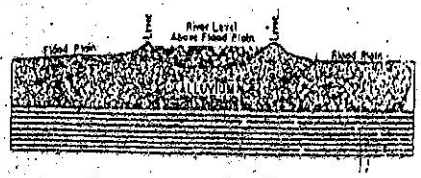


Fig. 2.4 (a) Meanders
Why does a river form broad curves called meanders towards its lower course ?

Fig. 2.4 (b) Flood Plain
It is a low flat river plain experiencing overflow of water on both sides of its channel.

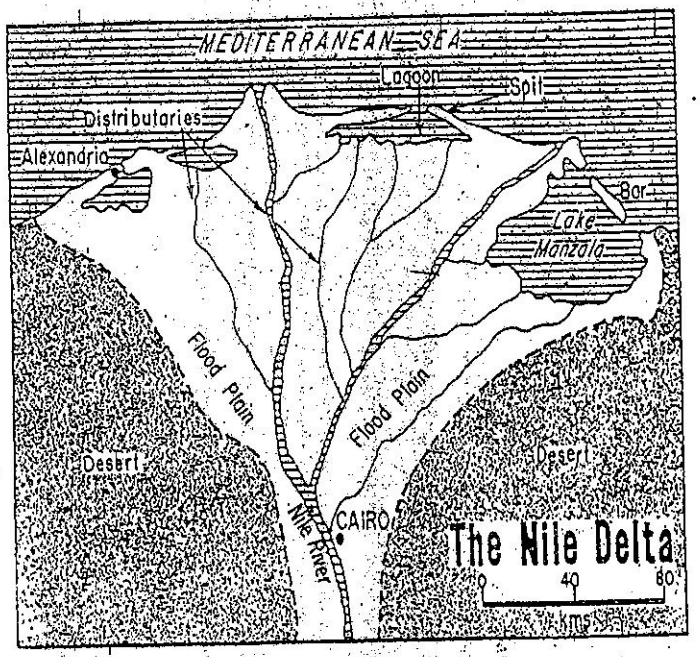


Fig. 2.5 A Delta

A delta is formed when the finest material like mud is carried by the river and is deposited at its mouth. On boming into the saline sea water, it starts settling down rapidly and gets projected into the sea. Why are most of the river deltas important to us ?

the river divides itself into a number of distributaries or branches. While a *tributary* joins the main river adding water from its basin, a *distributary* branches off from the main river carrying away a part of the water from the main river. The lower course of the river consists of a number of distributaries of various sizes extending over a large area of alluvial plain. This vast alluvial plain is called the *delta*, as its triangular shape resembles the Greek letter, Δ delta. The deltas of rivers contain fertile deposits of alluvium. For example, river Nile in Egypt and the east-flowing rivers of the Peninsular India such as the Godavari, the Krishna and the Kaveri have built deltas along the coast owing to the gentle slope in the lower course. West-flowing rivers of Peninsular India have no deltas, as they flow down rapidly along the steep western slope and deposit the alluvial sediments on the sea-floor. The Narmada and Tapi rivers enter the sea through deep narrow channels called *estuaries*.

The work done by a river in its valley comprises erosion, transportation and deposition. While transportation of sediments takes place throughout the river course, erosion is dominant in the upper course having a steep slope and deposition of material is typical of the lower course having a gentle slope.

In the middle course, neither erosion nor deposition is dominant, though both the processes take place. The capacity of rivers to wear down land masses is indeed quite large. Rivers like the Ganga, transport about one million tonnes of sediments everyday. It is estimated that at the present rate of erosion, all the land above sea-level in the United States would be worn down to sea-level in a period of about 12 million years. Is this possible?

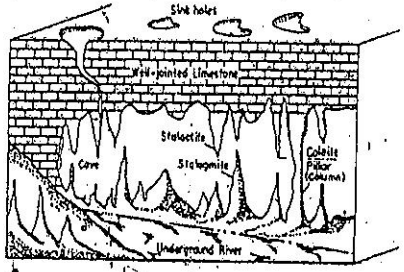


Fig. 2.6 Work of Underground Water

The limestone rock is soluble in water. The underground movement of water in such a rock leads to the formation of particular type of features. Recognise them in the diagram.

Underground Water

The underground water plays an important role as an agent of gradation in regions having soluble rocks like limestone. Limestone consists of calcium carbonate. Rain water absorbs carbon dioxide from the atmosphere. When rain falls on limestone rock, it reacts chemically with calcium carbonate in limestone resulting in the formation of calcium-bi-carbonate which is soluble. As rain water runs down the surface of limestone, it dissolves the rock along its path leading to the formation of furrows. This irregular surface with ridges and furrows is known as *clints* or *lapies*. If rain water stagnates, depressions are formed by solution. These are known as *sinkholes*. Percolation of water through joints and fissures leads to the formation of *caves* below the ground. As the caves are warm, water may get evaporated leading to deposition of lime in various shapes. Such deposits of lime are called *stalactites*, when they grow downward from the ceiling and *stalagmites*, when they grow upwards from the floor. In some caves, stalactites and stalagmites may join to form *pillars*.

Glaciers

Glaciers are moving masses of ice. They occur in polar regions and high mountain ranges having a permanent cover of ice and snow. The height above which there is a permanent cover of snow and ice is called the snow-line. In the equatorial regions, the snow-line is at a height about 5500 metres above the sea-level. As one moves poleward away from the equator, the height of the snow-line decreases gradually. In the polar regions, the snow-line is at the sea level.

Glaciers may be classified into two major types: *continental glaciers* and *mountain glaciers*. Continental glaciers occur in polar regions in the form of extensive and thick ice-sheets covering the entire land surface. The large continent of Antarctica is covered by thick ice-sheets. The extent of continental glaciers is not always constant. As the earth gets warmer, continental glaciers melt away along the margins reducing their extent. About one million years ago when the earth was much cooler, continental glaciers extended over northern parts of Europe, Asia and North America.

Mountain Glaciers

Mountain glaciers occur in high mountain regions such as the Alps and the Himalaya. In such regions, ice and snow accumulate in depressions and along valley heads near the summits. They move down along the valleys

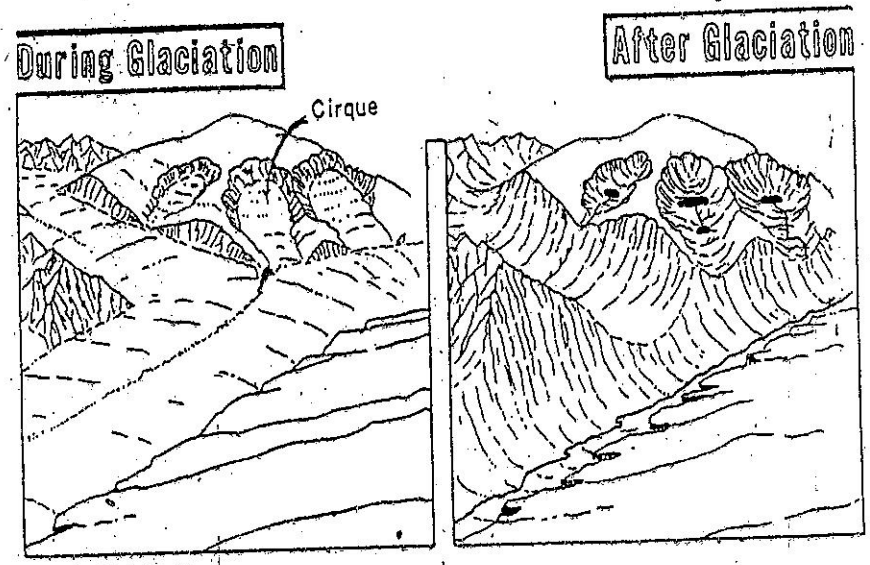


Fig. 2.7 (a) A Cirque
All mountain glaciers originate from cirques and move down the pre-existing valleys. Why the cirque gets a relatively flat floor and steep slopes on all sides after glaciation ?

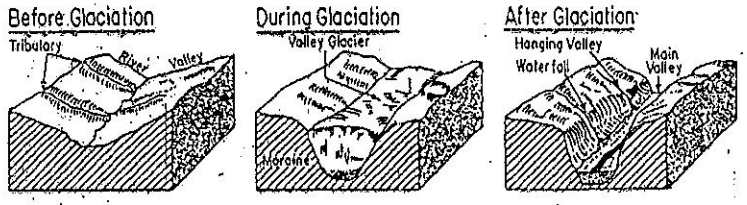


Fig. 2.7 (b) A Glaciated Valley
Note the work of a valley glacier in depositing morgines and leaving behind U-shaped valleys.

as tongues of ice. These are called valley glaciers. As the movement of solid blocks of ice is slowed by friction with the sides and floor of the valley, the average rate of movement of valley glaciers is hardly a few centimetres per day. Valley glaciers are short in length, generally not exceeding 100 kilometres. As the valley glaciers descend down to lower levels which are warmer, they melt away in the form of streams. The Himalayan rivers such as the Ganga and Yamuna originate from valley glaciers.

When snow falls in a mountain region, it accumulates in depressions around the summits. As more and more snow accumulates, it gets converted to ice under

pressure. The glacial erosion results in the formation of arm chair-shaped or circular depressions. These are called *cirques*. They have a relatively flat basin-shaped floor with steep slopes around it. The ice accumulates in such basins. Cirques get gradually enlarged owing to weathering of rocks along the edges. Cirques are usually small in size, varying in diameter from a few hundred metres to a few kilometres. Cirques are now observed in mountain regions which were once fully covered by the glaciers. The rivers originate from lakes which now occupy the deepest parts of the cirque basins.

As the glacier extends from the cirques along the former river valley, the shape of the valley gets modified owing to the large volume of the glacier. Glacier may overflow on either side of the V-shaped river valley. Glacier carries large quantities of rock particles which get embedded at the bottom of the glacier. Movement of the glacier along the valley leads to modificaton of V-shaped river valley into a *U-shaped valley*. The U-shaped valley has a broad flat floor and steep sides. The presence of U-shaped valleys in a mountain region indicates that it was covered by valley glaciers in the past.

When the glaciers melt away in the warmer lower slopes all the material carried by it gets deposited. Such deposits containing irregular heaps of rock particles of varying sizes are called *moraines*.

Winds

Wind action as an agent of gradation is different from that of rivers and glaciers which move down the slope. Winds may transport large quantities of fine particles of sand and dust even against the general slope of the land over hundreds of kilometres. Wind action is dominant in arid and semi-arid regions.

The absence of vegetation cover enables the winds to blow freely near the surface of the land and remove easily the dry particles of sand and dust. While coarse sand particles are only transported in the lower layers of the atmosphere owing to their weight, dust particles are carried in suspension even at higher level.

The erosive action of the wind is due to the impact of sand particles with objects in its path. As winds may blow from different directions, impact of sand particles may cause erosion from all directions. As wind erosion by forceful impact of sand particles is maximum at a height of a few metres above the surface of the land, typical landform that is commonly formed is called *mushroom rock*.

Mushroom rock resembles a mushroom in shape with a narrow trunk and a broad top portion. The narrow trunk indicates the level at which maximum wind erosion has taken

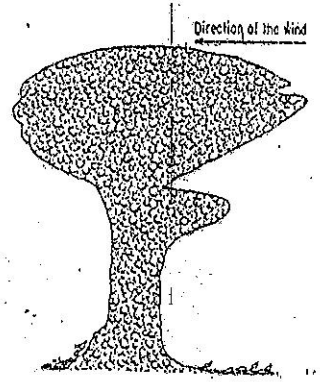


Fig. 2.8 A Mushroom Rock
A mushroom rock is the name of the landform caused by abrasion or erosion by wind. How wind erosion is selective in not eroding the rock into a regular shape ?

place. Wind erosion is less near the bottom portion of mushroom rock as wind velocity is reduced by friction with the land surface. Though wind velocity is great at the top portion of mushroom rock, erosion is less as winds do not carry much particles of sand at this level.

Winds deposit materials when their velocity decreases or when there are obstructions along their path or when rainfall occurs. Deposition of sand leads to the formation of sand dunes. Sand dunes may occur in different shapes and sizes. The most common type of sand dune is crescent-shaped with the tapering horns of the crescent extending in the direction in which the wind blows. These dunes are called *barchans*. Transport of sand by winds leads to gradual migration of sand dunes in the direction in which the wind blows.

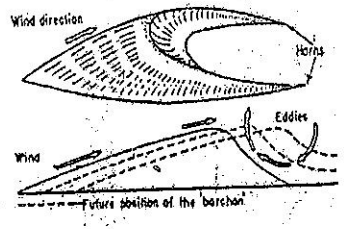


Fig. 2.9 Sand Dunes
The sand dune is the result of wind deposition. The common type of sand dune has a crescent shape with horns extending in the direction of the wind. Find out in which direction do the sand dunes called "barchans" migrate.

Dust particles are transported by winds over hundreds of kilometres and they get deposited in humid regions when rainfall occurs. Such dust particles may accumulate over an extensive area covering the entire surface of the land. Such wind blown deposits are known as *loess deposits* and occur over a large area northwest of Beijing in China.

Waves

The action of waves as agents of gradation is limited to the narrow zone of contact between land and sea. Waves are generated by the friction of the wind on the surface of waters. When waves travel towards the sea shore and break, they develop a considerable force when large quantities of water dash against the shore with high velocity, consequently land along the shore gets eroded. As the waves recede from the shore, eroded particles are transported and get deposited on the sea floor and along the shore. Thus, the work done by waves consists of erosion, transportation and deposition.

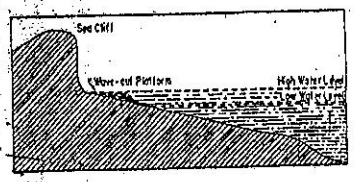


Fig. 2.10 (a) A Wave-cut Platform
The sea waves strike at the foot of the cliffs along a rocky coast. The cliff gradually moves landwards as a result of this repeated action. A flat platform, called wave-cut platform, is left behind where the cliff was once standing.

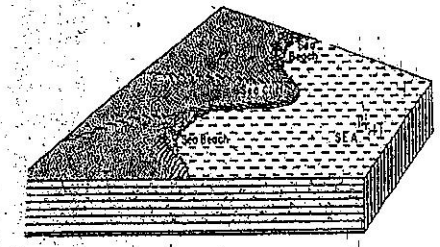


Fig. 2.10 (b) Sea Beaches and Sea Cliffs
A strong wave erosion produces a steep sea-facing cliff along a rocky shoreline.
Beach sand or pebbles are found mostly along narrow lanes or gently sloping shorelines where wave-erosion is weak. India has its well known beaches along coast of Kerala, Goa and Orissa.

Wave erosion along the shore results in the formation of *cliffs* of varying heights. Cliffs have a steep slope facing the sea. As the waves break at the foot of the cliff, cliffs recede in land gradually leaving a flat *wave-cut platform* along the shore. Cliffs are well developed along shorelines having a steep slope because waves break near the shore. In the case of shorelines having a gentle slope, the sea is shallow near the shore and waves break in the off-shore region. Therefore, cliffs are not formed along the shore.

Deposition of materials by waves results in the formation of *beaches* along the shore. Beaches may contain deposits of sand, gravel or pebbles in varying proportions. Wide beaches are developed on gently sloping shorelines. Deposition by waves may also result in the formation of narrow elongated *sand-bars*. Sand-bars vary in shape and may extend parallel to the shore or at an angle to the shore. The shallow sea between the sand-bar and the shore forms a lagoon or marsh and gets gradually filled up by sediments. The shallow backwaters along the Kerala coast are of such origin.

INTERNAL PROCESSES

The Himalayas are made up of layers of sedimentary rocks having fossils of marine organisms. Therefore, it becomes evident that these high mountain ranges must have originated from sediments deposited in shallow seas. The sedimentary rocks comprising the Himalayas show evidences of having been folded, deformed and displaced to a large extent. Such compression and uplift of layers of sedimentary rocks would have been possible only by the operation of internal forces on a large scale. Such internal forces are responsible for volcanic eruption, movements of the earth's crust and earthquakes. These internal forces are called *tectonic forces*.

While the external gradational processes can be observed, the nature of internal forces cannot be observed or measured as they operate in the interior of the earth. Our knowledge of the composition structure and physical conditions in the interior layers of the earth is not adequate to enable us to get a clear picture about the internal forces. However, the effect of internal forces may be seen on the surface of the earth in the form of major landforms.

Earth Movements

Movements of the earth's crust are classified into two major types: (i) Vertical movements; and (ii) Horizontal movements. Vertical movements lead to either uplift or subsidence of the earth's crust along lines of weakness which are called *faults*. Displacement of the earth's crust takes place along the fault line. When displacement takes place along two adjoining faults, the portion between them may get uplifted to form a block mountain or pleateau, or subside to form a basin. *Rift Valleys* in East

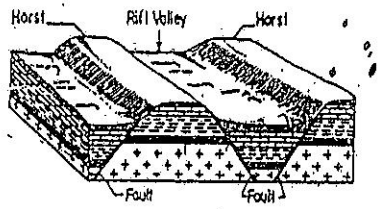


Fig. 2.11 Rift Valley
Note the sunken blocks of land in relation to the two adjacent raised blocks. As a result of vertical movement they lie between two faults on either side. Which block is called the Rift Valley and which one is the horst block ?

Africa are typical examples of such basins bounded by faults. Large scale vertical movements of the earth's crust are called *epeirogenic* or *continent-building movements*.

Horizontal movements of the earth's crust

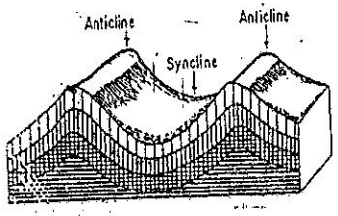


Fig. 2.12 Simple Folds
The horizontal pressure on the sedimentary strata changes them in upfold and downfold. The upfold is called anticline where the rocks incline in opposite directions; The downfold is named as syncline where the strata incline in the same direction.

are responsible for folding and displacement of the layers of rocks. Simple folding consists of alternating upfolds called *anticlines* and downfolds called *synclines*. Such simple folds rarely occur. More often folds get compressed to such an extent that the layers of rocks get displaced over long distances resulting in complex structure. Large-scale horizontal movements are called *orogenic* or *mountain-building movements* as they are responsible for the fold mountains like the Himalaya.

Earth movements of both vertical and horizontal types have taken place at different periods of earth's history. Major mountain ranges and plateaus are their present distribution to these earth movements.

Volcanoes

A volcano is a hole or fissure in the earth's crust through which *magma* ash, gases and rock material from the earth's interior is erupted. Magma consists of molten rock with gases and steam. As the magma flows out on the surface, the gases and steam escape rapidly. The molten rock called lava cools down gradually and gets solidified. The eruption of material from the interior layers may occur explosively or quietly.

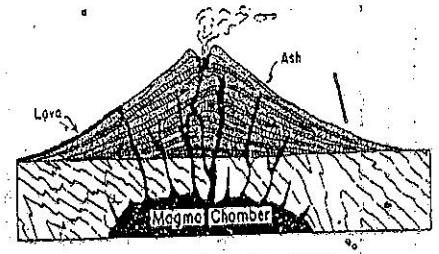


Fig. 2.13 Volcanic Cone with a Crater
A volcano is an opening in the earth's crust through which lava, gases and steam reach the earth's surface.

The most common type of volcano is called the *Central type* in which eruption occurs at a point through a narrow pipe or passage. The hole or opening through which the eruption takes place is called the *vent* of the volcano. The erupted material accumulates around the vent to form a cone-shaped hill. The hill grows up by the successive layers of lava and intervening layers of particles of rocks, boulders and other material produced by explosive eruptions. Explosive eruption may cause a depression around the vent. Such a depression or basin at the summit of the volcanic cone is called the *crater*. Most of the major volcanoes are of the *cone and crater* type in origin and appearance. A chain of such volcanoes forms a volcanic mountain range.

In some parts of the world such as the Deccan Plateau, Northern Ireland and Iceland, volcanic eruption has taken place along narrow fissures or cracks in the earth's crust. These are called *fissure eruption*. Fissures may be several kilometres in length. Large volume of magma may spread over a large area forming layers of lava sheets. These form plateaux having a series of steps and extending over several hundred square kilometres. In the western part of the Deccan Plateau, the thickness of the lava sheets exceeds 1000 metres.

volcanoes are usually classified into three types on the basis of their frequency during the period of recorded history. *Active Volcanoes* are those which have erupted in the recent past. There are about 500 active volcanoes, most of which are located in and around the Pacific Ocean. *Dormant Volcanoes* are those which have erupted in early periods of history but are now quiet. *Extinct Volcanoes* are those which have not erupted in the historical periods. Vesuvius Volcano in Italy which was considered extinct erupted suddenly in 79 A.D.

Earthquakes

Whenever there is a sudden displacement of a part of the crust due to tectonic forces, it causes tremors or waves which travel in all directions from the centre of disturbance. These sudden tremors are called *earthquakes*. The centre from which the earthquake waves originate is called the *Seismic focus*. The point on the earth's surface vertically above the seismic focus is called the *epicentre*. Most of the earthquakes have seismic focus at depths of less than 60 km. The intensity of the tremors is maximum near the epicentre and decreases with distance from the epicentre.

Earthquakes occur frequently in unstable portions of the earth's crust. Earth movements along lines of weakness and volcanic eruptions cause tremors on the earth's surface while hundreds of mild earthquakes occur daily, strong tremors which cause large-scale damage to life and property are less frequent. The intensity of the earthquake wave and its time of occurrence is recorded by Seismograph.

Passage of earthquake waves may cause vertical and horizontal displacement of the earth's surface. Cracks or fissures may be formed over long distances. River courses may be altered leading to sudden floods. Landslides may block rivers forming lakes.

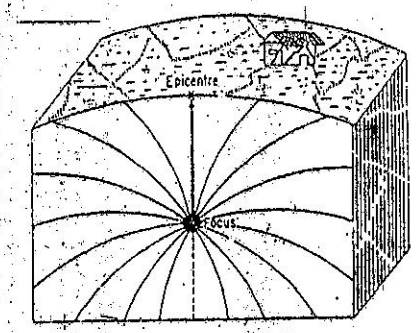


Fig. 2.14 Seismic focus and Epicentre
Examine the location of epicentre on the earth's surface directly above the focus or the point of origin of the earthquake down below.

Roads, railway lines and buildings are damaged, causing extensive loss to human life and property. In cities, gas and water pipelines may get disrupted. When the epicentre lies on the sea floor, huge seismic sea waves advance towards the coast submerging large areas along the coast.

Earthquakes occur more frequently in the recently formed folded mountain regions which are relatively unstable. About two-thirds of the earthquakes originate in the Circum-Pacific belt along the west coast of North and South America and the east coast of Asia. The Alpine-Himalayan mountain belt in Europe and Asia accounts for 20 per cent of the earthquakes.

In India, earthquakes of severe intensity have occured in the Kashmir Valley (1823 and 1885), Kumaon Hills (1803), Cachar (1869), North Bihar (1934), Assam (1897 and 1950), Kinnaur and Uttarkashi districts in 1975 and 1991 respectively and Latur (1993). The Deccan Plateau is usually considered as a stable block, free from earthquakes. But in 1967 and in 1993 earthquakes rocked Koyna Nagar and Latur

region, respectively. In areas, where earthquakes occur frequently, such as Japan, buildings are constructed so as to withstand tremors of the earthquakes.

The external gradational forces such as rivers, acting on the earth's surface, transfer large quantities of material from the continents to the oceans. This disturbs the equilibrium of the earth's crust. The internal forces help in re-establishing the equilibrium by uplift of land masses, formation of fold mountains or eruption of huge masses of lava by volcanic action. The tectonic forces which cause earth movements and the gradational processes act together to maintain a state of balance or equilibrium in the earth's crust.

SELF-STUDY

Review Questions

1. Answer the following questions briefly:
   - (i) What is meant by 'weathering'?
   - (ii) Describe the work done by a river in its upper course.
   - (iii) Examine the role of underground water as an agent of gradation.
   - (iv) What are the typical landforms produced by wind action.
   - (v) Attempt a classification of volcanoes on the basis of their activity.
2. Distinguish between
   - (i) Aggradation and degradation.
   - (ii) Stalactites and Stalagmites.
   - (iii) Tributary and distributary.
   - (iv) Continental glaciers and Mountain glaciers.
   - (v) Anticline and Syncline.
3. Match the following:

Agents of gradation	*Landforms*
(i) River	Barchan
(ii) Glacier	Cliff
(iii) Underground water	Moraines
(iv) Wind	Caves
(v) Waves	Meander

4. Describe the work of a river as an agent of gradation.
5. Examine the landforms produced by earth movements.

Do it yourself and find out:

1. Prepare clay models of landforms described in this chapter.
2. Collect press-cuttings about recent earthquakes and volcanoes.
3. Make a field trip in the area around the school and identify the landforms.
4. Draw diagrams to show the following landform: meander, cirque, barchan, U-shaped valley.
5. Locate some important gorges made by rivers in India and elsewhere. Note down their characteristics.
6. Identify Indian rivers which do not form deltas. Try to find out various reasons for this phenomenon.
7. Collect information on extension of Rajasthan desert in the areas around it and on the steps taken to check it.

Books to Read

Bunnet, R.B., *Physical Geography in Diagrams*, New Delhi : Orient Longman.
Goh Cheng Leong, *Certificate Physical and Human Geography*, New Delhi : Oxford University Press.
Monkhouse F.J., *Principles of Physical Geography*, London : University of London Press.
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CHAPTER THREE

Realms of Water

OUR EARTH is unique in having an abundance of water in the form of oceans. Presence of large quantities of water is responsible for moderating the temperature conditions. The surface water of the oceans does not get heated as rapidly as the land surface. Two and a half times more energy is needed to heat water than heating the land surface. Moreover, a part of the sun's rays falling on the water surface gets reflected and another part of solar energy is utilised for evaporation of water into water vapour. The sun's rays have to penetrate to a greater depth for heating the oceans than the land. As the solar energy is heating up a large volume of water by convection, temperature of the atmosphere over the oceans is much less than that over the land surface. The large expanse of oceans is thus responsible for reducing the extremes of temperatures not only between summer and winter but also between day and night.

Water in the Oceans

Ocean water contains a larger quantity of salts in solution as compared to water on the land or groundwater. Salinity of water refers to the quantity of salt dissolved in it. The average salinity of sea water is 35 gm per kilogram. The salinity is less than average in coastal regions where large rivers add fresh water to the oceans. The salinity is above average in tropical regions owing to greater evaporation of sea water.

When surface water gets heated by the sun, water evaporates and increases the concentration of salts. Surface water becomes denser and sinks, and sub-surface water rises up. Thus, salinity of sea water causes vertical circulation.

The saline waters of the oceans have provided ideal conditions for the origin of different life forms. It is believed that life originated in sea and spread to land later. Ocean waters are rich in a variety of organic life from minute plankton to huge whales.

Ocean Floor

The ocean floor is not a level surface as was believed earlier. The relief features of the ocean floor are more varied than those on the continents. Adjoining the shore is a shallow stretch called the *continental shelf*. The edge of the continental shelf extends up to a depth of 150 to 200 metres. This shallow sea floor contains sediments deposited from the land. The average width of the continental shelf is about 70 km. Though in some areas the width may be a few hundred kilometres. The shallow seas of continental shelf provide rich fishing grounds. About one-fourth of the world's petroleum is produced from oil wells on the continental shelf.

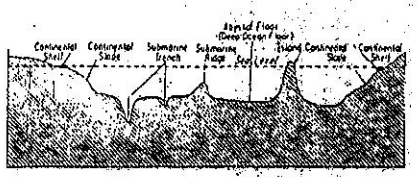


Fig. 3.1 Submarine Relief
The ocean floors also have varied and well-marked features as we have on land. Why is the continental shelf most useful to us ?

Continental Slope

Continental slope represents the edge of the continental block. It has a steep slope linking the continental shelf and the deep sea floor lying at an average depth of about 3600 metres.

About 40 per cent of the ocean floor consists of relatively flat basin called the *abyssal plain*. The depth of the abyssal plain may vary from 3000 to 5000 metres. The flat surface of the plain is the result of accumulation of sediments on the sea floor.

In some oceans, narrow, elongated ridges, resembling the mountain ranges on the land, rise from the sea floor. These are called *submarine ridges*. Peaks of these ridges may rise above sea level to form islands. *Submarine plateaus* and *volcanic cones* may rise from the sea floor.

In some parts of the abyssal plain, deep, narrow, steep sided depressions are found. These are called *deeps* or *trenches*. Generally such trenches occur along the margins of the abyssal plains. The depth of these trenches may vary from 6000 to 11000 metres below sea level. The major submarine relief features such as ridges and trenches are the result of tectonic forces. For example, a submarine ridge runs through the Atlantic Ocean from north to south. Deep trenches occur along the margins of the Pacific Ocean.

Water in the Air

Water is added to the atmosphere when evaporation takes place owing to heating of water bodies by solar radiation. When water gets heated, it becomes water vapour and mixes freely with other gases in the atmosphere. The process of evaporation cannot continue endlessly. There is an upper limit beyond which water vapour cannot be added to the atmosphere. For example, at a temperature of 10°C, one cubic metre of air can hold 11.4 gm of water vapour. This upper limit is known as the state of saturation. Warm air can hold more water vapour than cool air.

The amount of water vapour present in the atmosphere gives a measure of humidity in the atmosphere. Absolute humidity measures the actual quantity of water vapour present in a given volume of air. It is expressed in grams per cubic metre. A more useful measure of

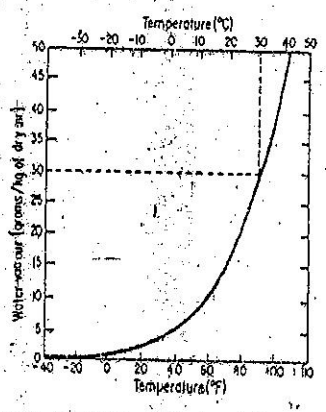


Fig. 3.2 Water Holding Capacity of Air
Note how warm air holds more water in the form of water vapour than the cool air. That is why the air at 10°C temperature needs less water vapour to saturate than air at 30°C temperature.

humidity in the air is *relative humidity*. Relative humidity is expressed as a ratio between the actual water vapour present in the atmosphere and that needed to saturate the atmosphere at that temperature. This is expressed in percentage. For example, at 20°C, air can contain a maximum of 17 grams of water vapour per cubic metre. If the actual water vapour present is only 8.5 gm, the relative humidity is 50 per cent. Relative humidity increases with decrease of temperature or addition of water vapour. Relative humidity decreases with increase of temperature or decrease of water vapour. The critical temperature at which saturation level is reached is called *dew point*.

Condensation

Condensation is the opposite of evaporation, as it involves conversion of water vapour into droplets of water or crystals of ice. Condensation starts only when the air is cooled beyond the dew point temperature. When the relative humidity exceeds 100 per cent, the excess of water vapour present in the atmosphere gets condensed as minute droplets of water. For example, when air at a temperature of 20°C contains 15 gm of water vapour per cubic metre and gets cooled to 10°C, it can hold only 11.4 gm of water vapour at saturation level. The excess of 3.6 gm of water gets condensed. Condensation can take place only when minute solid particles are present in the atmosphere. Water vapour condenses as a thin film around minute particles of dust, salt grains, pollen grains, etc. These droplets of water float in the air and form clouds. Clouds may also contain tiny crystals of ice. Clouds are classified into different types on the basis of their forms and heights at which they are found.

Precipitation

Precipitation is the process by which condensed water from the clouds falls through the atmosphere and reaches the earth's surface as rainfall and snowfall. Precipitation takes place only when millions of minute droplets of water in the cloud aggregate to form a large size particle which falls down owing to its weight. The physical processes leading to precipitation of moisture from the air are more complex than the process of condensation.

Forms of Precipitation

Rainfall is the most common form of precipitation in which rain drops are a few mm in diameter. Less intense rainfall consisting of particles of the size less than 0.5 mm in diameter is called *drizzle*. When condensation takes place at temperature below freezing point, water vapour condenses directly into ice crystals. These may fall down to the earth as powdery mass or flakes of snow. This form of precipitation is called *snowfall*. Snowfall is quite common in middle and high latitudes and high mountain regions. When rain falls through a cold layer of air near the earth's surface, rain drops get frozen into ice and fall down. This form of precipitation is called *sleet*.

When there are strong vertical currents in the atmosphere, condensation takes place at high altitudes at low temperatures. Ice crystals grow in size gradually but do not fall down owing to ascending currents. The ice crystals grow to large size of a few centimetres in diameter and fall down as solid masses. This form of precipitation is called *hail*. Hailstones cause damage to crops and buildings.

Water on the Land

Precipitation of water from the atmosphere results in water falling on the land surface as well as in oceans. Water falling on the land runs down the slope of the land in the form of streams and rivers. Water may also get stored on the land in the form of ice sheets. While extensive and thick ice sheets occur in Antarctica, Greenland and other regions around the Poles, less extensive ice sheets occur in the high altitudes of mountain regions. Of the total water available on the surface of the land, about two-thirds is in the form of ice sheets. Imagine what would happen, if the earth becomes warmer and ice sheets melt gradually. Sea level would rise gradually submerging coastal regions. What would happen, if the earth becomes cooler?

Surface water on land is the most easily accessible source of water for human needs, including agriculture and industries. The quantity of surface water in a region depends not only on the total precipitation and its seasonal distribution but also on the nature of rocks and soils on the surface of the land.

Underground Water

A part of the rainfall which falls down on the land surface seeps below the surface through the soil layer, pore spaces, joints and fissures in the rocks. The quantity of seepage depends on the nature of rocks and soils. Sandy soils and rocks like sandstone allow water to seep through readily. Such rocks are called *permeable rocks*. *Impermeable rocks* are those which do not allow seepage of water in large quantities. Clayey soils and shale are impermeable rocks. Rocks like granite are not porous but they allow water to seep through joints and fissures present in them.

The seepage of water through soils and rocks produces a zone of saturation below the surface. In this zone, all the pore spaces, joints and fissures are saturated with water. The upper limit of this zone of saturation is called the *water table*. The water table is not a level surface as its name implies. The depth of water table varies from place to place and also with season.

Water stored below the surface of the land is a result of accumulation over a long period. Underground storage is not subject to loss by evaporation like surface water in lakes and rivers. In some places, underground water may not be potable on account of dissolved salts. Soil moisture and underground water sustain the growth of vegetation on the land.

Human beings have been tapping underground water in localities where surface water is not freely

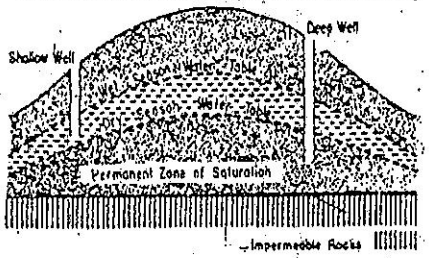


Fig. 3.3 (a) Water Table
A part of rainwater accumulates as underground water and produces a saturated zone. The upper limit of the zone of saturation is called water table. How wells at different places and in different seasons indicate varying depths of the water table ?

available. Underground water is being used not only for domestic needs but also for irrigation and industries. Underground water is drawn from open wells or bore wells.

Have you observed the level of water in open wells in your locality? In the case of shallow wells, water may be drawn by human or animal power. Oil engines or electric motors are used to draw water from deep wells. What causes change in the level of water in wells? Why is it that shallow wells dry up earlier than deeper wells?

Underground water may reappear on the surface in the form of *springs*. Springs occur along joints or fissures in rocks. Some springs may contain hot water. While some springs may be perennial, others dry up during a part

of the year.

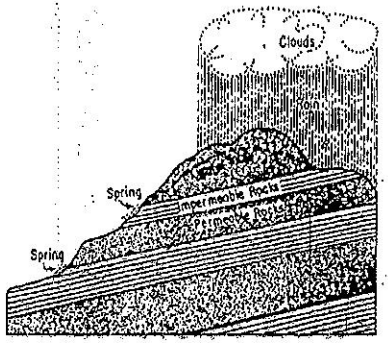


Fig. 3.3 (b) Formation of Springs
The underground water sometimes reappears on earth's surface as springs. Why are springs more common in the hills ?

In some regions, excessive use of underground water for irrigation or urban water supply has resulted in progressive lowering of water table and depletion of underground storage. In such places, water is stored in ponds. This permits the recharging of underground water by increasing the seepage. Careful planning is necessary to integrate the use of surface water and underground water so as to satisfy our growing needs.

Water in the Biosphere

Water plays an important role in sustaining various forms of life on the earth. Plants absorb nutrients from soil moisture and ground water. Excess water gets added to the atmosphere in the form of water vapour which escapes through the pore spaces in the leaves. This release of water vapour from the leaves is known as *transpiration*. In the equatorial forest regions, large quantities of water vapour are added to the atmosphere by this process.

Animals also need water for their sustenance and growth. Water forms an important constituent of the body weight of animals. Water plays a crucial role in the biological processes as a reacting medium in bio-chemical processes such as photosynthesis and as a medium holding and transporting nutrients in solution and carrying away waste products of metabolism. Thus, water circulates not only through atmosphere and lithosphere but also through the biosphere.

Hydrological Cycle

We have already seen a brief account of the circulation of water from the oceans to the atmosphere and then to the lithosphere and back to the oceans. The hydrological cycle is in reality much more complex involving a number of sub-cycles. For example, water from oceans may get evaporated and enter the atmosphere as water vapour. Water may get precipitated back from the atmosphere of the oceans. In this sub-cycle, lithosphere is not involved. Name the other possible sub-cycle.

Global Water Balance

The total quantity of water available in hydrosphere, atmosphere and lithosphere remains constant though the quantity available in each one of these realms may vary from place to place and according to seasons. There is not only circulation of water between these realms, but also changes of state from liquid to gaseous or solid states and vice-versa.

We have seen that oceans contain 97 per cent of all water available on the earth. Fresh water forms the remaining 3 per cent. Out of this 3 per cent, ice sheets and glaciers store three-fourths of all fresh water available. Lakes and rivers carry only very small quantities as compared to ground water storage.

There is excess of evaporation over precipitation in the ocean. This is compensated by run-off from the land. Thus,

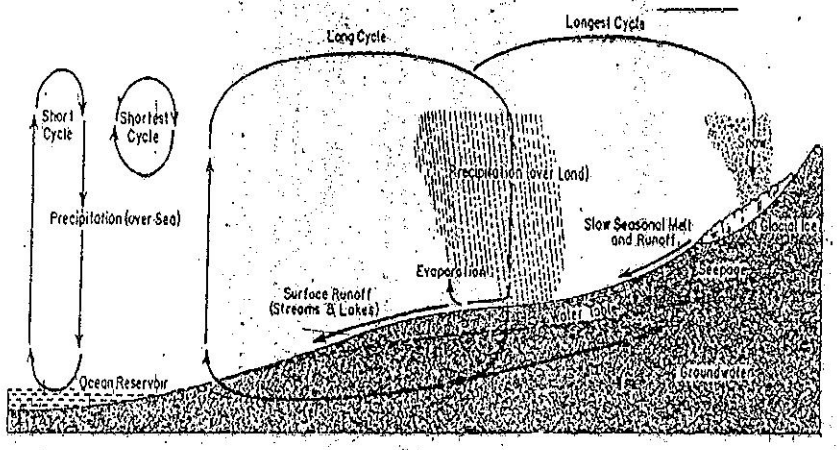


Fig. 3.4 Hydrological Cycle
Note that the hydrological cycle is not a simple circulation of water between ocean, atmosphere and the land. There are a number of subcycles operating within it. Study them carefully in the diagram.

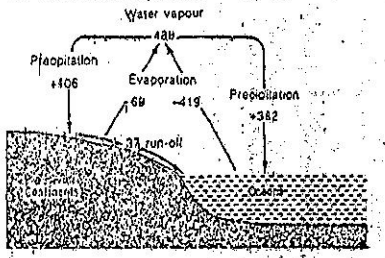


Fig. 3.5 Water Balance
Volume of water is given in thousand cubic kilometers per year. Mark the amount of water lost from the oceans through its evaporation. The oceans regain the water through precipitation and its run-off into them. This maintains a near balance of water on the earth.

there is a state of balance, if the earth is taken as a whole. (Fig. 3.5)

Any change in the pattern of circulation of water causes changes in the quantity of water available on the land, in the soil layer and as underground water. As humans and other organisms on the land depend on surface and sub-surface water, even small variations cause drought and floods. Though abundant water may be available in the oceans and in the atmosphere, the quantity available for use by man is determined by precipitation on the land, and water stored on the land and below the ground.

SELF-STUDY

Review Questions

1. Examine briefly the significance of water in oceans.
2. What processes are involved in changes of physical state of water.

3. What are the different forms of precipitation?
4. What is meant by water table?
5. Give a brief account of 'hydrological cycle'.

Distinguish between

1. Continental shelf and Continental slope.
2. Relative humidity and Absolute humidity.
3. Evaporation and Transpiration.
4. Permeable rocks and Impermeable rocks.

Give a technical term for each of the following:

1. The process which leads to the formation of clouds.
2. Upper Limit of the zone of saturation of water below the ground.
3. Temperature at which air gets saturated.
4. Precipitation in the form of large ice crystals.

Answer the following questions:

1. Discuss the importance of underground water and its occurrence.
2. Examine the circulation of water in the hydrosphere.
3. Describe the role of water in the biosphere.

Do it yourself and find out

1. Study the different sources of water supply in your area and indicate their adequacy.
2. Note the level of water in rivers, lakes, wells in your locality in different months and prepare charts.
3. Note the dates on which rainfall or snowfall occurs in your locality and identify the seasonal contrasts.
4. Locate important hot water springs of our country.

Books to Read

E.O.Robinson, *Outlines of General Geography*, New York: Macmillan.
Lake, P., *Physical Geography*, Calcutta: Macmillan and Co.
Monkhouse F.J., *Principles of Physical Geography*, University and London Press.
N.K.Horrocks, *Physical Geography and Climatology*, London: Longmans.

CHAPTER FOUR

The Air Around Us

AMONG THE PHYSICAL ELEMENTS of the environment, the atmosphere is the most dynamic in nature. The temperature and other physical conditions change not only between day and night but also at shorter intervals of a few hours. A sudden thunderstorm on a summer afternoon may cause heavy rainfall and reduce the temperature considerably. We can observe change in the velocity and direction of winds as also movement of clouds in the sky. Strong cyclonic winds may uproot large trees and cause destruction to buildings. You are already aware that energy is the basis for all types of work and movement. The main source of energy for all types of circulation in the atmosphere is the sun. The sun is a vast, hot gaseous mass containing predominantly hydrogen and helium. In the central core of the sun, hydrogen is converted into helium releasing huge quantities of energy in all directions.

The sun emits a form of energy known as electro-magnetic radiation. Of the huge quantity of energy radiated by the sun, the earth intercepts only 1 in 2,000,000,000 parts. The amount of energy radiated by the sun has remained almost constant. The radiant energy reaching the outer limit of the earth's atmosphere at a surface perpendicular to the sun's rays is estimated at 2 calories per sq cm per minute.

Insolation : Insolation refers to incoming solar radiation. It is in the form of short waves. The sun radiates nearly half of its energy at wavelengths of visible light. As the insolation enters the atmosphere, a part of it is reflected, another part is absorbed and the remaining reaches the earth's surface. Reflection of insolation takes place by clouds, snow-fields, oceans and other water-bodies. About 35 per cent of insolation is lost by reflection.

Ozone present in the upper layers of the atmosphere absorbs ultraviolet radiation and protects the earth's surface from its harmful effects. The other gases in the atmosphere and dust particles, together absorb only 14 per cent of insolation. This means that the atmosphere is transparent to insolation and does not get heated directly by it.

Terrestrial Radiation: The remaining 51 per cent of the insolation reaches the earth's surface which gets heated. The surface of the earth in turn radiates heat in the form of relatively long waves. This is called *terrestrial radiation.* As the amount of energy radiated by the earth is equal to the amount of insolation absorbed by the earth's surface, the terrestrial radiation may be estimated at 51 units. Out of this, water vapour, carbon dioxide and other gases in the lower layers of the atmosphere absorb 34 units or nearly 70 per cent. Remaining 17 units are radiated back to space.

Heat Balance: The figure given here shows

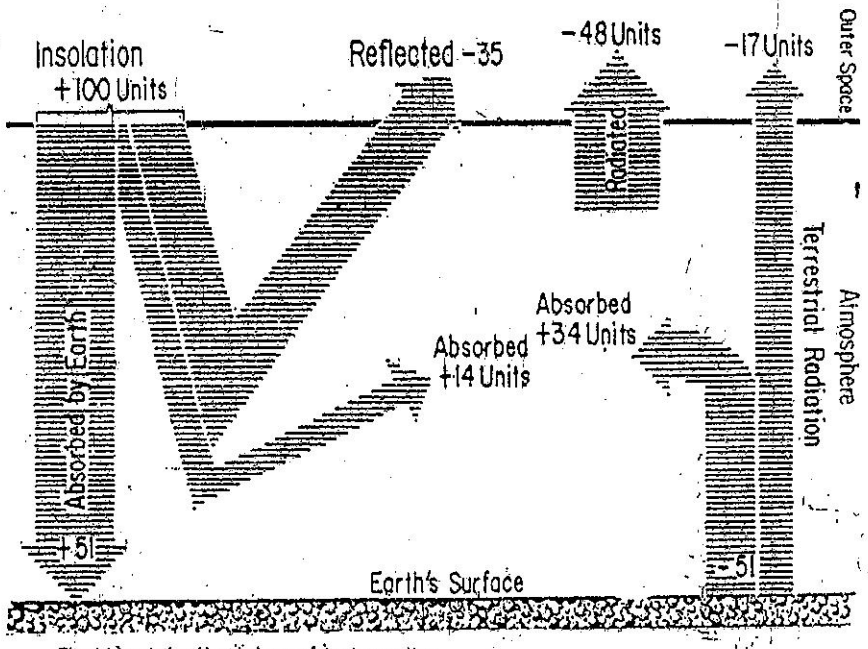


Fig. 4.1 Insolation Heat balance of the Atmosphere.
The surface of the earth is heated by the incoming solar radiation. What percentage of total incoming radiation is received by the earth? What percentage of heat is radiated back by the earth to the atmosphere?

that there is a delicate heat balance in the system. Of the 100 units of insolation entering the atmosphere, 35 units are reflected, 17 units are radiated by the earth's surface and 48 units are radiated by the atmosphere. Thus, there is no gain or loss of heat.

The atmosphere absorbs 14 units from incoming insolation and 34 units from terrestrial radiation, making a total of 48 units. The atmosphere radiates 48 units of energy back to space.

The earth's surface absorbs 51 units of insolation and radiates back the same amount. Therefore, there is no net gain or loss by the earth and the atmosphere.

It is seen that the atmosphere gets primarily heated by radiation from the earth's surface and not by direct insolation. The action of the atmosphere may be compared to that of a glasshouse or greenhouse in which vegetables and flowers are grown in cool regions. Glasshouse is warmer from inside than outside because glass permits radiation to get in but does not allow radiation to escape out immediately. The atmosphere surrounding the earth also acts like a greenhouse by permitting insolation to pass through and absorbing terrestrial radiation. This is known as *greenhouse effect* of the atmosphere. The atmosphere acts like a blanket keeping the

earth warm. What would be the condition if there had been no atmosphere around the earth?

As the atmosphere is primarily heated by radiation from the earth's surface, the shape of the earth and its rotation and revolution are important factors affecting the temperature. As the earth is a sphere, the sun's rays do not fall vertically at every point on the earth's surface at any given time. If the earth were flat, the sun's rays will fall vertically at all points at a given time. When the sun's rays are overhead at the Equator, they are tangential to the earth at the two poles. At the poles, the sun will be seen at the horizon. This condition would prevail permanently, if the axis of the earth were at right angles to its orbit around the sun.

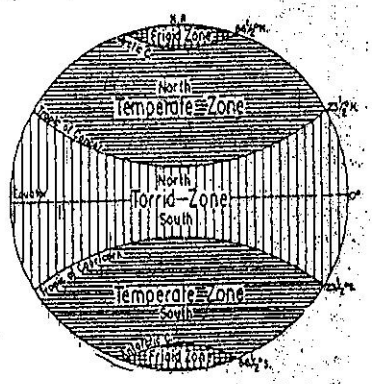


Fig. 4.2 Temperature Zones
Insolation as received on the earth primarily determines the distribution of temperature. Note how globe has been divided into torid or tropical, temperate and frigid zones with the help of latitudes for showing the above distribution.

Latitudinal Zones: As the axis of the earth is inclined at 23½° from the vertical, all places at which the sun's rays are vertical on any day lie between the Tropic of Cancer (23½° N) and the Tropic of Capricorn (23½° S). This is called the *Tropical Zone*. In this zone, the sun's rays are vertically overhead during a part of the year. This zone receives maximum insolations as the angle of incidence of the sun's rays varies between 43° and 90° at the Tropics of Cancer and Capricorn (see Appendix I). At the Equator, the variation in angle of incidence is between 66½° and 90°. Vertical rays heat the surface of the earth to a greater extent than inclined rays, as the energy is concentrated on a smaller area and as also the length of passage through the atmosphere is shorter.

Temperate Zones are the regions between the Tropic of Cancer and Arctic Circle (23½° N to 66½° N) and the Tropic of Capricorn and the Antarctic circle (23½° S to 66½° S). In these zones, the sun's rays are never vertical during the year. The angle of incidence and the duration of sunshine are greater in summer than in winter. The contrasts between summer and winter are much greater than in the Tropical Zone. As the latitude increases, the angle of incidence of sun decreases, though the duration of sunshine may be longer in summer.

Polar Zones are the zones surrounding the Poles and extending up to the Arctic circle in the Northern Hemisphere and up to the Antarctic circle in the Southern Hemisphere. In these zones, while the sun's rays are not received during the long winter, the duration of sunlight may be more than 20 hours during summer. As the longer duration of sunlight does not compensate for the low angle of incidence, temperature is quite low even in summer.

Latitudinal Heat Balance

We have seen that there is a heat balance if we consider the earth and the atmosphere together as a system. There is no net gain or loss of energy, though transfer of energy takes place between the earth and the atmosphere.

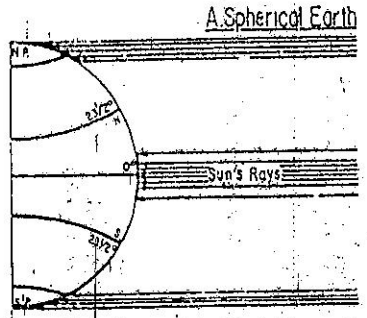


Fig. 4.3 (a) Incidence of the Sun's Rays
Note the sun rays falling vertically overhead at the equator on spherical earth. They are tangential at the two Poles on spherical earth. Which rays have a high angle of incidence and which give a low temperature ?

The spherical shape of the earth introduces changes in the horizontal distribution of insolation between latitudinal zones. It is seen that in the latitudinal zone between 37° N and 37° S, the incoming radiation is much more than outgoing radiation. In the middle and high latitudes, the outgoing radiation is in excess of incoming radiation. These are regions of deficit. How is it possible for the outgoing radiation to be in excess of incoming radiation? This is possible only when surplus energy from the low latitudes is transported to the middle and high latitudes. Such a transfer of heat energy takes place by circulation of winds and ocean currents. The differential heating of the earth and its atmosphere is responsible for circulation in the atmosphere and oceans. Such a circulation of air and water maintains heat balance in the earth-atmosphere system.

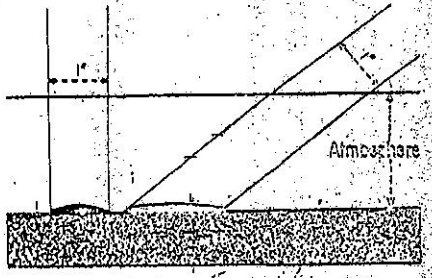
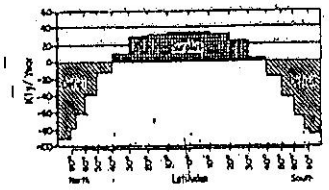


Fig. 4.3 (b) Vertical and Inclined Sun's Rays
Note how the two types of sun rays have different heating effect on the earth's surface.

Land and Sea Contrasts : As the atmosphere gets heated from terrestrial radiation, the nature of the earth's surface is an important factor in the heating and cooling of the atmosphere. The major contrast is between the land masses and oceans. The land surface which consists of rocks is a bad conductor of heat, only a thin surface which consists of rocks and soils gets heated by conduction. As the entire energy heats up a thin layer, temperature rises rapidly during day-time. As the land surface is a good radiator of heat, it cools down rapidly at night.

When insolation reaches the water surface, a part of it is reflected. Water gets heated by convection and, therefore, convection currents dissipate radiant energy over a greater depth than on land. Water heats up more slowly than land owing to its physical properties. About two and half times as much energy is needed to heat a unit volume of water through 1°C as compared to the same volume of land through 1°C. Therefore, water surface does not get heated during day-time as rapidly as the adjoining land surface. Water surface also cools down more slowly during the night.

Similar contrasts occur between summer and winter as well. Land masses are warmer than the oceans in summer and cooler than the oceans in winter. This means contrasts in temperature between day and night, and between summer and winter are greater over land areas than over oceans. As coastal regions experience the influence of the adjoining oceans, temperature contrasts are much less than in the interior of land masses. Compare such contrasts between Moscow and London. Such contrasts are insignificant in higher latitudes where land and sea are covered with ice.



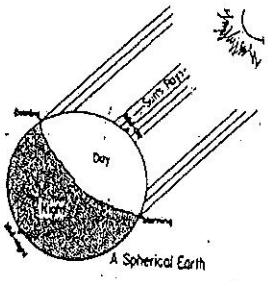


Fig. 4.4 (a) Latitudinal Heat Balance
The distribution of insolation on the surface of the earth is not uniform. Name the zones of surplus as well as deficit energy. How is the heat balance maintained ?

Fig. 4.4 (b) Sun's Rays at Different Times
Note the nature of the sun rays and their heating effect at different times of the day on a rotating spherical earth. Why temperature starts decreasing in evenings and the nights and also during winter months ?

Prevailing Winds : The temperature of a place is modified by prevailing winds. In winter, land winds lower the temperature while sea winds increase the temperature. In summer, land winds increase the temperature and sea winds lower the temperature. Winds blowing from low latitudes are warmer than those blowing from middle and high latitudes. The effect of such winds may be felt only for a few days, as wind direction may change.

Ocean Currents : Surface currents transport large quantities of water over thousands of kilometres. Warm currents such as the Gulf stream in the Atlantic Ocean increase the temperature of coastal regions of Western Europe. Cool currents such as the California Current reduce the temperature of coastal regions, especially when winds blow towards the shore.

Altitude : As the atmosphere is heated from below, the lowest layer in contact with the earth's surface is the warmest. Normally, temperature decreases with height at a rate of 1°C for every 165 metres of height above sea-level. The higher layers of the atmosphere contain smaller quantities of water vapour and carbon dioxide and hence their capacity to absorb heat energy is much less than that of the lower layers. Therefore, hill stations like Nainital are cooler than Delhi. High mountain ranges form barriers for movement of winds and influence the temperature of region on the seaward side. For example, the Himalayas protect the Gangetic lowland from cold winds of Central Asia. Therefore, Calcutta is warmer than Canton in South China in winter though both are located on the same latitude.

Diurnal and Seasonal Cycles

The temperature of the atmosphere at any place at a given time depends on the balance between the incoming and outgoing radiation. The daily cycle of temperature shows a gradual increase from sunrise to about 3.00 p.m. when the maximum temperature is recorded. This is the period when incoming

radiation is more than outgoing radiation. Temperature decreases in the evening and night, and reaches a minimum before sunrise. Though the angle of incidence of the sun's rays may be maximum around 12.00 noon, maximum temperature is recorded at about 3.00 p.m. indicating the time lag involved in heating of the atmosphere from below by the heated earth's surface. The difference in temperature between maximum in a day and minimum during the night is known as diurnal range of temperature. The diurnal or daily range of temperature is greater at places in the interior of continents than those along the coast.

The seasonal differences in temperature are primarily due to the differences in the angle of incidence of the sun's rays and duration of sunlight (Appendix I). Generally in the Northern Hemisphere, maximum temperature is recorded in July though the maximum insolation is received around 21 June. There is a time lag of about 30 to 40 days. Similarly, the minimum temperature is generally recorded in January, about a month after the period of minimum insolation (21 December). The seasons are reversed in Southern Hemisphere. The annual range of temperature is lowest in the equatorial region as the amount of insolation received does not show much variation between summer and winter. Annual range of temperature is greater in the interior of continents in middle latitudes. For example, Delhi has much greater annual range of temperature than Chennai. This means winters are colder and summers are warmer in Delhi than in Chennai.

Pressure and Winds

Unequal heating of the earth and its atmosphere by the sun and rotation of the earth bring about differences in atmospheric pressure. There are three major low pressure belts with alternating belts of high pressure. The equatorial region is a low pressure belt. On either side of

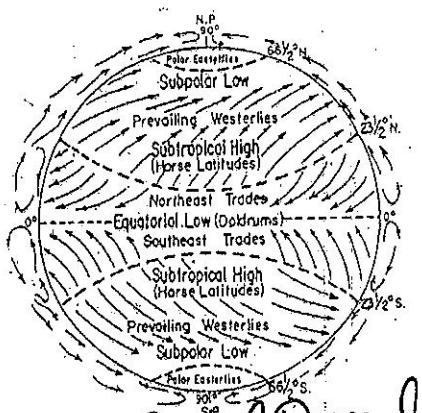


Fig. 4.5 Major Pressure and Wind Belts
Note the pressure belts and the planetary winds of the world. Name the winds and their directions.

this lies a high pressure belt in the sub-tropical zone in each hemisphere. This is called the sub-tropical high pressure belt. The Polar regions are centres of high pressure. Between the Polar high pressure and the sub-tropical high pressure in each hemisphere lies a belt of low pressure called the Sub-Polar Low Pressure belt.

Winds blow from belts of high pressure to those of low pressure. The direction of winds gets deflected due to rotation of the earth. The major planetary winds are the Trade Winds, the Westerlies and the Polar Easterlies. The Trade winds blow from the sub-tropical High Pressure belts in each hemisphere towards the equatorial low pressure. The direction of Trade winds is north-easterly in the Northern Hemisphere and south-easterly in the Southern Hemisphere. The Westerlies blow from the sub-tropical High Pressure belts in each hemisphere to the adjoining Sub-Polar Low Pressure belts. The direction of Westerlies is south-westerly in the Northern

Hemisphere and north-westerly in the Southern Hemisphere. The Polar Easterlies blow from the Polar High Pressure centres to the Sub-Polar low pressure belts in each hemisphere. Unlike the Trade winds and the Westerlies, the Polar Easterlies are variable in intensity and direction.

Seasonal Migration: The apparent seasonal migration of the sun between the Tropics of Cancer and Capricorn leads to a migration of thermal belts and this causes migration of major pressure belts poleward during summer and equatorward during winter. This causes migration of planetary winds also. Such a migration brings about striking seasonal contrasts in the middle latitudes. Seasonal contrasts are minimum in the equatorial and polar regions.

The pattern of planetary wind is modified by the centres of high pressure and low pressure. In Northern Hemisphere, winds blow in an anti-clockwise direction around a low-pressure centre and clockwise around a high-pressure centre. Wind directions are reversed in the Southern Hemisphere.

Other Wind Systems: Besides the major pressure and wind belts, there are other pressure and wind systems of local significance and of shorter duration. Of these, the *monsoon winds* are the most important as they affect a large area in Asia. Monsoon winds are characterized by seasonal reversal of wind direction. Monsoon conditions are well developed over the continent of Asia because of its large size and the striking seasonal variations. During summer, winds blow from the Indian and Pacific Oceans towards the low-pressure centre located in the interior of Asia. During winter, high pressure prevails over the interior of the continent and cold dry winds blow from the high pressure towards the oceans.

Cyclones and anticyclones are pressure systems of local significance. *Cyclones* are centres of low pressure having ascending currents of air. As winds converge towards the low-pressure centre, passage of cyclone produces strong winds and heavy rainfall. *Anticyclones* are centres of high pressure from which winds blow out in all directions. They are associated with clear skies and fair weather.

Land and Sea Breezes of coastal region are examples of local winds. During day-time, land gets heated rapidly and low pressure gets formed due to ascent of hot air. Sea breeze blows in the afternoon towards this low pressure. During night, the air over sea is warmer than the air over land. Therefore, land breeze blows from high pressure over land to the relatively low pressure over the sea.

Distribution of Precipitation

We have already examined the importance of water vapour in the atmosphere and the processes of evaporation, condensation and precipitation. The distribution of precipitation is related to the direction of winds with reference to the distribution of continents and oceans. *On-shore winds* blowing from the oceans towards land masses cause precipitation as they contain large quantities of water vapour. *Off-shore winds* blowing from the land masses contain low moisture content and do not cause much precipitation. Ascending currents of air give rise to heavy precipitation, as ascent results in cooling of air leading to condensation and precipitation. Such ascent may be caused by convectional currents or mountains acting as barriers to winds. In middle latitude cyclones, warm air from the sub-tropical zone is forced to ascend over cold air from the Polar regions. Descending currents of air get warmer and drier during descent and such regions are dry.

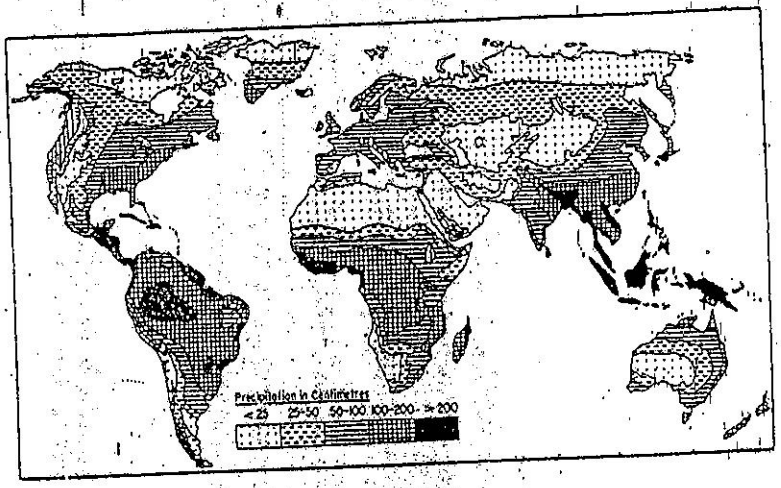


Fig 4.6 World Annual Distribution of Precipitation
Mark the regional variations in the distribution of precipitation on the earth. Name three countries each receiving very heavy rainfall and very scanty rainfall.

Regions of High Rainfall (more than 200 cm per year) : A study of the world map showing annual distribution of rainfall shows three regions of heavy rainfall—(i) Equatorial regions of Africa, South America and South-east Asia; (ii) Western Coastal regions of middle latitudes in Western Europe and North America; and (iii) Coastal regions of Monsoon lands of Asia. The equatorial regions have uniformly high temperature throughout the year. This causes convectional ascent of air giving rise to heavy rainfall almost throughout the year. Convectional

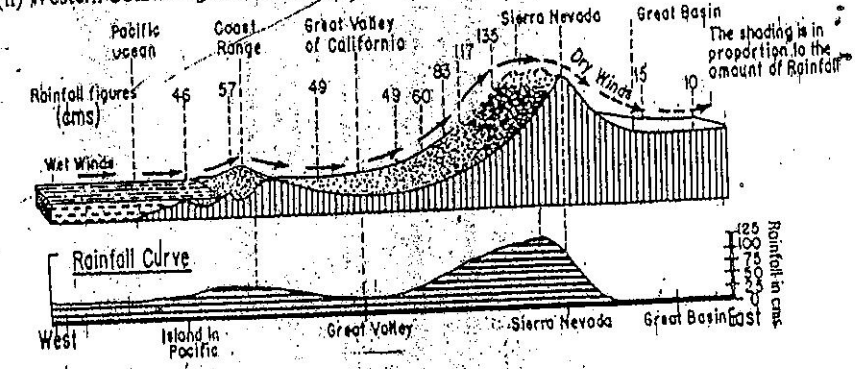


Fig. 4.7 (a) Relief Rainfall
Note the contrast in rainfall on the windward and the leeward sides of the Rocky Mts. in North America. A rainshadow is formed to the east of the Rockies. How does it happen ?

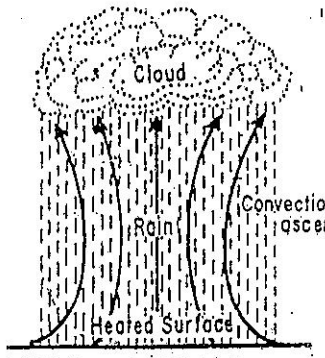


Fig. 4.7 (b) Convectional Rainfall
Note the warm moist air rising and causing the formation of clouds. Heavy downpour often accompanied by thundershowers takes place in this type of rainfall. In what parts of the world is it very common ?

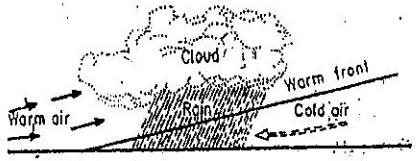


Fig. 4.7 (c) Cyclonic Rainfall
The uplifting of warm and moist air is the result when winds blow from all sides towards the low pressure in a cyclone.

ascent of air reaches maximum intensity in the afternoon leading to a sudden downpour, sometimes accompanied by thunder and lightning. This is known as *Convectional Rainfall*. Besides the equatorial region, convectional rainfall may occur in summer in the interior of continents.

The western margins of continents in the middle and high latitudes receive heavy rainfall as the Westerly winds are blowing from sea to land. In these regions, rainfall is mainly associated with the passage of mid-latitude cyclones. This is known as *cyclonic rainfall*. Rainfall is quite high in mountain regions along the west coast as in British Columbia in North America and Southern Chile in South America.

The monsoon region in south Asia owes its heavy rainfall to strong winds which blow from the Indian Ocean towards low pressure in the interior of Asia during summer. The rainfall is especially heavy on the slopes of mountain regions located perpendicular to the path of winds. This is called *orographic rainfall*, as mountains force the ascent of air resulting in cooling and precipitation. The west coast of India and the East Himalayan region get high rainfall from the south-west monsoon in summer.

Regions of moderate rainfall (100 to 200 cm per year) : In the sub-tropical regions, trade winds blow from the north-east in Northern Hemisphere and south-east in the Southern Hemisphere. Therefore, eastern margins of continents in the sub-tropics get more rainfall as the easterly winds blow from the oceans. As these winds are more intensive in summer owing to low pressure in the interior of continents, rainfall is mostly concentrated in summer months. The amount of rainfall decreases from east to west towards the interior. Eastern Brazil, East China, Southeastern United States are examples of regions of moderate rainfall. Such moderate rainfall regions also occur on either side of the equatorial region of heavy rainfall.

Regions of Low Rainfall (Less than 25 cm per year) : Regions of extremely low rainfall are known as deserts. These are classified into three major types.

(a) Tropical deserts occur in the western margins of continents in the trade wind belt. These regions are exposed to dry winds blowing from the land masses. Californian desert in the United States, Sahara, Arabia, Western Australia, Kalahari in South-west Africa, Atacama in South America are examples of hot-deserts.

(b) Interior regions of large continents which are away from the influence of moisture bearing winds from the oceans are the regions of low rainfall. Some regions such as Tibet and Iran are rain shadow basins surrounded by high mountains. These deserts are called *mid-latitude deserts.*

(c) Cold deserts occur in the Polar regions. These are centres of high pressure with cold dry winds blowing out in all directions. Therefore, these regions are extremely dry. Antarctica and Greenland are examples of cold deserts.

Seasonal Distribution of Rainfall

In the equatorial region, as seasonal variations in temperature and pressure conditions are least, convectional rainfall occurs throughout the year. In some places, there may be two maxima associated with the equinoxes in the months of March and September when the sun's path crosses the equator. Similarly, in the western margins of continents in middle latitude such as Western Europe, westerly winds prevail throughout the year and these winds blow from warm oceans towards the continent. These regions also get rainfall throughout the year.

In most other parts of the world, rainfall is mostly limited to the summer season. This is associated with the formation of low pressure over continents during summer and the blowing of winds from the oceans towards this low pressure. In winter as the continents become centres of high pressure, cold and dry winds blow out in all directions. Hence, winter is dry season. In the sub-tropical regions on either side of the equator, convectional rainfall is limited to the hot summer season only.

The Mediterranean region stands out as the only region which is dry in summer but gets rainfall in winter season only. This is due to the seasonal migration of wind belts. This region gets rainfall from cyclones and depressions in the westerly wind belt in winter as the area is located in the western margins of continents. In summer, this region is under the influence of trade winds blowing from the land. Therefore, there is no rainfall in summer.

Apart from such seasonal variations in the distribution of rainfall, there are annual variations as well. Annual variability of rainfall is quite high in the monsoon regions of Asia and the regions receiving moderate rainfall. In such regions, deficiency of rainfall leads to drought and excess rainfall causes floods. Annual variations in rainfall are associated with changes in the pattern of circulation in the atmosphere which cause changes in the direction and intensity of surface winds over land masses. A better understanding of the circulation of the atmosphere and the processes involved in precipitation would enable us to predict droughts and floods more precisely.

Weather and Climate

We have examined the distribution of temperature, pressure and winds, and precipitation in the earlier sections. Weather is a composite picture of these various elements at a particular time at a place. A variety of weather conditions may be experienced at a place depending on the season of the year. Weather conditions may vary at intervals of a few hours or a few days. For example, cloudy and rainy weather may last a few days.

Climate is different from weather. Climate refers to the general features based on average values of several elements of weather. Climate of a place may be considered as an integrated or synoptic picture of weather conditions over a long period of time such as a season or year. While weather may refer to a particular place, climate refers to the atmospheric conditions over a large area.

Elements of Weather and Climate

The atmospheric condition at any place is a combination of several elements such as temperature, pressure, winds, humidity, precipitation, sunshine and cloudiness. These are measured by using a variety of instruments at the Meteorological Observatory. The data from several observatories are transmitted to a central office where they are plotted to prepare weather maps. Such weather maps help in understanding weather conditions over a large area. Weather maps also help in forecasting weather conditions.

An idea of climate of a place is obtained from mean monthly values of temperature, rainfall and other weather elements. Such 'mean values' are obtained from records relating to a long period of at least 35 years, so that short period variations are eliminated. For example, mean rainfall for the month of July is the average of July rainfall for the preceding 35 years. Thus, climatic data are based on calculated averages, while weather data are actual observations recorded at a specific time. Climatic maps represent the average conditions for a month, season or year as a whole unlike weather maps which indicate weather condition at a specific time.

Factors Affecting Climate

The climate of a place depends on a number of factors which affect the various elements of climate. We have already examined the factors which affect temperature, pressure and winds, and rainfall. As these factors of climate vary from place to place, climatic conditins are also different in different parts of the earth. Apart from regional variations, there are also seasonal variations in climate.

Latitude: Latitude is the most important factor affecting climate. Latitude of a place determines the amount of insolation received from the sun and its range of seasonal variation. The amount of insolation received is maximum at the Equator and decreases to a minimum at the Poles. Seasonal contrasts are minimum at the Equator and maximum at the Poles.

The pattern of atmospheric circulation and surface currents in oceans is modified by the effect of earth's rotation. It is evident that main temperature zones and major pressure and wind belts are related to latitude.

The amount of moisture in the atmosphere is also related to latitude, as the capacity to hold moisture in the form of water vapour is related to temperature. In the lower latitudes, high temperature causes maximum evaporation from ocean and other water bodies. Evaporation is minimum at the Poles. The moisture content of the atmosphere decreases from the Equator towards the Poles. The distribution of precipitation also shows a general decline from the Equator to the Poles. Thus, there is a general tendency for temperature and rainfall distribution to correspond with latitudinal belts.

Land and Sea Contrasts

The latitudinal patterns of energy and moisture would persist, if the earth's surface were homogeneous. But the uneven distribution of land and sea, and the striking contrasts in physical properties of land and sea cause changes in the general pattern. We have already seen that the land masses are warmer in summer and colder in winter than the adjoining ocean. Both daily and seasonal contrasts of temperature are greater on the land masses than on the oceans. These temperature variations result in the formation of low pressure in summer and high pressure in winter on the land masses. These pressure

conditions induce strong on-shore winds in summer and off-shore winds in winter. Such seasonal reversal of winds are responsible for the monsoon regions in Asia as land and sea contrasts are well-marked owing to the large size of the continent.

The distribution of rainfall is also modified by distribution of land and sea. In the sub-tropical zone, eastern margins of continents receive over 100 cm of annual rainfall, while the western margins are tropical deserts. This pattern or rainfall distribution is related to on-shore winds on the eastern margins and off-shore winds on the western margins. In the middle latitudes, the westerly winds from the oceans cause heavy rainfall on the western margins. Rainfall decreases eastwards in the interior of continents.

Relief Features

High mountain ranges and plateaus act as barriers for the movement of winds in the lower layers of the atmosphere. We have already seen that the Himalayan ranges act as a barrier to cold winds from central Asia. Mountain ranges force winds to ascend up the slopes. This may lead to considerable rainfall on the windward slopes. On the leeward side beyond the crest of the mountain range, air descends and gets heated. This relatively dry region is known as the *rain-shadow region*. Pune which is located in the rain-shadow region of the Western Ghats gets lower rainfall than Mumbai. Mountain regions have much lower temperature than the adjoining lowlands owing to their high altitudes. Shimla, Darjeeling and Kodaikanal are hill stations which serve as 'summer resorts'.

Ocean currents: Ocean currents transport large quantities of water over vast distances. We have already examined the effect of ocean currents on the temperature of adjoining land masses. The effect of ocean currents is well-marked when winds blow on-shore from sea to land. Warm ocean currents increase the moisture content of the atmosphere and cause rainfall along the coast.

Climate and Humans

Climate of a region affects man directly and indirectly. Changes in temperature are directly felt and man adapts himself by wearing clothes appropriate to the season. Woollen clothes worn in winter protect us from cold. Cotton clothes are preferred in the hot summer as they absorb sweat and allows air circulation. People living in colder regions use tight-fitting clothes, while those living in tropical regions wear loose garments which permit movement of air so that body is kept cool. Exposure to extremes of temperature during hot waves or cold waves may cause death. Climatic changes resulting in droughts and floods affect man directly.

Houses built by humans are also adapted to the climatic conditions. In regions of heavy rainfall like Kerala, houses have steeply sloping roofs to drain off the rain water. Flat roofs are commonly found in deserts. In cooler regions, houses have glass panels for doors and windows to allow more sunlight and heat. In warmer regions, houses have broad verandahs to protect them from direct sunlight. Windows are large to allow greater circulation of air so that inside of the house remains cooler than the outside. In mountain regions like the Himalayas, south-facing slopes are preferred for construction of houses as they are exposed to sunlight. Humans are now using mechanical devices like fans, air-conditioners, heaters, humidifiers, etc., to overcome the adverse climatic conditions and to live in comfort. Such devices, however consume large quantities of energy.

The climate has many indirect effects on us. The type of natural vegetation and the crops cultivated are related to the climate of a region. Each plant species needs certain growing season having a range of temperature and moisture conditions. Climate sets limits to the range of crops that could be cultivated. For example, sugarcane, cotton, rice are the crops suited to the Tropical regions. They cannot be cultivated in the middle or high latitudes having low temperatures. Availability of water is also a limiting factor for certain crops like sugarcane and rice. Rearing of domestic animals like cattle and sheep is also related to the climatic conditions. Similarly, the types of forests in a region and their commercial exploitation is related to the climatic conditions. Thus, the primary occupations like agriculture, animal rearing and forestry are influenced by climatic conditions. Though humans have taken certain steps to overcome the limitations of climate, such as cultivation inside glass-houses and stall feeding of animals in specially built shelters, such conditions may not be commercially viable.

The differences in climatic conditions which bring about differences in the crops cultivated are responsible for encouraging the exchange of products. For example, industrial countries in middle latitudes have to import cotton and jute from the countries in the tropical region. The pastoral industry in Australia and New Zealand thrives on the demand from European countries. Thus, the differences in climate provide the basis for international trade in agriculture, pastoral and forest products.

The modes of life of the tribal peoples are still directly related to the climatic conditions. Such primitive tribes living in tropical rain forests or Tundra region depend primarily on food-gathering, hunting and fishing for their livelihood. They have to migrate from place to place in search of food. Rearing of domestic animals such as cattle and sheep is practised mainly in grassland regions. In semi-arid and arid regions, nomadic tribes migrate in search of pastures for domestic animals and water supply. Such nomadic tribes also live in the Polar Tundra regions.

The humans with their advanced technology are able to lead a comfortable life in any climatic condition. They are able to cultivate vegetables and flowers in glass-houses even in Polar regions. They import their food, clothing and other requirements from other countries. They have evolved synthetic products to overcome shortage in natural products like rubber. Humans have learnt to adjust and adapt themselves to the varying climatic conditions. In this process, they are also responsible for modifying the climatic conditions.

SELF-STUDY

Review Questions

1. Explain 'greenhouse effect'.
2. Describe the concept of 'heat balance'.
3. What causes changes in the angle of incidence of the sun's rays during different seasons.
4. Name the major pressure belts.

5. Describe different types of deserts.
6. Examine the effect of altitude on temperature.

Distinguish between

1. Insolation and terrestrial radiation.
2. Diurnal range and annual range of temperature.
3. Convectional rainfall and orographic rainfall.
4. Weather and climate.

Answer the following questions

1. Give an account of the factors affecting climate.
2. Describe the distribution of rainfall on the earth.
3. Discuss the heat balance indicating latitudinal variations.

Do it yourself and find out

1. Visit the nearest meteorological observatory and note the instruments used.
2. Keep a daily record of weather conditions in your locality in a notebook. Describe the seasonal contrasts.
3. Collect weather maps of India published in newspapers and study seasonal contrasts.

Books to Read

Glenn Trewartha, *Introduction to Climate*, New York: McGraw Hill.
Preece, D.M., and Wood, H.R.B., *Foundations of Geography*, London: University Tutorial Press.
E.O.Robinson, *Outlines of General Geography*, New York: Macmillan.

CHAPTER FIVE

Biosphere

WE HAVE already seen that our earth is a unique planet in having a biosphere. There are a variety of organisms in the biosphere. They are broadly divided into the plants, animals and microbes. More than 10,00,000 animal species and 3,00,000 plant species are known to exist. These organisms exist in the zones of contact between the atmosphere, hydrosphere and the lithosphere. There is exchange of matter and energy between these three elements of the physical environment and the organisms in the biosphere. While the animals are able to migrate from place to place according to seasonal changes, plants are rooted to the soil and they make physiological adjustments to seasonal changes. Plants and animals are interdependent on one another.

Though the biosphere is a relatively thin layer, it has great significance to our life. The organisms in the biosphere provide a variety of food for us and also raw materials which provide clothing and shelter and other needs of man. Our existence and survival on the earth depends on the biosphere. Therefore, it is necessary to understand the interrelationships between the organisms in the biosphere and also the links between the physical environment and the biosphere.

Ecosystem: Plants, animals and other organisms together with the physical environment with which they interact constitute the *Ecological System* or *Ecosystem*. *Ecology* is the science which deals with interrelationships between the various organisms living in an area and also their relationship with the physical environment. The organisms living in an area interact with one another as there is exchange of matter and energy among themselves and with the physical environment. As there is constant interaction, ecosystem is as dynamic as the physical environment. Any change in the physical environment brings about suitable adaptation by the various organisms.

Components of Ecosystem

An ecosystem consists of both living or *biotic* and non-living or *abiotic* components. The abiotic components of the physical environment influence the types of organisms living in an area. For example, the organisms living on the land masses are different from those in sea water. Climatic conditions bring about variations in the types of plants and animals found in different land masses.

The non-living components of the ecosystem consist of chemical substances found in the soil, water and atmosphere. These chemicals may be *inorganic* substances like water, oxygen, carbon dioxide and minerals like phosphates, nitrates, etc., or *organic* materials like carbohydrates, fats, proteins and vitamins. Other abiotic elements of the

climate are temperature, rainfall, duration of sunlight, winds, nature of soil, slope of the land, composition of water bodies, etc.

The biotic components are broadly divided into two major groups—the *producers* and the *consumers*. The producers are organisms which produce their own food from the physical environment. These are called *autotrophic organisms*. Green plants are primary producers, as they produce organic matter utilising sun's radiant energy. This is called *photosynthesis*, as organic materials are synthesised using sunlight from minerals, and water in the soil and carbon dioxide from the atmosphere. The presence of green pigment called chlorophyll in the leaves of plants, makes photosynthesis possible. In ocean waters, phytoplanktons are primary producers as they produce their own food using solar energy.

All other organisms are called consumers *or heterotrophic organisms*, as they depend on other organisms for their food. An organism that feeds only on plants is called a *herbivore* or *primary consumer*. A rabbit is a herbivore. A consumer that feeds on animals only is called *carnivore* or *secondary consumer*. A lion is a carnivore. The humans are *omnivore* as they eat both plants and animals. A fourth group of consumer feeds on dead or decomposed tissues of plants and animals. They are called decomposers or *detritus feeders* e.g., bacteria and fungi, termites and maggots. Apart from getting energy and nutrients from the plant and animal, the detritus decomposers convert organic

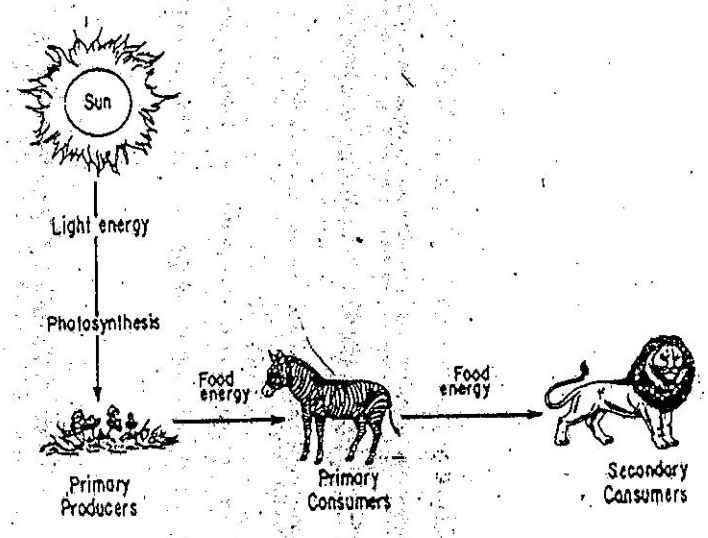


Fig. 5.1 Food Chain
Note how energy from sun is transferred in the form of food from one to another organism. This transference takes place within a system called the ecological system or an ecosystem.

materials into inorganic substances. These are taken up by green plants and help in completing the cycle of soil nutrients.

Food Chain and Food Web

All organism, including humans need food which provides energy for growth, maintenance and reproduction. A part of the energy provided by food is used for biological processes and the rest is dissipated to the environment as heat energy by the process of respiration. Undigested food is excreted and enters the detritus path. In a grassland, grass is eaten by rabbits and rabbits are eaten by foxes. This is a simple food chain. In cases where some organisms eat a variety of other organisms, food chain becomes more complex, such complicated network of food chain is called a *food web*. As a variety of organisms live in the ecosystem and there is competition for food among them, food webs are very complex.

Each group of organism occupies a *trophic* or feeding level. All green plants and other producers in the ecosystem occupy the *first trophic level*. Herbivores which feed on plants occupy the *second trophic level*. Carnivores that eat herbivores are at the *third trophic level*. The different levels are not equal in terms of energy available, as only a fraction of energy is transferred from lower to higher level. The trophic levels may be represented in the form of a pyramid, called *ecological pyramid*.

The percentage of energy transferred from one trophic level to another is called *ecological efficiency*. The efficiency of energy transfer from one trophic level to another varies from 5 per cent to 20 per cent depending on the types of organisms and environmental conditions. In the terrestrial ecosystem, only

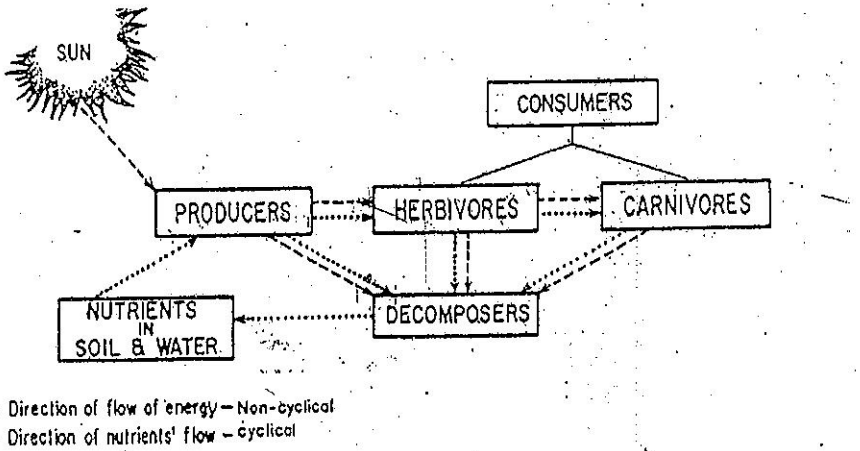


Fig. 5.2 Cycle of Energy and Nutrients Flow in Ecosystem
The diagram shows how energy flows in a non-cyclic manner from sun to primary producers and to various consuming species. A part of it becomes a waste and is reduced into inorganic nutrients by the decomposing bacteria in the long run. Note that the nutrients flow is cyclical in character

10 per cent of plant material is eaten by herbivores. That means on an average, only 10 per cent of energy is transferred from one trophic level to another. This means 100 kg of grain is needed to produce 10 kg of meat. Such low efficiency is due to the fact that not all the organisms present at one level become easily available as food for the consumers at higher level. Predators may not be able to capture all the prey available. Those organisms which escape the predators, eventually die and they provide food for the decomposers. Because ecological efficiency is low, the capacity of ecosystem to support organisms at the higher trophic levels is limited.

Energy and Mineral Movement : A model of energy and nutrient movement in the ecosystem may be examined. The sun provides radiant energy for the producers to manufacture food. The energy is transferred from producers to herbivores and then to the carnivores. Dead or decomposed remains of producers, herbivores and carnivores provide energy for the decomposers. While a part of the food energy consumed is assimilated by organisms, rest of it is dissipated as heat by respiration. There is uni-directional flow of energy from the sun until it is dissipated as heat.

The movement of mineral nutrients from the soil to the plants helps in the growth of the plants. These nutrients are consumed by herbivores and consumers for their growth. When the plant and animal organisms die, decomposers like bacteria and fungi feed on them and break them down into inorganic nutrients. These are available in the soil to be recycled by plants. The flow of mineral nutrients through the system is cyclic.

The ecological system maintains its stability by continuous input of energy from the sun and the cyclic movement of nutrients.

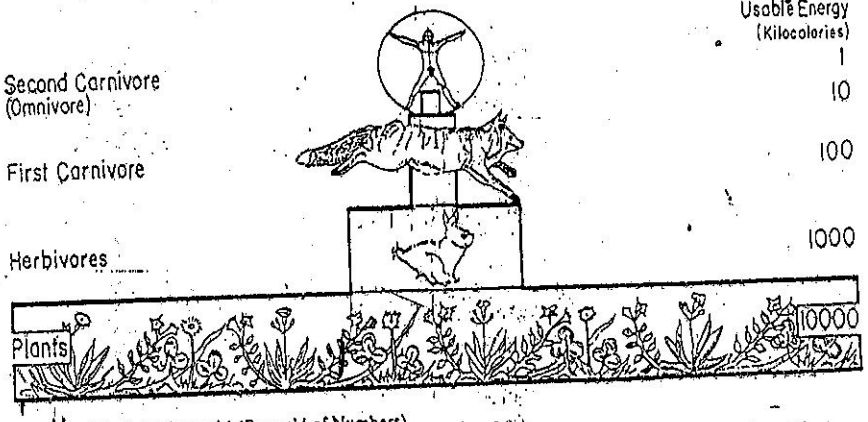


Fig. 5.3 Food Pyramid (Pyramid of Numbers)
The pyramid has a broad base which represents primary producers. Note human consumer at the top level of the pyramid.
As human being can get one kilocalori only if the primary production in the form of organic matter is 10,000 kilocalories at the base.
The supply of food becomes uncertain by greater increase in human population, the feeding area remaining the same.

through the system. Decomposers play an important role in maintaining the supply of mineral nutrients.

Major Ecosystems of the Earth

The ecosystems of the earth may be divided into two major types—Aquatic Ecosystems and Terrestrial Ecosystems. Aquatic ecosystems may be further classified into fresh-water, estuarine and marine ecosystems. Terrestrial ecosystems are classified on the basis of climatic conditions.

Aquatic Ecosystems

The concentration of dissolved oxygen and the sunlight penetration of water and the availability of nutrients are limiting factors for aquatic organisms. The photosynthesis is limited to the zone up to which sunlight penetrates, i.e., to a depth of 30 metres.

In fresh water lakes, which are deep, there are two distinct zones, the surface layer which is warm and exposed to the sunlight penetration and the bottom layer which is cold and dark. While the upper layer is rich in oxygen, the bottom layer is rich in nutrients. Seasonal mixing of water between the two layers enables the survival and growth of organisms. Lakes get gradually filled up by sediments to become marshes and swamps. These have high productivity of variety of plants, water birds and fishes, as nutrient content is quite high.

Rivers have a wide variety of organisms. In the upper reaches, owing to turbulence and swift flow of water, aquatic plants and animals are equipped to get themselves anchored to rocky surfaces. In the lower reaches of a river, the layer of alluvial sediments provides habitat for burrowing animals and bottom feeders. Most organisms living in rivers depend on detritus derived from decaying organic matter added to the river from adjoining landmasses or lakes.

Estuaries are the most productive among the aquatic ecosystems. This is the zone of mixing of fresh and salt water. Sunlight penetrates to the bottom owing to shallow depth. Tidal action enables mixing of nutrients. Luxuriant plant growth favours rich fauna like crabs, oysters, shrimp, fishes and birds. Estuaries provide safe breeding grounds for certain varieties of fish as low salinity acts as a barrier to ocean predators.

Marine ecosystem is the largest in terms of surface area of the earth. Unlike land, the ocean is a surprisingly uniform habitat. Three distinctive habitat zones may be identified as the inter-tidal, the neritic and the oceanic zones.

Inter-tidal zone refers to the area between high tide and low tide levels. As water is in a state of continual motion between high tide and low tide, burrowing organisms such as clams, crabs, snails, etc., are found on sandy stretches. On rocky shores algae, barnacles and oysters attach themselves to rocky surfaces.

The neritic zone extends from the shoreline up to the limit of the continental shelf. On the shallow water of continental shelf, adequate sunlight is available. Nutrients washed down from the land are abundant. This zone with estuaries accounts for 50 per cent of productivity of sea. World's richest fishing grounds are located on the continental shelves.

The oceanic zone refers to wide open ocean beyond the edge of the continental shelf, though the sunlight may be present in surface water, nutrients required for photosynthesis are not adequate. As productivity is quite low, open oceans are *biological deserts*. Though a variety of organisms from phytoplankton to large sharks and whales are present, they are scattered over a large area. As food sources

are scattered, the larger fishes have powerful swimming ability to cover vast distances in search of food.

Terrestrial Ecosystems

Terrestrial ecosystems are of great concern to us as we live on the land and our needs for food and other materials are met from terrestrial ecosystems. The surface of the land has a cover of vegetation of great diversity depending on climatic conditions. Plants occur in distinct groups of communities in areas having similar climatic conditions. These are called *biomes.*

Moisture : Moisture and temperature are the two important limiting factors of terrestrial ecosystems. Water is essential for plant growth because nutrients needed for growth are supplied in a dissolved state from the roots to the leaves through the medium of water. We have seen that water plays an important role in photosynthesis as well as germination, growth and reproduction of plants.

Plants are generally classified into four major types on the basis of their water requirements. *Xerophytes* are those which are able to survive in dry regions. *Hydrophytes* are those which can tolerate excessive moisture. Most plants need moderate quantities of moisture and these are called *mesophytes.* Plants which adjust themselves to seasonal variations in moisture are known as *tropophytes.*

Huge trees thrive well in regions of heavy rainfall. As the water supply gets reduced, the size of the trees and their density gets reduced. Short stunted trees, grasses and scrub are found in regions of low rainfall. In areas having a distinct dry season, plants shed their leaves in order to reduce loss of water by transpiration. Plants also develop deep roots to tap water from great depths. Barks protect tree trunks and branches from drying out; leaves develop thorns, waxy surfaces, needle shapes, etc., to reduce loss of moisture by transpiration and for protection from grazing animals. In regions having cold winter, plants shed their leaves and remain dormant in winter.

Temperature: Every plant has optimum temperature requirements for germination, growth and reproduction, and also a range of temperature beyond which it cannot survive. In the Tropics, temperature is not a limiting factor and a wide variety of plants thrive there. In middle latitudes, as there are extremes of temperature between summer and winter, fewer plant species occur. Plant growth ceases when temperature falls below 6°C. In Polar regions and high mountains, plant life is scanty as the length of the growing season is short. In Tropical regions, plant growth is possible throughout the year as the temperature is always above 6°C. While the global pattern of major vegetation types such as forest, grassland, scrub, etc., are governed by the availability of moisture, the temperature induces variations in species within the major formations. Thus, while forests occur from the Equatorial region to areas beyond 60° N. and S, the types of trees vary depending on the range of temperature.

Other Factors: Among the other factors, soil is the most important. Soil provides the medium for plant growth. Soil formation is a slow process which involves physical, chemical and biological changes. Climate is the most important factor of soil formation. The distribution of major soil types is related to the major climatic regions. Relief and drainage features are other factors affecting the type of vegetation. In mountain regions, as temperature decreases with altitude, the type of vegetation varies according to altitude.

Global Distribution of Biomes

Forests, grasslands, thorny shrubs and Tundra are major plant formations. Forests occur in areas of humid climates with abundant water supply. Grasslands are found in regions of moderate rainfall. Thorny shrubs are typical of arid regions and Tundra is limited to cold Polar regions.

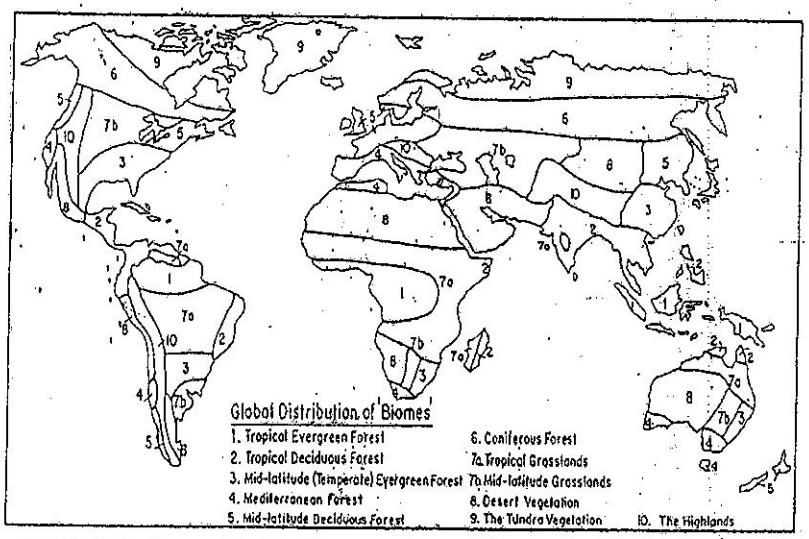


Fig. 5.4 Major Biomes of the World

Biome is a large ecosystem occupying a part of the earth like the Tundra, Grasslands, Tropical Forests and Deserts, etc. Each biome has a distinctive type of vegetation and animal life. It is determined by the type of soil and climate.

Forest Types: Forests are classified into evergreen and deciduous forests. In evergreen forests there is no mass shedding of leaves during any season of the year. Deciduous forests are those in which trees shed their leaves in a particular season in order to conserve loss of moisture through transpiration.

Tropical Evergreen Forests: These occur in Equatorial regions and Tropical coastal regions having heavy rainfall. Hot, humid conditions favour luxuriant growth of variety of vegetation. Trees have broad leaves to permit transpiration of surplus moisture. As there is no dry season, plants grow throughout the year. Shedding of old leaves and growth of new ones takes place throughout the year. Hard wood trees like mahagony, ebony and rosewood are of commercial value. Mangrove forests occur in coastal swamps and deltas.

Mid-Latitude Evergreen Forests: These are found in the eastern margins of continents in the sub-tropical belt. The forests contain hardwood trees with broad leaves. Major regions are South China, South-eastern U.S.A., South Brazil, East coast of South Africa and South-eastern Australia. Evergreen

oak, eucalyptus and wattle are some trees of economic value.

Mediterranean forests occur in the Western margins of continents in middle latitudes. These regions receive moderate rainfall in winter and summer is dry. Trees are adapted to withstand the dry summer without shedding of leaves. Plants have spiny, waxy or small leaves to reduce transpiration. Trees have deep roots to tap water from depth. Thick barks also prevent loss of moisture. Trees are widely spaced and shrubs occur in between. Cork, oak, olive and chestnut are the common trees found in these forests.

Coniferous forests are evergreen forests which extend as a continuous belt around the North Polar region and high mountains in Europe, Asia and North America. The growing season is limited to the short summer season. Trees are tall, conical in shape and evergreen. They have thick needle-shaped leaves to reduce transpiration and to protect them from cold winter. Softwood trees like pine, cedar, fir, hemlock and spruce are found in these forests.

DECIDUOUS FORESTS

Tropical deciduous forests are found in sub-Tropical regions with a distinct dry season, such as Monsoon regions of Asia, parts of Central America, Brazil and Northern Australia. Trees shed their leaves in the dry season. These forests have fewer species and are less dense than the Tropical evergreen forests. Teak is a valuable hardwood tree found in these forests.

Mid-latitude deciduous forests occur in the coastal regions of cool climates. Main regions are Western Europe, North-eastern China, Japan, North-eastern United States, Southern Chile and New Zealand. Trees shed their leaves in winter as temperature is below 6°C. During spring new leaves sprout and rapid plant growth takes place in summer.

GRASSLANDS

Grasses are shallow rooted plants which thrive under varying climatic conditions. They often occur as undergrowth in forests or as small clumps in desert and Tundra regions. Extensive grasslands occur in regions of moderate rainfall between forests and deserts. Grasslands are divided into Tropical grassland and Mid-latitude grasslands.

Tropical grasslands occur in the interior of continents in the Tropical zone. Major regions are on either side of the equatorial region in Africa, parts of Brazilian plateau, Decan plateau and Northern Australia. Tall grasses about 2 metres in height dominate the landscape. These grasslands are known as *Savanna* in Africa and *Campos* in Brazil.

Mid-latitude grasslands occur in the interior of continents in middle latitudes receiving moderate rainfall. These grasslands are well developed in Russia interior of United States and Canada, South African plateau, coastal plains of Argentina and Uruguay in South America and Murray-Darling basin in Australia. The grasses are short and trees are absent. These grasslands are called *Steppes* in Eurasia, *Prairies* in North America and *Pampas* in South America.

DESERT VEGETATION

Owing to low rainfall, deserts do not have continuous cover of plants. Short scrubs occur in patches. Thick stems and thorny or wax-coated leaves prevent loss of moisture. Cacti, thorny bushes and coarse grasses are found in deserts. Acacia trees may be found in the margins of tropical deserts.

Tundra type of vegetation occurs around the North Pole in Eurasia and North America. There is a short growing season of less than three months during summer. Patches of mosses and lichens, wild flowering shrubs are seen. The land is snow covered during the long winter when the duration of sunshine is only a few hours during the day.

ANIMALS

There is a close relationship between animal life and vegetation in a region. Apart from providing food, the vegetation in a region provides a suitable habitat for animals. Though animals may move from place to place, each species can tolerate only a limited range of climatic conditions. Their physical build, colour, food habits, etc., are adapted to their environments. Changes in environment may bring out suitable adaptation by animals or their migration to another region or evolution of new species.

Animals living in Tropical forests are adapted to live among trees. Apes and monkeys have long limbs with opposable thumb so that they may climb trees or swing from one branch to another. The small forest deer which can move freely between trees and the large elephant which can rush through thickets and clumps of trees to make a path for itself live on the ground. A rich variety of birds inhabit the trees. Animal life in mid-latitude forest is almost similar but the variety of species is less and their rhythm of activity is strongly influenced by seasonal contrasts.

Grasslands are more open and permit rapid movement of animals on the ground. The zebra, deer and antelope which live in the grasslands have long legs and hard hoofs which permit them to move swiftly. Carnivorous animals like the tiger and lion and burrowing animals like the fox and rabbit are also common in this region.

In the cold tundra region, animals have thick skins or fur to protect them from cold. Animals take a long sleep during winter. Reindeer, musk ox, bear, wolf and fox are animals which live in this region. During winter, animals and birds migrate to warmer regions in search of food.

An understanding of the interrelationship between different species of plants and animals living in an ecosystem is essential for maintaining *ecological balance* in the biosphere. Owing to improper planning, human activities such as agriculture, forestry, commercial grazing, fishing and hunting have disturbed this balance leading to extinction of certain species. Clearing of forests for mining, construction of a dam for irrigation, draining of swamps for urban growth, etc., have long term impact on the ecosystem. Similarly, changes in the circulation in atmosphere and hydrosphere also affect the functioning of the ecosystem by modifying the energy and nutrient movement through the organisms in the biosphere.

SELF-STUDY

Review Questions

1. Describe the distribution of biosphere.
2. What is meant by ecosystem?
3. Examine the significance of photosynthesis.

4. Describe ecological efficiency.
5. Give an account of ecosystem in estuaries.

Distinguish between

1. Producers and Consumers.
2. Food Chain and Food Web.
3. Evergreen and Deciduous Forests.

Give a technical term for each of the following:

1. Organisms which produce their own food.
2. Organisms whose food is derived from plants and animals.
3. Organisms which feed on decomposed plants and animals.

Answer the following questions

1. Describe clearly the components of ecosystem.
2. Give an account of the factors which influence the terrestrial ecosystem.
3. Discuss the movement of energy and mineral matter in an ecosystem.

Do it yourself and find out

1. Collect pictures of various types of ecosystems and name them.
2. Name the most commonly occurring trees in your locality and find out their uses.
3. Collect pictures of wild life and name them.
4. Prepare a world map showing terrestrial ecosystem.

Books to Read

Davis, D.H., *The Earth and Man*, New York: The Macmillan Co.
Joseph M. Moran and others, *Introduction to Environmental Science*, San Francisco: W.H. Freeman & Co.
John F. Kolars and John D. Nystuen, *Physical Geography—Environment and Men*, New York: McGraw Hill.
H.Robinson, *Biogeography*, London: Macdonald and Evans Ltd.

UNIT II

Maps as Aid to Understanding Environment

WE SEEK to understand the environment of the earth as a whole as well as parts of it. As the earth is a large body, it is not possible to see the entire earth at the same time. Even satellite pictures show only the visible half of the earth. Owing to its spherical shape, the other half is hidden from view. The most appropriate way to represent the earth as a whole is by a globe, which represents correctly the relative sizes and shapes of continents and oceans.

Maps represent the earth on a suitable scale. Maps may be drawn to show the whole world or a continent or a country. Maps help us to visualise the distribution of various elements of the environment by appropriate signs and symbols. Maps of a general nature, such as topographic maps show a variety of features such as, relief, drainage, land use, human settlements and communications. Some maps, such as weather maps and road maps show individual features only. Maps are useful in understanding the relationship between different elements in a given area. For example, topographic map brings out the relation between relief features and land use.

Various kinds of diagrams also help in understanding the environment. These diagrams may be drawn on the basis of the data collected by field work or from other sources. These diagrams may bring out changes over a period of time or help in comparing the situation prevailing in different countries or regions. These maps and diagrams are tools to understand the environment and the impact of human activities on the environment.

CHAPTER SIX

Maps as Aid To Understanding Environment

OUR PLANET earth is so large that it is difficult to comprehend it as a whole. Even if one views the earth from space, one cannot observe the details clearly. A globe is the most perfect approximation of the earth. Globes help in understanding relative shapes and sizes of continents and oceans. Large globes are difficult to handle. Even on a large globe, only a few details can be shown as the space available is limited. While the globe is best suited to represent the earth as a whole, it cannot be used to represent a part of the earth, such as a continent or country.

A map is a representation of selected features of a part or whole of the earth's surface. Maps are essential to visualize at a glance large areas of the earth and bring out the interrelationship between different elements of the environment. Though air photographs may also help in such visualization, they cannot replace maps. While air photographs show a composite picture, maps show selected features only and help in better understanding.

There are different types of maps. Wall maps and atlas maps give a general picture of a large area such as a continent or a group of countries. Topographic maps are also general purpose maps which give more details about a small area. Town maps and village maps show details of streets, plots and fields in the area. These are called *cadastral maps.*

Maps which show selected features only are called *thematic maps.* For example, weather map is a thematic map showing weather conditions on a particular day. Population maps, road maps, maps of vegetation are other examples of thematic maps. Thematic maps may be helpful in studying the relationship between two or more variables in a region. For example, a population map of a region may be superimposed on a relief map to bring out the relation between relief features and population distribution. Thematic maps are more useful than general maps in studying environmental relationships.

Atlases: An atlas is a collection of maps of the world, continents and selected countries. Generally, atlases have political maps showing political boundaries, towns and cities, roads and railway lines and another set of maps showing physical features and drainage. Atlases may also have maps showing climatic conditions, land use, economic and population data. Atlases help us in comparing one map with the other.

Atlas maps are usually printed in colours. Height of land and depth of oceans are indicated by a range of colour shades. These maps show a variety of features by means of standard conventional signs and symbols. Do you find differences in the size and style of

lettering? What do they indicate? Examine the maps in your atlas and prepare a set of signs and symbols used indicating the meaning of each one of them.

Atlases also contain an index of place names in the end. Names are arranged alphabetically in the index. Map or page number, latitude and longitude references are given for each place. The index is useful in locating places on the maps. Use the index and learn to locate places on the maps given in your atlas.

Scale: Maps represent a part of the earth's surface on a proportionately reduced size. The scale of a map is the ratio or proportion between the dimension on the map and the actual dimensions on the earth. For example, a map may be drawn in which 1 cm represents a distance of 1 km on the earth. The scale of such a map is 1 cm to 1 km. Scale of a map may also be indicated by a fraction called the Representative Fraction (RF) in which numerator is 1.

$$\text{R.F. of a map: } \frac{1}{\frac{\text{Distance on the map}}{\text{Distance on the ground}}}$$

The R.F. of a map may be indicated as $\frac{1}{100,000}$ or 1 : 100,000. This means one unit of distance on the map is equal to 100,000 units on the ground. The unit may be a measure of length. Thus, the Representative Fraction is independent of any particular unit of measurement. If the R.F. of map is 1 : 100,000, it means that the scale of a map is 1 cm to 100,000 cm or 1 km.

Fig. 6.1 Linear Scale with Primary and Secondary Divisions
Divisions to the right of the zero mark are primary, whereas the sub-divisions to its left are secondary. How would you measure the distance of 2200 metres on this scale?

Another form of representing the scale of a map is the *linear scale.* This consists of a straight line graduated conveniently in terms of distances on the earth, e.g., kilometres. Actual distances between any two places on the map may be measured using the linear scale. Linear scales are drawn based on the scale of the map and units in which distances are to be measured. Some topographic maps may have two linear scales, one showing kilometres and the other indicating miles. A pair of dividers or a piece of string may be used to measure distances on the map and then corresponding distance may be measured from the linear scale. One sub-division of the linear scale is further sub-divided to measure distances more accurately. Examine atlas maps, wall maps or outline maps and note how the scale of the map is indicated. Measure distances between places, length of rivers, etc., on such maps.

Maps are classified as large-scale maps and small-scale maps on the basis of scale. The topographic map which is on a scale of 1 : 50,000 is a large-scale map. Wall map is a small-scale map. In a large-scale map, small areas are represented on a large size map. While a small-scale map, shows a large area on a small size map. How would you classify maps of continents in an atlas?

Directions

Directions are indicated on maps by a North-South line with an arrow indicating the north direction. If such indication is not given, the top of the map is taken as the north direction. Directions are measured from north. North-east (NE), South-east (SE), South-west (SW) and North-west (NW) are cardinal directions between the four major directions. For example, A is located north-east from O, and B is located south-east of O. Here, the precise measurement of direction involves measuring the angular distances of A and B from O using the north-south line as the basis. Join O and A by a straight line and measure the angle between ON and OA. If this angle is 50°, the direction of A from O is expressed as N 50° E. Similarly, to find the direction of B from O, join OB and measure the angle between OB and OS. If this is 40°, the direction of B is S 40° E.

Besides scale and the direction, each map has a title and a legend or a key to the symbols, colours or shades it uses.

Representation of Relief Features

The representation of relief features like hills, valleys, plains, etc., on a map is more difficult as the third dimension, namely height, has to be represented on a two-dimensional paper. The method of representation of relief features varies according to the scale of the map. In small scale maps, like wall maps and atlas maps, relief features are indicated by a scheme of graded colours called *layer colouring.* Each altitudinal zone is indicated by a particular colour. Usually lowlands are indicated by shades of green. Higher elevations are represented by shades of yellow, brown and red. Snow capped peaks are shown as white. Peaks are noted and heights indicated in metres or feet. Depth of the sea is shown by varying shades of blue. Darker shades indicate greater depth. This method of representation brings out major relief features like mountains, plateaus and plains in a general manner. Study your atlas map and prepare a scheme of layer colouring. Are similar shades of colour used to indicate same height interval in all maps?

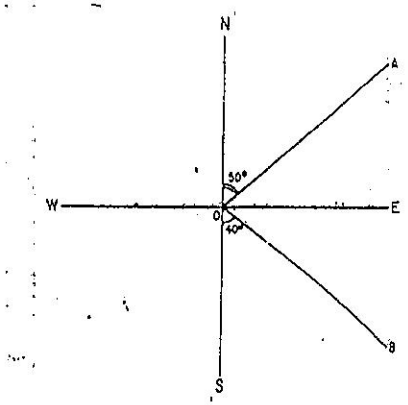
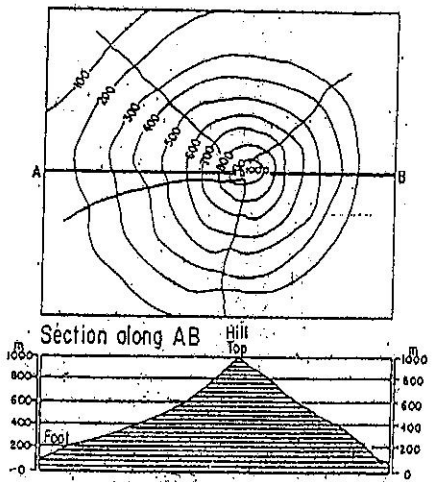
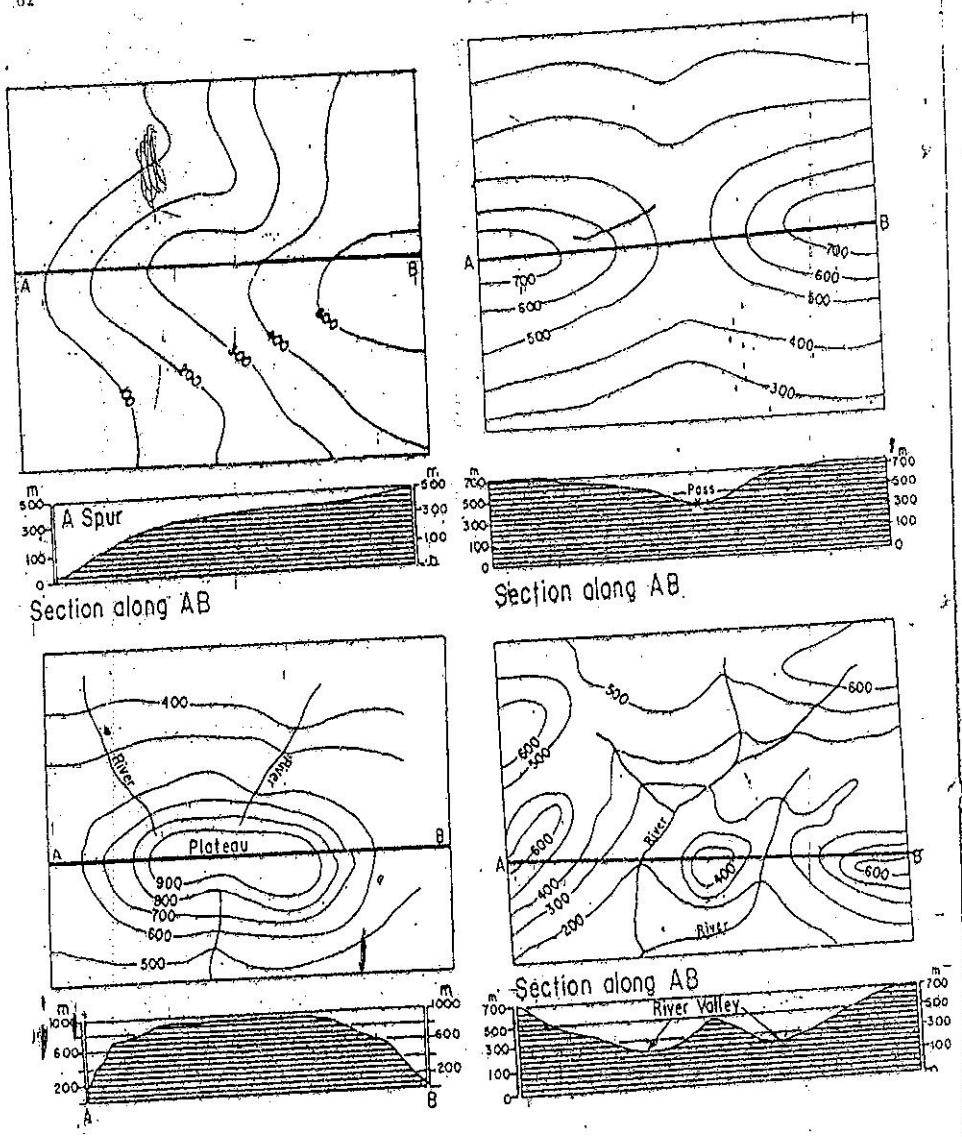


Fig. 6.2 Directions on the Map
Mark the four cardinal and other intermediary directions.
How the direction of 'A' from 'O' is called N 50°E ?

Contours On large scale maps, like topographic maps relief features are shown by contour lines. These are imaginary lines





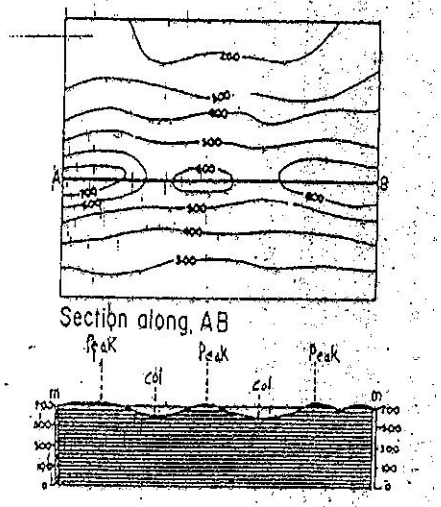


Fig 6.3 Contour Patterns of Some Prominent Relief Features

Observe the contours indicating different landforms and find out the difference with the help of cross-sections drawn under each. They show the heights as well as the form of land in each case.

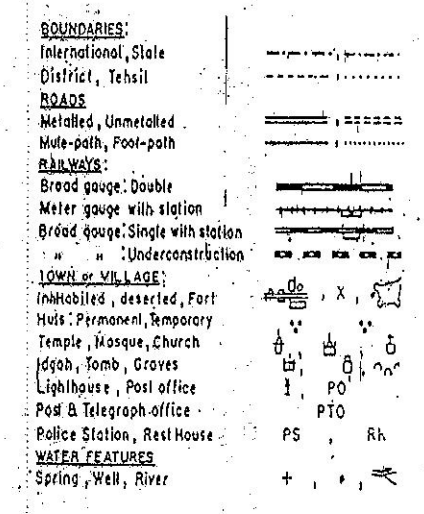


Fig. 6.4 Conventional Signs Adopted in the Topographic Maps of the Survey of India Department

Note the symbols of some such signs carefully. These are called the "alphabet" of a map.

drawn on a map, joining places having the same elevation above sea-level. Contour lines are based on a detailed survey of heights of several places in an area. The heights of each one of these places is marked on a map and contour lines are drawn by interpolation. Contour lines are drawn at definite intervals such as 20, 50 or 100 metres. Spacing of contours gives an idea of the slope or gradient. If contour lines are closer, it indicates a steep slope; gentle slope is indicated when contours are widely spaced. Contour diagrams of some of the common landforms are given in the figure. Study the cross-sections to get an idea of slope of the land.

Conventional signs and symbols: A lot of information is given on maps using signs and symbols in different colours. Rivers and water bodies are shown in blue. Human settlements and roads are indicated in red. Contour lines are drawn in brown. Railway lines and place names are shown in black. A knowledge of the commonly used signs and symbols is necessary to interpret the map.

Distribution maps: Distribution maps indicate the distribution of any particular feature in an area. Such maps may be a qualitative map such as a vegetation or soil map of a region or a quantitative map representing the population. The distribution of population may be shown by a *dot map* where each dot may represent a given number of persons. A population map of India may be prepared by dot method where each dot represents 1 million persons. Similarly, economic data like production of crops,

minerals, etc., may be shown by distribution maps.

Distribution of continuous variables like temperature, pressure, rainfall are usually represented by lines of equal value. Isotherms represent distribution of temperature, isobars are used to show pressure and isohyets are used to show rainfall on a map. Which one of these is shown by lines on the weather map published in newspapers?

The distribution maps help us to understand the distribution of different elements of physical and biological environments in an area. From such maps it is possible to infer the relation between climatic conditions, soil types and land use in a region. Maps representing the distribution of population in different Censuses bring out the changes in the distribution pattern over a period of time. Thus, a careful study of such thematic maps enables an understanding of the regional and periodical changes in a region.

Diagrams: Statistical data may be represented by a variety of diagrams also. These diagrams help in understanding the changes that have taken place over a period. The simplest form of a diagram is a *line graph.* On this graph, the time interval, months or years is shown on X-axis and the other variable is marked on the Y-axis. For example, growth of population in India from 1901-1981 may be shown by a line graph. The population value at each Census may be marked as a point and the points may be joined consecutively by straight lines. From such line graphs, it is possible to estimate the population of any year, for example to know the population of 1976, we may draw a line prependicular on the X-axis corresponding to 1976. From the point where this line meets the line graph, a perpendicular line may be drawn on Y-axis and that will indicate the population value for 1976. Such line graphs

may be drawn to represent production of crops, yields per hectare and similar data which vary over a period of time.

Bar graphs: A bar is a narrow elongated rectangle of uniform width. The length of the bar is proportional to the data it represents. Bars are drawn parallel to one another with uniform space between adjoining bars. Bars are usually drawn from a common base line either vertically or horizontally. A diagram consisting of a number of parallel bars is known as a *bar graph* or *bar diagram.*

Draw bar graphs to represent the following data.

Country	*Oil Production 1984*	*Reserves 1984*
	(in billion barrels)	
Saudi Arabia	1.7	169.00
Kuwait	0.4	90.00
Soviet Union	4.5	63.00
United States	3.8	34.5
Mexico	1.1	48.6

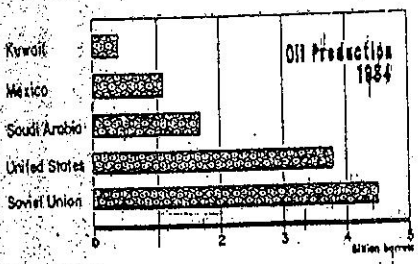


Fig. 6.5 Bar Diagram Showing Oil Production
Compare the oil production of important producers of the world.

Two bar diagrams may be drawn: one representing oil production and another representing total reserves. Let us first draw the bar diagram to represent oil production in 1984. A set of horizontal bars may be drawn. A vertical base line may be drawn near the left edge of the page. A horizontal base line may be

drawn to indicate the volumes of production. The first step is to decide the scale of the bar. A length of 1 cm may be taken up to represent 1 billion barrels of oil. Mark the scale on the horizontal line. The length of the bar representing Saudi Arabia will be 2.4 cm. Similarly, calculate the length of the bar for each country and draw the bars, so that they are of uniform width and parallel to one another. Label the bars by writing names of the countries. Using the same procedure, draw another bar diagram to represent reserves of oil.

Climatic Diagram. This is a combination of line graph and bar diagram. This diagram gives an idea of the climate of the station. The basic data needed are a monthly mean temperature and mean rainfall of each month. The table below gives the data for Mumbai. Months are marked on X-axis, each month having equal spacing. On the Y-axis temperature and rainfall values are marked choosing an appropriate scale. Mean temperature for each month is plotted as a point according to the temperature scale and these points are joined by a continuous curved line. This line graph shows the change of mean temperature from month to month during the year. Why is it that the annual range of temperature is low?

Rainfall data for each month are represented by vertical bars of uniform width. The length of each bar is proportional to the amount of rainfall in that month. Rainfall bars are shown as separate bars with blank space between them. Describe the seasonal distribution of rainfall. Can you explain decrease of temperature in July and August?

MONTH	J	F	M	A	M	J	J	A	S	O	N	D
Mean Temp °C	23.9	24.1	26.2	28.1	29.6	28.7	27.3	27.0	27.0	27.9	27.2	25.4
Rainfall in (mm)	4.1	2.0	1.5	1.5	18.3	464.8	613.4	328.9	286.0	64.2	17.5	2.3

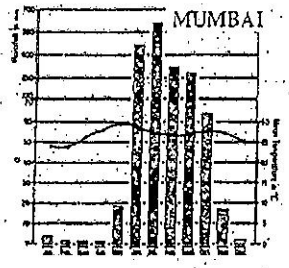


Fig. 6.6 / Line and Bar Graph
The figure shows the climatic data for Mumbai. The mean monthly temperatures are shown by a line graph, whereas average monthly rainfall is shown by vertical bars.

Read the information about the maximum and minimum temperatures and the duration of dry and wet seasons at Mumbai.

Study of Local Environment

The local environment around the school may be studied by making field trips during weekends or holidays. Observations may be made about the landforms, rivers, sources of water supply, drainage, land-use, crops cultivated, etc., covering both natural environment and cultural aspects. Examples of environmental pollution may also be noted.

The observations may be recorded on

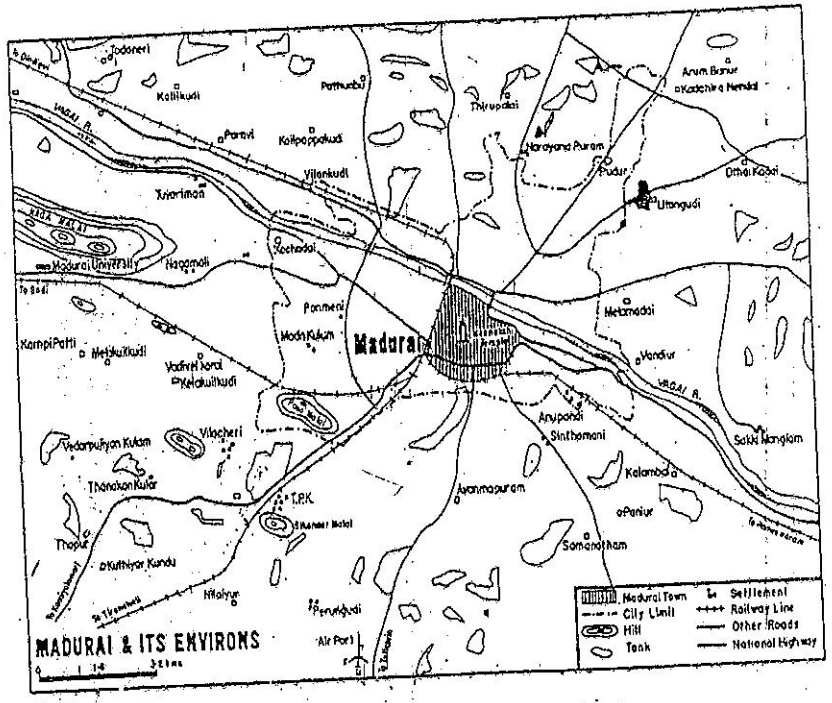


Fig. 6.7 Sketch of Madurai (Tamil Nadu) and Its Neighbourhood
Attempt a rough sketch of your own place on same lines indicating all important features.

village maps and town maps of the area or sketch maps may be drawn. The sketch maps need not be drawn to a scale. Photographs may be taken. Specimens of rocks, soils may be collected. The facts observed in the field may be used to illustrate concepts mentioned in various chapters.

SELF-STUDY

Review Questions

1. Examine the importance of thematic maps.

2. Discuss the relative merits of globes and maps.
3. In what ways is the scale represented on a map?
4. Describe the climatic diagram.

Distinguish between

1. Large-scale and small-scale maps.
2. Isotherms and Isobars.
3. Line graph and Bar graph.

Give a single technical term for each of the following :

1. Maps which show details of streets, plots and fields.
2. A ratio or proportion between the dimensions on the map and the actual dimension on the earth.
3. Imaginary lines joining places having same elevation above sea-level.
4. Representation of relief features by a scheme of graded colours.

Answer the following questions:

1. What is meant by scale of a map? How is it represented on a map?
2. Describe the methods used to represent relief feature on maps.

Do it yourself and find out

1. Study your atlas and prepare a list of conventional signs and symbols.
2. List the different maps in your atlas and indicate the scale of each map.
3. Study the map of your locality and identify the features on the ground.
4. Make a field trip and draw a sketch map.
5. Draw a climatic diagram based on climatic data given in appendix.

Books to Read

Bygott, J., *An Introduction to Map Work and Practical Geography*, London: University Tutorial Press.
Monkhouse & Wilkinson - Map and Diagrams.
Peter Gilson, *Success in Geography : Physical and Map Work*, London : John Murray.
Singh, R.L., and Dutt, P.K., *Elements of Practical Geography*, Allahabad: Students' Friends.

UNIT III

Human Impact on the Environment

THE IMPACT of humans on the environment varies from place to place. This is due to uneven distribution of population in the world. Fertile river valleys and deltas, and major industrial regions have high density of population. The impact of humans on the environment is greater in the developed countries like the United States, as the per capita consumption of food, energy and other resources is much greater than in the developing countries. The rapid increase in population in the recent decades has had serious consequences such as pollution of the environment and depletion of resources.

In the early periods of human history, most of the people were engaged in gathering or producing food. When agriculture came to provide surplus food, there was a division of labour among the people. This opened up a wide range of occupations. With a world-wide network of transport and communications, there has developed division of labour on an international scale. Some countries specialise in the production of certain commodities for export.

A study of different types of resources and their distribution would indicate how far they are adequate for the present and future needs of humans on the earth. Such a study brings out the urgent need to conserve our resources for the future. Utilization of resources has also resulted in degradation of the environment and pollution of air and water.

Based on the similarity in natural environments, it is possible to divide the world into Major Natural Regions. Though each region has a particular environmental condition, human life shows variations depending on the needs and aspirations of the people and their technological skill. The same environment produces different human responses in different parts of the world.

Examples of pollution of environment and the depletion of resources in recent years bring out clearly the need to protect the environment from future degradation. Case studies in area development are given so as to illustrate the impact of agriculture and industries on the life of the people at different levels of development.

2. Southen Asia comprising India, Pakistan and Bangladesh
3. North-west Europe which includes Great Britain, France, Belgium, the Netherlands, Denmark and Germany
4. North-eastern United States comprising the region between the Great Lakes and the Atlantic coast

Moderate Density Regions (50 to 100 persons per sq km)

Moderate densities of population occur in river villeys of South-east Asia, Central and Southern Europe, European Russia, Coastal lowlands in middle latitudes regions of South America and South Africa. These are regions of extensive agriculture and pastoral activities with some industrial development.

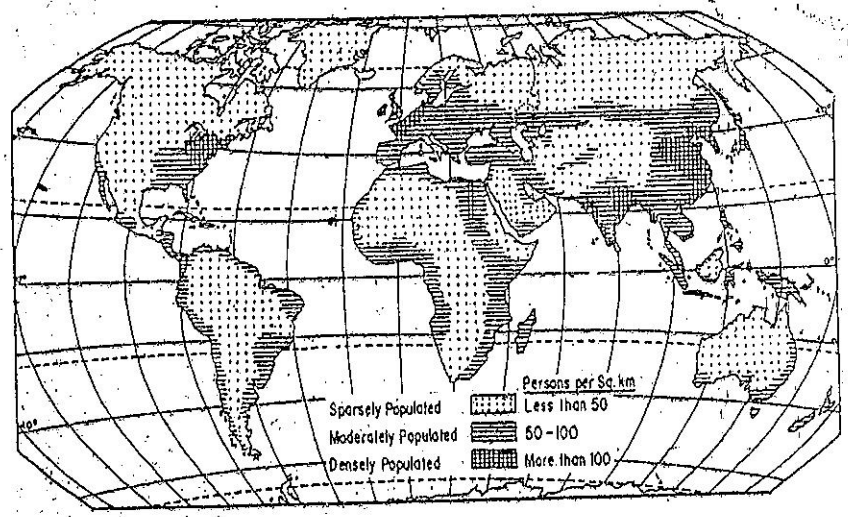


Fig. 7.1 World Distribution of Population
Note the uneven distribution of population shown by different shades of its density. What factors are responsible for these wide variations in the density of population ?

The high density in the first two regions of Asia is due to intensive agriculture in lowlands receiving adequate rainfall or irrigation facilities. Similar high densities prevail in the Nile Valley in Africa and the Island of Java in Indonesia. These are regions of intensive agriculture. The regions in Europe and United States have concentrations of population due to industrialization and urbanization.

Low Density Regions (Less than 50 persons per sq km)

These include almost 80 per cent of the land area, which is either too rugged, too hot or too cold, too wet or too dry for people to live in large numbers and engage in productive occupations. The Polar regions such as Antarctica and Greenland are extremely cold and are sparsely populated. The high mountains and dissected plateaus such as those in Central Asia have rugged relief which renders settlement rather difficult except in accessible areas. The Equatorial rain forest regions such as the Amazon and Congo basins are inhospitable to live. The Tropical deserts like Sahara and Western Australia do not favour human settlement, except in oases. In such inhospitable forests, deserts or mountainous regions, small number of nomads inhabit the area.

Factors Affecting Distribution of Population

Regions having favourable environments are more densely populated than the average for the world. For example, coastal lowlands and river valleys are densely populated as these have fertile soils and abundant water supply for agriculture. Mountainous and hilly tracts have relatively low density. Tropical and mid-latitude regions with moderate rainfall are more densely populated than the rain forests or deserts. In the high latitudes, growing season is too short for cultivation of wheat or corn and hence density of population is low. In the interiors of continents the rainfall is low and grazing of animals is the main occupation. As large area is required for grazing, density of population is low.

Thus apart from physical features and climate of the region, the cultural factors like the modes of life of the people also affect the density of population. The Equatorial forests and deserts which are inhabited by nomadic tribes have a low density as large area is needed to support each family by food gathering, hunting or fishing. The regions inhabited by pastoral nomads also have low density as people migrate with their animals in search of pastures. Regions of subsistence agriculture such as river valleys and deltas support high density of population owing to high yields of food grains. In industrial regions, the growth of industries and urban centres supports a high density of population as large number of persons are employed in industries, transport, communications and other services.

Though physical environment is favourable, parts of North America, South America and Australia have a low density of population, because such regions were recently settled by people who migrated from Europe. Parts of Siberia, Russia, Argentina, Brazil and Australia have sparse population as they are not easily accessible. Political factors such as restrictive immigration rules, are also responsible for keeping large areas almost uninhabited, although they have considerable potential for supporting a large population.

Growth of Population

The present pattern of distribution of population is the result of growth and spread of population during the past periods. During the early periods of human history, population growth was extremely slow. Scarcity of food, hostile environment and prevalence of diseases resulted in high death rate, which balanced high birth rate. Population, therefore, remained almost stationary or declined owing to famines and epidemics.

With the spread of agriculture, food supply was assured and large number of persons were needed for clearing and cultivating the land. With settled life and assured food suply, death rate declined gradually while birth rate remained high. Population increased rather slowly. People migrated to new areas and more land was brought under cultivation. At the beginning of the Christian era, population of the world was about 300 million.

The growth of population continued to be slow up to the Industrial Revolution in Europe. The Industrial revolution was followed by migration of people from Europe to North America, South America, Australia and

CHAPTER SEVEN

Our Growing Numbers

WE ARE a part of the biosphere and our existence and survival on the earth depend on our adaptation with the physical environment as well as the biological environment. The evolution of man as a distinct entity took place about one million years ago in response to changes in the physical environment. We learnt gradually to adapt different modes of life to varying environments and migrated to different parts of the world. Human activities have had their impact on the environment, depending on the number of people living in the area and their level of economic development. Per capita consumption of food, energy and other resources in developed countries is larger and its impact on the environment is much greater than equal number of persons living in developing countries in Africa or Asia. Therefore, the distribution of population needs to be examined in detail.

Distribution of Population

The total population of the world has crossed 5500 million in July 1992. The distribution of population has all along been quite uneven. More than 90 per cent of the population live in the Northern Hemisphere. The continent of Asia including Russia alone has nearly two-thirds of the world's population. The countries of China, India, Russia, the USA, Indonesia, Brazil, Japan, Nigeria, Bangladesh and Pakistan are the top ten nations in order of having more than 100 million persons.

Absolute numbers do not give any indication of the impact of population on the land and its resources. The number of persons living per unit of land area gives a better picture. This is expressed in the form of density of population per sq km of land area. The average density of population for the world as a whole is about 38 persons per sq km (1992), assuming that the entire population is spread uniformly over the land area. The actual density of population varies from region to region depending on environmental conditions. The density may vary from less than one person per sq km in the deserts to over 1000 persons per sq km in different areas. While the areas of relatively low density of population are large, areas of high density are small and scattered. Such unevenness in the distribution of population is seen not only in the world as a whole but also in each country or region. Such variations in density are due to differences in human response to the environment.

Regions of High Density (over 100 persons/sq km)

Four major regions of high density are found in the world.

1. Eastern Asia which includes China, Japan and Korea

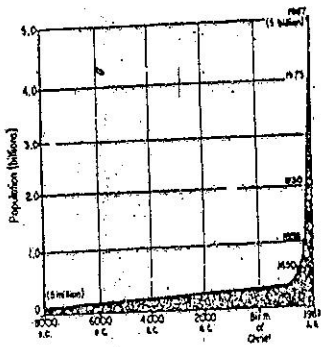


Fig. 7:2 The Growth of World Population
Mark the steepening of the curve in the last few decades

Africa. Along with this, there were a number of advances in the field of medicine which resulted in the control of plague, smallpox, malaria and other deadly diseases. Thus, death rate was gradually reduced due to better medical facilities, protected water supply, sanitation and other preventive measures. The rate of growth of population increased and reached 1000 million in 1850.

With the opening up of new lands in North-America, South America and Australia, new settlements came up and population increased by migration as well. In the countries of Asia, such as China and India, provision of medical facilities reduced the death rate rapidly and hence population growth was greater in the 20th century. World population reached 2000 million in 1930. After 1930, the rate of growth of population was much faster and by 1975, it increased to 4000 million. Another 1000 million were added in the next 12 years only and reached 5500 million in July 1992. It is estimated that world population would reach 6000 million by A.D. 2000.

Population of an area increases when birth rate exceeds death rate. Birth rate and death rate are expressed in terms of number of births or deaths per 1000 persons. Population also increases when immigration is more than emigration. Immigration refers to migration of persons into a country from other countries. Emigration refers to migration of persons from a country to other countries. As many countries have imposed restrictions on migration, this is no longer a factor for increase or decrease of population on a large scale.

The difference between birth rate and death rate gives the number of persons added per 1000 persons. For example, the birth rate Ethiopia is 49/1000 and death rate is 18/1000. The annual growth rate is 31/1000 or 3.1 per cent per annum. The annual growth rate is expressed as a percentage. The annual growth rate gives an indication of the number of years needed to double the population. If the annual growth rate is 2 per cent, population will double itself in 35 years. How many years are needed to double the population of Sweden which has an annual growth rate of 0.5 per cent? If the world as a whole is taken, the average birth rate is 26/1000 and death rate is 9/1000 and the annual growth rate is 1.4 per cent. **(Refer Appendix III for population Data for selected countries)**

Regional Variations in Growth

World may be divided into two major regions on the basis of population growth. The developed countries in Europe, and North America, Russia, Australia, New Zealand and Japan experience low population growth of less than 1 per cent per year. These countries have low birth rate and low death rate. In Sweden and Switzerland, death rate is slightly higher than birth rate indicating a decline in population. In the developed countries birth rate has declined along with death rate.

The developing nations in Asia, Latin America and Africa are having an annual growth rate exceeding 2 per cent. These countries have high birth rate and low death rate. Afghanistan has maximum growth rate of 5.3 per cent per year. In these countries, while the death rate has declined owing to better medical facilities, birth rate has remained high. China with the largest population (1255 million) in 1998 has reduced its birth rate in recent years and the annual growth rate is only 0.9 per cent. India with the second largest population has a growth rate of about 1.6 per cent per year.

Rapid growth of population in developing nations has resulted in environmental degradation. In parts of Africa, deforestation, soils erosion and fall in water table have resulted in gradual decline in yields of grain and scarcity of fuelwood. Some of these countries are facing drought and famine conditions. These nations need food aid and economic assistance, as they cannot afford to import foodgrains. Absence of such external aid may result in increasing death rate due to malnutrition, diseases, etc.

Some of the developing nations in Asia and Latin America are on the path of economic development. Spread of education, especially among women and external aid for economic development have resulted in low birth rate. These nations are likely to achieve stable population in a few decades. Thus, while some of the developing countries are likely to experience increase of death rate due to deteriorating environmental conditions, other countries are likely to reach the level of developed nations by a gradual decline in birth rate.

Population and Food Supply

We have already examined the role of humans in ecosystem. They are at the top of the ecological pyramid. Rapid growth of world population in recent decades has increased the number at the top of the pyramid. As ecological efficiency is only 10 per cent on an average, and as the area of land is finite, there is increasing pressure of population on the land. Cultivation of plants continues to be the most direct method of utilizing solar energy for food production. We have already seen that plants produce chemical energy from inputs of solar energy and inorganic matter by the process of photosynthesis. The rate at which such chemical energy is produced is known as *primary productivity*.

The primary productivity of an ecosystem is related to the physical environment of the region (Appendix v). Primary productivity is low in deep oceans and deserts. It is greater in forests than in grasslands. Equatorial and Tropical regions have higher productivity than mid-latitude and Polar regions. Maximum productivity is observed in shallow seas and lakes, marshes and swamps, estuaries and coastal plains.

Cultivation of crops like rice or wheat has low productivity, as such crops have a short growing season only. Sugarcane has greater primary productivity than rice, owing to its longer growing season. Cultivation of two or three crops in alternating rows or cultivation of more than one crop in the same field in different seasons will increase primary productivity of the land.

Forests are biologically more productive than cultivated lands, as they have a cover of perennial vegetation. Therefore, plantation of perennial plants might provide more food than traditional foodgrains. This depends on producing new food sources from trees, such as leaf proteins as well as change in food habits of the people. Planned utilization of such perennial plants would provide inexhaustible source of food in the future.

Food supply from animal sources like cattle, sheep, poultry, etc., represents second level in the food chain. The efficiency of production of animal food is on an average about 10 per cent of primary production by plants. Though animals consume large amounts of plants as food, only about 10 per cent is assimilated by them. For example, if cattle consume 100 kg of grass, they are able to increase their body weight by 10 kg. It has been calculated that one ton of hay fed to one cattle would produce 110 kg of meat in 120 days while the same amount of hay fed to 300 rabbits would produce 100 kg of meat in 30 days. Rabbits are able to produce the same quantity of meat in only one-fourth time needed by beef cattle. Therefore, in terms of meat production per unit time, rabbits are four times more efficient than beef cattle. Poultry consume 6.3 kg of grains to produce 1 kg of meat. Production of milk by dairy cattle and eggs by poultry also involves consumption of large quantities of food from plant sources.

Thus, it is evident that to support the same population, more land would be needed, if people prefer animal food to foodgrains. In other words, a purely vegetarian diet would support more population on a given area of land than a diet which includes animal food. Animal food such as meat, eggs and dairy products contains more proteins than foodgrains. Proteins are needed for a healthy life. Protein can also be synthesized from leaves of trees, pulses, oil cake and other plant products. At present 75 per cent of protein needs of man are obtained from cereals, vegetables and legumes, and only 25 per cent from animal sources. Excessive consumption of animal food is not desirable as it leads to accumulation of excessive fat in body tissues. In view of this, per capita annual beef consumption in the United States has declined substantially from what it has been in 1970s. It is not likely that man will give up animal food completely and become herbivorous. Moreover, animals are also feeding on land which is not suitable for cultivation. They are also consuming plant residues which cannot be directly consumed by man.

An understanding of the energy flows in the ecosystem would enable man to utilize solar energy to a maximum extent for building up plant and animals tissues. Plants and animals which grow rapidly would provide more food during a year. Stall feeding of cattle in sheds is more efficient than rearing them on open grassland. In the case of animals reared for meat, it is desirable to know the period of maximum growth of body weight for each animal and slaughter them after this period. Prolonged feeding of animals does not lead to proportionate increase in body weight.

Humans have not fully utilized the enormous food resources of the oceans. The total primary production in the oceans is greater than that of the land. Minute algae are the primary producers. These are consumed by tiny herbivorous organisms and shell fishes which are primary consumers. Larger fishes feed on these herbivorous organisms. A careful study of the marine ecosystem, especially the shallow waters of the continental shelf and estuaries, may provide abundant source of food for us.

Lakes, ponds, rivers and other inland waters are also highly productive, if nutrients are added to them. Fish farming is estimated to yield more than 1000 kg of fish per hectare in parts of South China. Fish farming may also be done in small ponds and paddy fields.

World's foodgrains production has increased from 624 million metric tons in 1950 to 1881 million metric tons in 1989. If the world as a whole is taken, per capita availability of foodgrains is about 360 kg in 1989.

Though world's total food supply has been increasing at a rate slightly higher than the growth of population, it is estimated that about 500 million people are living under conditions of serious malnutrition. Their calorie intake is less than 80 per cent of the requirement to prevent stunted growth and serious risk to health. Food deficits have worsened in countries of Africa. Per capita consumption of grain varies from 180 kg in Africa to 800 kg in the United States. There is need for increasing the food production to keep pace with rapid growth of population.

About 30 per cent of world's total land area or 4000 million hectares is estimated to be cultivable. The rest of the land is either too cold, too dry or too rugged or otherwise unsuitable for cultivation. Of the cultivable land, about half is actually cultivated. The rest is in pasture, grassland or forested. Developing countries have just over half of the world's land under cultivation but support 75 per cent of world's population. Cultivated land available per capita is less than one-third of a hectare. In the developed countries, cultivated land available per capita is a little more than half hectare. During the recent decades, area under cultivation has been expanding at the rate of only 0.1 per cent per year. Therefore, the prospects of increasing the area under cultivation are not bright in the future.

There is greater scope for increasing the productivity of the land under cultivation. More than 70 per cent of increase in the world grain production from 1950 is the result of increased yields per hectare. The Green Revolution has been responsible for increasing yields by use of better seeds, irrigation facilities and use of fertilizers and pesticides. China and India with large populations have become self-sufficient in food production. The average grain yield for the world as a whole is 2.5 tons per hectare. Japan is able to produce 5.7 tons of foodgrain per hectare, while the average for countries of low income is less than 2.0 ton per hectare. High yields (6.8 tons) in Switzerland and the Netherlands have been maintained by increasing the use of energy for various agricultural operations. This may not be possible in developing countries owing to high cost of energy.

There are other ways of increasing the productivity apart from increasing the use of energy from fossil fuels. Agricultural applications of biotechnology holds a promising future. Research in plant genetics would increase yields of food grains and fodder crops. Greater use of plant and animal residues in the form of compost will help in recycling nutrients and reduce the need for chemical fertilizer. Greater use of sprinkler system or drip irrigation will reduce water requirements and enable larger area to be irrigated.

About 25 per cent of foodgrains are lost before harvest by various kinds of pests. Wider use of pesticides would reduce such losses. Additional 25 per cent of food produced is lost after harvest during distribution, storage and handling. Such wastage can be reduced to a minimum by better methods of storage in rat-proof sheds instead of open storage. Losses also occur during processing of foodgrains like milling of rice to remove the husk. Prevention of such losses should go hand in hand with steps to increase productivity from plants and animals in order to ensure greater per capita availability of food.

Among the countries of the world, about 100 countries in Africa, Latin America and Asia are dependent on imports of food from other countries. Major food exporting countries are United States, Argentina, Australia and Canada. Russia has also been facing food deficit in recent years. China, India and coun-

tries in West Europe are self-sufficient in normal years. Natural hazards like droughts, floods and destruction from pests and diseases create scarcity conditions in some years.

There are political, economic and social barriers which prevent movement of food from surplus to deficit nations. While some food deficit nations like Saudi Arabia, Singapore and Libya can afford to pay the cost of imported food, African nations like Ethiopia, Mali, Mauritania and Chad cannot afford to pay for food imports. Such countries have to depend on food-aid from other countries. United Nations has proposed World Food Bank from which such assistance can be provided. Our struggle for obtaining food needs from the environment is as old as humans themselves. A solution to the food problem depends as much on an understanding of the ecological processes as on an understanding among the nations to share the available food and stave off hunger for ever.

SELF-STUDY

Review Questions

1. Answer the following questions briefly :
   - (i) Which is the most populous continent in the world?
   - (ii) What is meant by 'density of population'?
   - (iii) Explain the reasons for low density of population in some parts of the world.
   - (iv) Indicate the growth of world population after 1850.
   - (v) Explain how a purely vegetarian diet would support more population on a given area of land.
   - (vi) Name the nations which are having food deficit.
2. Distinguish between the following :
   - (i) Birth rate and Growth rate.
   - (ii) Emigration and Immigration.
3. Give an account of the distribution of population in the world.
4. Contrast the growth of world population before and after 1850.
5. Contrast the growth of population between developing and developed countries.

Do it yourself and find out

1. Gather population data about your village or town from 1901 Census to 1981 Census.
2. Draw a line graph and describe the growth of population.
3. Note the different sources from which various items of food are obtained.
4. Study the population data relating to Algeria and Australia given in Appendix and comment briefly on the differences noticed.

Books to Read

George Demko and others, *Population Geography–A Reader*, New York : McGraw Hill Book Company.
Goh Cheng Leong, *Certificate Physical and Human Geography*, New Delhi : Oxford University Press.
John F. Kolars & John D. Nystuen, *Physical Geography–Environment and Man*, New York : McGraw Hill.
Joseph M. Moran and others, *Introduction to Environmental Science*, San Fransisco : W.H. Freeman & Co.

CHAPTER EIGHT

Human Occupations

HUMANS HAVE to work in some form or other in order to get food and survive on the earth. While roots of plants spread far and wide in search of nutrients for growth, all animal organisms move out in search of food. The struggle for food in turn leads to struggle for space from which food may be obtained. Larger animals need a larger area for obtaining their food needs. In the case of humans, there is division of labour so that all of them need not engage themselves in food production directly. While a portion of the labour force is engaged in food production, others are engaged in other activities which serve the needs of the community.

The economic activities of people may be broadly divided into three groups: Primary, Secondary and Tertiary occupations. Primary occupations include agriculture, grazing of animals, lumbering, fishing and mining. These activities produce food products, fibres, timber, fuels, minerals, etc., from the natural resources. With the use of modern technology, the productivity of primary occupations has increased in recent years. The use of tractors and other machinery, irrigation, application of fertilizers and pesticides has increased yields many times. Compared to primitive methods of cultivation, the use of high yielding varieties of seeds, hybrid cattle and sheep has also increased the productivity.

Secondary occupations are those which involve processing of primary products. Agricultural, pastoral and mineral raw materials are processed by manufacturing industries to produce finished products. For example, manufacture of cotton textiles is a secondary occupation, as it involves processing of cotton to produce yarn and cloth. Secondary occupations result in adding to the value of primary products.

Tertiary occupations include provision of various services to the people such as education, health, transport, trade, administration, etc. These are necessary to provide all the basic needs of the community in villages and towns. People engaged in different occupations are interdependent. While those engaged in primary occupations provide food needed by the population and raw materials for those engaged in secondary occupations, people engaged in secondary occupations provide finished products for use by the community. Persons engaged in tertiary occupations provide other needs of the community like protected water supply, sanitation and medical facilities, education, transport, trade and effective administration.

In the early days, most people were engaged in primary occupations only. After the Industrial Revolution in Europe, the availability of cheap power led to the growth of manufacturing industries. In developed countries, the secondary and tertiary occupations employ more people than the primary occupations. In developing countries, most of the working population is engaged in primary occupations only.

PRIMARY OCCUPATIONS

Food-gathering, Hunting and Fishing

People in some regions of the world lead a simple life, as they are solely dependent on the bounties of nature. They gather fruits, nuts, roots, leaves from the plants for their food. Food-gathering involves migration in search of edible products from plants. Hunting for animals and birds and fishing in lakes and rivers provide a nutritious supplementary food. They use simple implements like spears, bows and arrows for hunting. Nets and traps are used for fishing. Locally available materials are used for making their clothing and shelter. Such tribal communities have an intimate knowledge of their habitat and they live in harmony with their environment. As most of their requirements are met from the local environment, a large area is needed to support each community.

Such communities are the Pygmies of Africa, the Semang of Malaysia, Bushmen and the Aborigines of Australia living in Tropical deserts and the Inuits and Lapps living in the Polar regions. However, rapid changes are taking place in the modes of living of many of these communities.

Animal-rearing

The domestication of animals is one of the early steps in the development of civilisation. People living in different environments have domesticated different animals. Cattle are commonly reared in the Savanna grasslands and camels are typical of Tropical deserts.

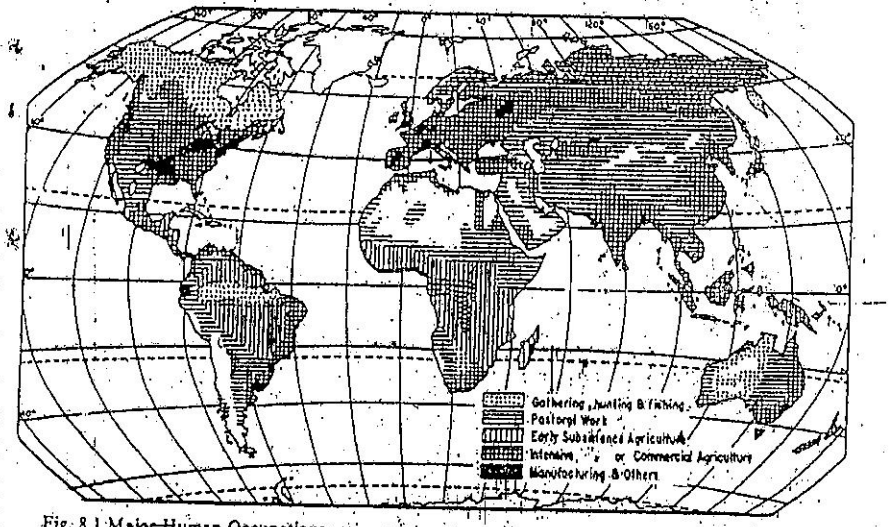


Fig. 8.1 Major Human Occupations
Draw a list of countries where people are mainly occupied in primary, secondary and tertiary activities.

Steppe grasslands are suited for rearing of sheep and reindeer are reared in the Tundra region. In mountain regions of Andes, Llama and Alpaca are herded and in Tibet and in parts of Himalaya yak are reared. Domestic animals provide milk, meat, wool, hides and skins to satisfy our essential needs. The communities whose main occupation is rearing of animals do not lead a settled life at one place. They are called *nomads* as they migrate from place to place in search of pastures and water supply. Each nomadic tribe lives in a well-defined territory and people are aware of seasonal changes and availability of pastures and water supply within the territory. In mountain regions, herders climb to higher elevations in summer to graze the animals and descend to the valleys in winter. Such seasonal migration of people with their animals is called *transhumance*. For example, *Gujars*, *Gaddis*, *Bakarwals* and *Bhotiyas* are important communities practising transhumance in the Himalaya.

The Fulani of Nigeria and the Masai of East Africa are cattle-herders in the Tropical grassland. Their wealth is measured by the heads of cattle owned by them. The Bedouins of Sahara migrate with their camels and goats in search of pastures. The Kirghiz of Central Asia used to migrate with their animals from the lowlands to the mountain slopes during summer. These nomadic tribes live in tents and lead a hard life. Their numbers are small as the carrying capacity of the land is low. With the development of transport and communication facilities, these nomads exchange their animal products for agricultural and manufactured products. Some of the nomadic pastoral tribes have migrated to other areas and are leading a settled life.

In modern times, the rearing of animals is being undertaken on scientific and commercial basis. Commercial pastoral industry does not entirely depend upon natural grasslands. Fodder crops and grasses are cultivated over extensive areas and animals are housed and fed. Special breeds of animals are reared to give maximum yields of milk or meat. Large cattle ranches in the United States and Argentina rear cattle for meat production. Dairying has developed on a large scale in Denmark and New Zealand. Commercial rearing of sheep for wool and mutton has developed in Australia and New Zealand. Commercial grazing of animals does not involve migration of people. Machinery is used extensively for cultivation of fodder crops and processing of milk and meat. The animal products are exported all over the world.

Agriculture

Agriculture is the most widely practised occupation. This involves clearing the land of all vegetation, ploughing the land and cultivation of selected plants which provide food or fibres or other products needed by us. The most primitive form of agriculture is called *shifting agriculture*. Shifting agriculture is practised mostly by the people living in the Tropical forests. They cut trees and burn them to make a clearing. They usually plant tuber crops like yams and tapioca, etc., by using a digging stick. Root crops give a large yield and roots can be stored easily for long periods without getting spoilt. Women attend to cultivation while men engage themselves in food gathering, hunting and fishing.

The clearing made in the forest is abandoned after two or three years as the forest re-establishes itself gradually. Yields of root crops also decline owing to loss of soil fertility, growth of weeds and soil erosion. People migrate and make a fresh clearing in the forest. By this process of migratory cultivation, the original forest is replaced by a less

dense secondary forest. Large areas are needed to support a small community. Shifting agriculture is practised by hill tribes in north-east India, Semangs of Malaysia and the tribals of the Amazon basin.

With increasing demand for forest, mineral and other products, transport facilities were extended to the forested regions. These communities are coming into contact with the outside world. The territory available for shifting agriculture has become reduced by encroachment of people for mining and other purposes. The communities like the Aborigines of Australia and the Native Indians of North America have rapidly declined in number. Others have adopted a settled life. The external contacts have gradually changed the modes of life of the people.

Sedentary or permanent agriculture is the most important step in the progress of human civilisation. Farming encouraged permanent settlement as it involved work almost throughout the year. Careful observation of seasonal conditions was necessary to cultivate selective crops in each season. Clearing the land, ploughing the soil, careful use of available water by irrigation and drainage channels and harvesting the crop needed cooperation of the people living in a village. As surplus food was available, there was no need to migrate from place to place. The straw or stalks provided food for domestic animals which provided labour for ploughing and irrigation.

A strong social organisation was built up and surplus food was shared by persons who provided various services to the community like priests, teachers, doctors, barbers, washermen, etc. Festivals came to be celebrated in the leisure period between the harvest and the next sowing season. Methods of land measurement and mapping, and maintenance of accurate records of land ownership became necessary. Discovery of the wheel made it possible to use animal-drawn carts for transport of surplus foodgrains to exchange them with other produce. Laying of roads enabled contact between different communities leading to exchange of ideas and growth of civilisation.

Agriculture started as a subsistence type as it provided immediate needs of the local community. With the development of transport and trade between nations during the last hundred years, agriculture came to be highly specialised. Single crops were cultivated over vast areas using machinery for most of the agricultural operations. Cotton, sugarcane, corn, wheat were cultivated on a large scale with a view to export them to other countries. This is known as commercial agriculture. Commercial agriculture may also provide food for domestic animals like cattle and sheep. Plantation agriculture is highly specialised type in which hundreds of hectares are cultivated with crops like coffee, tea, spices and rubber. These are cultivated and processed in large factories mainly for export. Plantation agriculture involves investment of huge capital and employment of a large labour force. Plantation agriculture is prevalent in parts of Malaysia, India and Sri Lanka.

Lumbering

Lumbering as a commercial venture has developed in the coniferous forest regions having soft wood trees. Trees are cut on a large scale to provide timber and to manufacture wood-pulp, paper and synthetic fibres. Sweden, Finland, Baltic states, Russia, Canada and the United States have extensive coniferous forests where lumbering has developed on a commercial scale. Machinery is used for felling trees and hauling the logs. In these regions, utilisation of forests is properly planned. New trees are planted in cleared tracts. These regions have adequate transport facilities. Large quantities of wood, pulp, paper and

newsprint are exported all over the world.

Lumbering has not developed on a large scale in the tropical and Sub-Tropical forest regions. These areas are generally inaccessible. The forests are having a variety of trees and dense undergrowth. Commercial exploitation is restricted to a few accessible regions. Teak, mahogany sandalwood and rosewood from the Tropical forests and beech; birch, maple and oak from the mid-latitude forests are utilised for construction purposes and for making furniture. In densely populated regions like India, China and parts of Africa, trees, shrubs and other plant cover have been removed on a large scale to provide fuelwood and charcoal. As there is no systematic planting of trees in cleared tracts, removal of forest cover has resulted in soil erosion and floods.

Fishing

Fishing on a commercial scale has developed in coastal regions in middle latitudes. Mechanised boats and trawlers are used to catch fish. Large ships serve as floating factories which process the catch and pack them in tins. Refrigerated holds in ships enable export of fish to many parts of the world. Japan, United States, Baltic states, Russia, United Kingdom and Norway have developed commercial fishing on a large scale.

Mining

The distribution of valuable minerals is highly uneven and mining may become profitable only for a few years. When the mineral ores get exhausted or when mining becomes uneconomical, miners leave the site. Miners usually live in temporary shelters near the site of mining. Quality of the ore, geological conditions of occurrence, depth of mining and accessibility are important factors in selecting the site for commercial exploitation. The opening up of mines leads to the provision of transport facilities and opening up of the area for settlement. The gold rush led to the migration of people to California and Western Australia. Though power operated tools are used for mining, miners face a difficult task, especially when they work at great depths. Fires, floods and caving in of ceiling lead to accidents in mines.

Apart from the mining of ores, large number of persons are employed in processing and refining the ores. Such processing units are located near the mines or near the consuming centres. As it is more economical to transport crude petroleum than a variety of petroleum products, oil refineries are located near ports and consuming centres. The number of persons employed in mining and related occupations will vary from year to year depending on the opening up of new mining centres in place of those which are closed, cost of ore, demand for ore, discovery of new deposits in other countries and other factors.

SECONDARY OCCUPATIONS

After the Industrial Revolution, the greater use of coal and oil resulted in the growth and spread of manufacturing industries. These utilise the products obtained from primary occupations like agriculture, animal rearing, lumbering, fishing and mining, and process them into finished products. For example, sugar mills manufacture sugar from sugarcane and sugarbeet. Similarly, while mining of coal and iron ore is a primary occupation, manufacture of iron and steel is a secondary occupation. Different types of industries may get located close to each other as the finished product of one may form the raw material for another. For example, a textiles mill producing yarn and cloth results in the development of units for dyeing, processing of yarn and cloth and garment factories.

The range of secondary occupations available in a country and the number of persons employed depend on the extent of industrial development. In the developed countries of Western Europe, Russia, United States and Japan, secondary occupations employ more persons than primary occupations. The development of industries depend on the availability of raw materials, power, labour, capital and market for the finished product. Apart from these factors, availability of transport and communication facilities, cost of raw materials and power, labour cost and the cost of finished product are also important economic considerations.

The workers in manufacturing industries are employed in diverse type of occupations in sugar and textile mills, dairying, meat, packing, iron and steel, chemicals automobiles, railway, ship building industries and in oil refineries.

Manufacturing industries may also be grouped into large-scale, small-scale and cottage industries, depending on the number of persons employed, quantity of mechanical power used and the value of products manufactured. Artisans engaged in making handicrafts out of local materials, handloom weavers, workers engaged in basket weaving, mat weaving, carpet weaving, etc., are engaged in secondary occupations and may be grouped under cottage industry. Each unit may employ only a few persons and mechanical power may not be used.

Small-scale industries use mechanical power and may produce a variety of components for large industries. Units producing or assembling electronic goods such as radio sets, television sets, plastic goods are generally small-scale industries. Large-scale industry may employ hundreds of labourers and have capital investment of many lakhs of rupees. Some of these industries like manufacture of automobiles or two-wheelers adopt assembly line method for mass production. Raw materials and various components are assembled at different points on the assembly line. As the product moves on the assembly line, each labourer performs a given task and in the end, the finished product rolls out. In such factories each worker specialises in performing a particular job which he repeats over and over again.

The development of manufacturing industries has resulted in widespread use of machinery for primary occupations like agriculture, mining and fishing.

TERTIARY OCCUPATIONS

Tertiary occupations include a wide range of personal and professional services provided to the community. These occupations are in the field of education, health, trade, transport, banking, insurance, communications and administration. With the growth of industries, urban population increased rapidly and the demand for professional services grew. The number of persons employed in tertiary occupations is greater in towns and cities than in rural areas. Persons employed in tertiary occupations are equally performing an important role as those employed in primary or secondary occupations which involve production of various comr dities.

Occupational Pattern

The growth of population in the last fifty years has had its impact on the occupational patterns. In developing countries, the number of dependents (non-working population) consisting of children and old people is in excess of working population. This means that each person in the working population has to support a large number of dependents. There is also growing unemployment among the youth, as the number of persons seeking employment is increasing faster than the

number of jobs available. People seek employment in other countries where opportunities are available. Growing unemployment among the youth causes social tensions, especially when they are educated unemployed.

In developed countries, as the population is not growing rapidly, the number of youth seeking employment is less than in the last decade. Therefore, persons entering the labour force are able to get jobs or get self-employed. Though the number of dependent children is less, there are a large number of old people owing to greater longevity. The working population is more than the dependent population. Families are small in size and the standard of living is high.

Role of Women

In the early periods of human history, women used to look after children and aged, while the men went out in search of food. When agriculture developed, women were also engaged in work on the farms, such as transplanting, weeding and harvesting. Other occupations like mining, lumbering and fishing do not employ women in large numbers. With the spread of education and vocational training facilities in developed countries, women are able to get employment in a variety of occupations in manufacturing industries and services. In developing countries, women are lagging behind men in education and, therefore, they lack avenues of employment. With the spread of education and increasing awareness among women, the number of women entering the labour force has been increasing in recent years. The role of women has changed from that of a caretaker of the family to that of a breadwinner. As more and more women get educated and find jobs, they will get their importance recognised by society.

SELF-STUDY

Review Questions

1. Answer the following questions briefly :
   - (i) What is meant by division of labour?
   - (ii) Give three examples of primary and secondary occupations.
   - (iii) What is meant by transhumance?
   - (iv) Who are nomads? Give examples.
   - (v) How are manufacturing industries classified?
2. Distinguish between the following :
   - (i) Primary and secondary occupations.
   - (ii) Subsistence agriculture and shifting agriculture.
   - (iii) Cottage industry and Small-scale industry.
   - (iv) Commercial agriculture and Plantation agriculture.
3. Give an account of animal rearing as an occupation.

4. Examine the significance of secondary occupations.
5. Do it yourself and find out :
   - (i) Make a list of occupations of parents/guardians of pupils in your class. Classify them as primary, secondary and tertiary occupations.
   - (ii) On an outline map of the world, mark areas of nomadic herding and commercial grazing of animals.
   - (iii) Visit any industry in your locality and list out the raw materials used and find out the places from where they are obtained.
   - (iv) Find out the addresses of pupils in your class and prepare a sketch map to show the area from which they come to school.

Books to Read

D.H. Davis, *The Earth and Man*, New York : The Macmillan Company.
Norman Pounds, *Success in Geography, Human and Regional*, London : John Murray.
Preece, D.M. and Wood H.R.B., *Foundations of Geography*, London : University Tutorial Press.

CHAPTER NINE

Our Resources

WE SATISFY all our needs from the immediate natural environment or from other parts of the world. Different elements of the environment, such as land, rivers, plants, animals, etc., acquire meaning and value with reference to the needs of people living in the region. The needs of people are not the same everywhere. They vary depending on the stage of cultural and technological development of the people. For example, the vast fertile plains of North America had no resource value to native Indians except as hunting grounds. The vast iron ore deposits of Chota Nagpur plateau in India had no resource value until iron and steel plant was established. Gifts of nature acquire value as a result of technological development. Transport facilities provide an opportunity for development of resources. Parts of the vast lowlands of Siberia were developed for agriculture only after the advent of agricultural machinery and provision of roads and railway lines. Waterfalls had very little resource value until harnessing of hydro-electric power was made possible by technological development.

Cost is an important factor in resource development. The oceans could provide abundant freshwater if a cheap process of removing dissolved salts is developed. Low grade mineral ores are mined only when high price of metal makes it profitable to mine them. Parts of Rajasthan desert acquired resource value when canal irrigation was introduced.

Rocks, minerals, soils, rivers, plants and animals are the gifts of nature or natural endowments. They become resources only when man locates them or finds a use for them or proposes to use them. The relative importance of a resource varies depending on the needs of man in the different periods of human history. Hence, the available resources in an area are not always fixed, while the natural endowments are finite. For example, a river is a natural endowment. It becomes a resource when man utilizes the river for irrigation, power development, navigation, etc. Some of the resources may cease to be so, when the natural endowment is no longer useful. For example, mine may get closed and cease to be a resource when mineral deposit gets depleted.

Classification of Resources

Resources may be classified on the basis of their sources of origin. For example, mineral resources, plant resources, animal resources, soil resources are identified according to their origin.

Resources may also be classified on the basis of their continued availability. Some resources like forest and water may be used continuously year after year. They are called

renewable or replenishable resources. Such resources do not get exhausted in a few years. On the other hand, mineral resources may get exhausted after some years. These are called *non-renewable or non-replenishable resources*. Coal and oil are examples of non-renewable resources. There is a limit to the availability of such resources in the world.

Another method of classifying resources is according to the stage of development of a resource. *Potential resources* are those which are likely to exist in the region. For example, Africa has vast potential resources of water power. *Actual resources* are those which have been surveyed and their quantities are fairly well determined. The development of an actual or identified resource depends on the available technology and the cost involved. That portion of the resource which can be developed economically is termed a *reserve*. Change of technology may make it profitable to mine low grade ores and thus convert a resource into a reserve. Similarly, an increase in world prices of metals like copper has made it profitable to utilize low grade ores and thus a resource becomes a reserve. The development of a resource available in a country depends on the stage of technological development of the people.

Human resources are the most important resource of a nation. The number of persons living in a nation does not give an indication of the human resources available, as many of them may be illiterate or do not possess skills or adequate training for development of natural resources. Hence, development of human resources is essential. This involves not only general education which develops an awakening among the people but also imparting of skills in the use of mechanical power and machines for development of agricultural, mineral and other resources. For example, the vast resources of Africa remained undeveloped because they were not aware of their importance. Although they had the skills, the appropriate technology for developing the resources was also found lacking. Nations like the United States and Russia, Germany, Japan, etc., developed their natural resources only after development of human skills and technology. The development of human resources encourages development of natural resources not only to meet the local demand but also for export.

The economic development of a region depends on the availability of various types of resources in the region, the needs and aspirations of the people inhabiting the region and the skills and technology possessed by them. The distribution of resources of various types as well as the distribution of population in a region is highly uneven. Therefore, it results in striking contrasts in levels of development not only between various nations but also within each nation. The world distribution of various types of resources and the impact of their development are examined in the following pages.

Land Resources

Land is an important resource as humans live on it and obtain most of their needs from the land. Land is put to different uses such as construction of buildings, roads and railway lines, cultivation, grazing of animals, mining, industries, etc. The proportion of land put to different uses varies from one region to another, and also from time to time in the same region. For example, in recent decades, forests have been cleared for cultivation, mining or other uses resulting in a reduction in forested area.

Physical features of the land put certain limits to its use. The slope of the land, presence or absence of soil cover, the

availability of surface or underground water the nature of rocks and minerals present are some of the factors which indicate the type of land-use in an area. Relatively level land with adequate water facilities favours cultivation of crops. Steep slopes are not favourable for the construction of houses and highways. Occurrence of valuable minerals will encourage their mining.

Economic and human factors are also important. For example, high cost may prevent cultivation on hill slopes by terracing. Low grade ores may remain unutilized owing to high cost of mining. Land-use in an area also depends on the modes of life of the people. Nomadic herdsmen may utilize the land for grazing of animals only even though such land may be suitable for cultivation.

Accessibility of an area by roads and railway lines results in the development of land. For example, extensive cultivation of wheat in the Prairie region of Canada was made possible by the development of roads and railway lines. Lands near the village site are generally more intensely used than the lands on the margins of the village. Construction of new roads and railway lines in a region changes the land-use pattern, as has happened in Siberia.

The extent of land available in any region is limited and there may be consistent demands on the available land. The same piece of land may be used for cultivation, construction of buildings, setting up of a factory, mining, construction of airport or for recreation. Proper planning of land-use with reference to the nature of land and the needs of community would provide maximum returns. Improper use of land, such as clearance of forest for cultivation may result in soil erosion. Reclamation of low lying land or marshes has resulted in making such land available for construction of buildings or other uses, as has been done in Mumbai region in India and in the Netherlands. A detailed survey of the present land-use and planning of future land-use is necessary for optimum use of land resources.

Soil Resources

Soils are indispensable for the growth of all plants. Soils are the most important natural resources, as humans and other animals depend on plants for their food. The soil consists of mineral matter such as sand and clay as well as organic matter such as decayed leaves, flowers, dead tissues of organisms, minute bacteria and earthworms. It also contains varying amounts of moisture and air between soil particles. Soils are formed by physical, chemical and organic changes which take place continuously in the soil layer. Soil formation is a slow process and it may take thousands of years to form a thick soil layer.

Soil formation is governed by factors such as the climate, nature of parent rock, the topography of the land and the type of vegetation. Among these, climate is the most important as it affects weathering of rocks, the quantity of moisture in the soil layer and the nature of vegetation. While soils are usually formed by weathering of rocks on the surface of the earth, soils may also be formed by deposition of material by agents of gradation. Alluvial soils in river valleys and deltas are formed by this process. These soils are fertile because they contain minerals and organic matter obtained from different areas and deposited in the valleys.

The surface of the soil layer is affected by the soil forming process and the denudational processes of running water and winds. There is generally an equilibrium between these two processes in areas where the natural vegetation remains intact. In such areas, the rate of removal of soil particles by denudational processes is equal to the rate at which soil particles are added to the layer by soil forming processes. When this equilibrium is disturbed, soil particles are removed from the surface at a faster rate by agents of gradation. This condition indicates soil erosion and if this process continues, the entire soil layer may be removed in a few years.

Water Resources

The distribution of water resources has been discussed in the chapter on 'Realms of Water'. Water is essential for existence and survival of plants, animals and humans, human needs water for all his domestic needs like drinking, cooking, washing, etc. Supply of protected water for all human settlements including large cities involves considerable expenditure in locating sources of supply, purifying and arranging distribution by pipelines. Water is also needed for all economic activities such as cultivation, pastoral industry, manufacturing industries like iron, steel, paper, thermal power stations, etc. Water has also been harnessed for generation of hydro-electric power.

We have already seen that distribution of fresh water resources from precipitation, rivers and underground water is highly uneven. While in the rainy season, water may run-off rapidly leading to floods, surface water may dry up in the dry season. Such seasonal contrasts in volume of water in rivers may be regulated by construction of dams to store the water in reservoirs and utilizing it in the dry season. Though water may be available at great distances from cities, tapping such sources involves considerable expenditure. Besides regional and seasonal variations in the availability of water in a region, economic factors like the cost of supplying water in relation to increasing demand, leads to acute shortages of water. In some of the developing countries in Africa and Asia, rural folk have to walk a few kilometres to get water for domestic needs. There has been greater awareness among the people of the importance of water resources for meeting their growing needs. Political factors such as boundaries between states and nations also stand in the way of sharing available water supplies.

Humans are affected not only by scarcity of water but also by its occasional abundance leading to floods. Floods may cause large-scale destruction of human lives and property and loss of crops. A solution to the problem of abundance or shortage of water supply in a region lies in making a detailed survey of water resources available and planning their utilization. Multipurpose projects like Damodar Valley Project and Bhakra Nangal Project represent integrated approach to the utilization of water. Construction of dams and canals enable regular supply of water for irrigation, domestic needs, industries, generation of hydro-electric power, navigation and other needs. Such multipurpose projects also help in preventing soil erosion and floods.

Apart from surface water from rivers, lakes and tanks, humans have been tapping underground water through wells. Human labour and animals have been utilized for drawing water from wells. With the electrification of rural areas, pump sets are used for drawing water from open wells and tube-wells. This has resulted in excessive utilization of underground water resulting in lowering of water table in some regions. In such regions underground water has been drawn at a rate higher than the rate of seepage of water. Regulation of sinking of new wells and drawal of water from existing wells is necessary to prevent further lowering of water table. Construction of percolation ponds may increase seepage of water into the water table.

Agricultural Resources

Agriculture has been practised by humans for over forty centuries. Land, soil and water are the basic resources needed for agriculture. River valleys and coastal plains have relatively level land, fertile alluvial soils and abundant water supply and thus favour cultivation. In high latitudes, the short duration of growing season is a limiting factor, while in the Tropical regions, low rainfall is a limiting factor. Rugged topography is a limiting factor in mountainous and plateau regions. Thus, the extent of land suitable for cultivation is limited.

With rapid increase in population, new areas have been cultivated by clearing forest or grassland, terracing of hill-slopes, draining marshes and swamps, and extending irrigation facilities. Use of tractors and other machinery for agriculture have made it possible to cultivate large areas with minimum of human labour. The Prairie grasslands in the United States and Canada, and the Steppe grasslands in countries of Europe are examples of extensive agriculture using machines.

In recent decades, increase in productivity has been responsible for increase in agricultural production. Use of fertilizers, pesticides, high yielding varieties of seeds have resulted in increased yields per hectare. We have already seen large variations in yield between developed and developing nations. This indicates that there is further scope for increasing yield per hectare.

In earlier chapter, we have examined different types of agriculture such as shifting agriculture, subsistence agriculture, commercial agriculture and plantation agriculture. Each type of agriculture is typical of certain regions and the types of people who live in such regions. Economic factors like cost of cultivation, changing prices of agricultural commodities, are other factors influencing the crops cultivated and the area under each crop.

Agriculture started with cultivation of foodgrains needed by the people. In course of time, fibre crops like cotton, jute, commercial crops like tobacco, sugarcane, sugarbeet, and a variety of spices also came to be cultivated. Plantation agriculture yields tea, coffee and rubber. Thus, agriculture comprises the cultivation of a variety of crops besides food grains. Each crop requires specific environmental conditions for its cultivation and, therefore, the pattern of distribution of each crop is different from that of the others.

Certain crops like rice and sugarcane can be grown only in Tropical regions having adequate water supply from rainfall which is supplemented by irrigation, if necessary. While only one crop of sugarcane may be grown in a year, more than one crop of rice may be grown during a year. As the environmental conditions for both these crops are almost the same, the choice of crop depends on economic factors.

Cotton, tobacco, millets and oil seeds are cultivated in Tropical regions with moderate rainfall. In some dry areas, cotton and tobacco may also be grown under irrigation. Area under each crop may vary from year to year depending on seasonal conditions and economic factors.

In the middle latitudes, wheat is the main food crop which is cultivated in regions having warm summer with moderate rainfall. In sub-Tropical regions, such as China and India, wheat is grown in winter. In middle latitudes, it is cultivated in spring and summer as winter is too cold. Large farms and use of agricultural machinery have enabled extensive cultivation of wheat in the United States, Canada, Russia, Ukraine and Australia. Other crops cultivated in middle latitudes are corn or maize, barley, rye, oats and sugarbeet.

A variety of fruit trees are also grown. In the Tropical regions mangoes, bananas and citrus fruits like lime, oranges, etc., are cultivated. In the middle latitudes, apples, olives and grapes, etc., are found suitable for cultivation. The Mediterranean region of the world is specially well developed for growing a number of fruits. Can you find out why it is so and what fruits suit its climate?

Besides food grains, agriculture produces a number of crops which provide raw materials for a variety of industries. Thus, the development of agricultural resources encourages the growth of agro-based industries.

Animal Resources

Animals provide meat and milk products which supplement food obtained from agriculture. Animals are also a source of wool, hides and skins which are needed by humans. In developing countries, animals supplement human labour for work on the farms. Cattle and buffaloes are used for ploughing, drawing water from wells and pulling carts.

In the newly settled continents such as North America, South America, and Australia the mid-latitude grasslands have favoured pastoral industry on a commercial scale. In wetter and warmer regions cattle are reared. Sheep rearing is widespread in cooler and drier regions. Sparse population of these areas favours animal rearing which needs less human labour than cultivation. Special breeds of animal have been developed for specific purposes such as meat cattle, dairy cattle, sheep or mutton and sheep for wool.

Technology have encouraged the establishment of large factories for slaughtering cattle and sheep for meat and other products. The use of refrigerated containers in ships has enabled export of meat and dairy products over long distances. The United States, Baltic states, Ukraine, China, Argentina, Brazil, Australia and New Zeland are major producers of meat and meat products. Dairying involves transport facilities for the collection of milk from the farms and delivering it to the processing centres within a few hours. Rearing cattle for milk requires more labourers than rearing cattle for meat. Commercial dairying has developed close to large cities which offer a ready market for milk and milk products. Milk from villages are collected and processed in factories located near cities. Denmark, the Netherlands, parts of Australia and New Zealand have specialised in export of dairy products like milk powder, butter and cheese.

Rearing of sheep for wool has developed on a large scale in Australia, New Zealand, Argentina and South Africa. These countries export wool. Machines are used for shearing wool from sheep and for processing and grading it for export.

Animal rearing is not commercially developed in the Tropical regions. Though our country has the largest number of cattle, they are used as draught animals on the farm. Yield of milk is poor on an average. Steps have been taken to organise dairying on a commercial scale to meet the increasing demand from urban centres. In many of the Tropical countries consumption of meat and milk products is quite low.

Forest Resources

We have examined the different types of forests in the chapter on Biosphere'. Forests occur in those regions which receive abundant rainfall. Forests now cover about 30 per cent of the land area of the world. Areas which are too dry or too cold do not have forest cover. Forests were more extensive in the past. There has been 30 per cent decrease in forest area after human intervention. Forests have been cleared for cultivation, mining and for other uses. Forests have also been cleared for timber, firewood and other products.

Forests play an important role in the environment. Trees absorb carbon dioxide from the atmosphere and release oxygen to the atmosphere. They also add water vapour to the atmosphere by the process of transpiration. Forests prevent soil erosion as the roots of the trees bind the soil particles. Forests provide a safe habitat for wild animals, birds and other organisms. Forests encourage seepage of water and thus reduce the quantity of run-off. Forests provide raw materials for the manufacture of wood pulp, paper, and synthetic fibres, besides timber for construction and furniture making.

Destruction of forest cover in recent decades has resulted in environmental degradation. Besides soil erosion, floods have become more disastrous affecting large areas. Reservoirs are getting silted up rapidly. Level of water table falls rapidly and wells dry up. The habitat of animals and birds gets destroyed.

In the developing countries of Asia and Africa, forests have been cleared to meet the increasing demand for firewood and charcoal. In Africa, forest area has declined by 25 per cent in the last 35 years. With increasing demand for paper and newsprint, there is need to exploit the forest resources to a greater extent. Forests are renewable resources and, therefore, systematic tree planting in cleared areas would preserve forest cover and sustain the yield. As we have come to realise the need to preserve forests, tree planting is being encouraged in all wastelands. Planned renewal of forest cover and controlled forest utilization would provide yield of timber every year.

Commercial utilization of forest resources has taken place in mid-latitude forests and coniferous forests. Norway, Sweden, Finland and Canada export large quantities of wood pulp, paper and newsprint. United States and Russia have valuable forest resources. In Equatorial region, the dense forests are not commercially exploited, owing to inaccessibility, prevalence of diseases and thick undergrowth. Monsoon forests in India and South-east Asia provide valuable trees like teak, rosewood, mahogany and sandalwood. Some of these forests have been cleared for plantation of tea, coffee, rubber and spices.

Wild Life Resources

Wild life refers to plants, animals, birds and other organisms which live in natural habitat. We have seen that all organisms in the biosphere are interdependent, as they are part of a food web. There is a balance in the environment if the relative number of species is not disturbed. Human economic activities have resulted in disturbing the natural habitats of many species. Indiscriminate hunting of animals and birds for food, furs, feathers or skins has already resulted in extinction of some species. Others are on the verge of extinction. Such extinction of species would upset the ecological balance in the environment.

We have come to realise that conservation of wild life is important for the future. National Parks and protected forests have been established to preserve the original habitat. Animal and bird sanctuaries have been set up to protect wild life. These wild life preserves are places of scenic beauty and they attract large number of tourists.

Fisheries

Fishing has been practised since ancient times. Oceans and seas contain vast resources of marine life. We have seen that such resources are more abundant in the coastal zone of shallow waters than in the open ocean. In developing countries, where consumption of meat is low, fish provide the only source of

animal protein in the diet of the people. The oil derived from fishes is used as tonic and their residuals as fertilizers. Fish may also be obtained from rivers, lakes, tanks and other inland waters. Large-scale fishing has developed in favourable locations which are rich in fish.

The world's major fishing grounds are located along the shores of continents where cool and warm currents converge between 40°N and 50°N. Such regions are rich in plankton and shoals of fish. The Grand Banks off the north-east coast of North America and the seas around Japan are major fishing grounds. The Dogger Bank in the North Sea is also a rich fishing ground as the shallow seas extend over a large area. Fish are also abundant in the zones of upwelling of water along the west coast of tropical deserts. The upwelling of water from lower layers brings up rich nutrients and fish shoals feed on them. The rich fishing grounds along the coast of Peru and Chile are located in the zone of upwelling of cold waters.

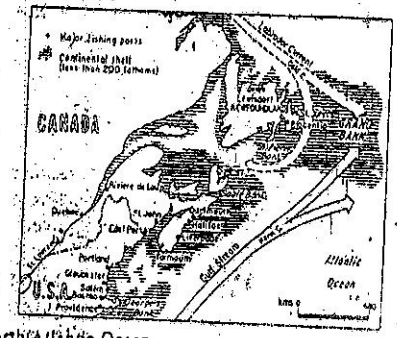


Fig. 9.1 (a & b) Major Fishing Grounds of the North Atlantic Ocean

Examine the Bank Fisheries of the North East and North West Atlantic Ocean.

What factors are responsible for the location of these fisheries.

Name the major fishing ports of each country close to these two regions.

Fishing in the open ocean involves use of large ships with facilities for processing and preserving the fish caught over a number of days. Commercial fishing has given birth to large-scale trade in fish and fish products. The total catch of marine fish in the world is estimated at 141 million tons. Japan leads the world with about 26.5% of the total catch. Baltic States Russia, South Korea, North Korea, United States, China, Peru and Norway are other leading countries in marine fishing.

Fishing is also practised in inland waters mainly for local consumption. The total production from freshwater sources like rivers, lakes, tanks, etc., is only one-eighth of the total catch. One advantage, however, is that inland fishing enables fish to be included in the diet of the people living far away from the coast. Fish culture is practised in some of the reservoirs built across rivers. Quick growing varieties of fish are grown and two or three harvests are possible in a year. This is known as pisciculture. Fish culture is similar to rearing of domestic animals for meat. In China, fish culture is undertaken in paddy fields. Oyster farming is common in Japan for producing pearls.

There is a significant decline in catches of marine fish in some of the fishing grounds. Pollution of coastal waters, oil spills and oil drilling in continental shelves and over-fishing are some of the causes for such decline. Man is at present utilizing 75 per cent of the total potential, if we consider the world as a whole. But in some locations, there is over-fishing, resulting in decline of fish catches.

The marine fisheries provide renewable resources of food, provided efforts are taken to control the annual catches. The tropical parts of oceans have great potential which has not been utilized on a commercial scale. International agreements have been made to control the catch of Whales. Similar agreements are needed among the major fishing nations to avoid overfishing in the major fishing grounds in the Atlantic and Pacific Oceans. It is also possible to develop fish culture in coastal waters. Increased intake of fish would increase the protein content of diet of the people without affecting the biotic resources on the continents.

Mineral Resources

Minerals include all materials derived from the earth by mining. Such materials may be of organic origin like coal or petroleum or inorganic in origin. Inorganic substances include both metallic and non-metallic materials. Minerals are dug out from the earth either from the surface or at varying depths.

Though minerals occur widely in rocks, they can be mined economically only at places where their concentration is high. A rock in which a particular metallic mineral occurs in a concentrated form is called an *ore*. Therefore, mining is limited to sites where ores occur. Though iron and aluminium may be found in most of the rocks, they are mined in those localities where they occur as ores.

Many metallic minerals like gold, silver, lead and zinc occur as ores in the form of narrow lodes or veins in igneous or metamorphic rocks. Coal and lignite occur as seams or layers between sedimentary rocks. Petroleum and natural gas occur in the pore space in sedimentary rocks. Some minerals like tin, gold and diamonds occur in gravel, sand and other alluvial deposits on the river beds. Denudation of rocks in the upper reaches of river basins has removed them from their original sites. They have been transported by rivers and deposited in the lower reaches. Such deposits are called placer deposits.

The occurrence of rich mineral deposit in an area may remain unexploited if physical and economic conditions are unfavourable. For example, mineral deposits in tropical forests or deserts remain unexploited due to harsh living conditions.

Generally high grade ore located near urban centres or ports are the first to be mined. When they get exhausted or mining conditions become difficult, distant deposits are opened up or imports are made from other countries. When prices increase, it becomes economical to mine low grade ores also. Price increase also gives fillip to exploration and discovery of new deposits even in areas which were considered unfavourable. Continuous exploration of new resources is necessary to ensure supply of minerals as old mines get exhausted in a few years.

Mineral ores contain a number of substances along with the mineral. The percentage of mineral occurring in the ore varies from place to place. Minerals have to be processed to remove impurities and obtain pure mineral. Processing of iron ore to obtain iron involves establishment of a large manufacturing unit at great cost. Petroleum cannot be used in its crude form. It has to be refined into petrol, diesel oil, kerosene and other products. Mining of ores encourages growth of industries near the site of mining or near the markets.

Mineral Fuels

Coal, petroleum and natural gas are the common sources of energy. As these substances are of organic origin, they are also called fossil fuels. These account for 88 per cent of world's production of commercial energy. Hydro-electric power and nuclear power account for the balance 12 per cent as shown in the following table. The distribution of sources of power is highly uneven. Some countries have to import the entire demand for power.

Table

Sources of Power	*Percentage (1989)*
Oil	38.5
Natural Gas	21.5
Coal	27.8
Hydro-electric	6.6
Nuclear	5.6
	100.0

About half of the world's population in developing countries still depends on firewood and charcoal, animal residues like cowdung, crop residues such as stalks of harvested plants as domestic fuel. While coal, oil and natural gas are non-renewable sources of power, plants and animals provide renewable sources of power. Solar power, wind power and tidal power are also renewable sources. Hydro-electricity and nuclear power are other sources of power. Hot springs and geysers are sources of geothermal power.

Coal : Coal provided the basis for Industrial Revolution in Europe. The invention of steam engine and internal combustion engine increased the demand for mechanical power. Before the Industrial Revolution, man was relying on domestic animals, winds (wind mills) and running water (water wheels) to supplement human labour. With the discovery of oil and hydro-electricity, the importance of coal has declined gradually.

Coal is a bulky commodity and its transportation over long distances is costly, while oil can be easily transported by pipelines or tankers over long distances. The burning of coal leaves a large residue in the form of ash which has to be removed periodically. The burning of oil does not leave any residue. Widespread use of oil for automobiles, railway engines and aircraft, has increased the consumption of oil. Coal is indispensable for smelting of iron ore in blast furnaces.

Coal is an organic deposit consisting of remains of forest vegetation of past geological periods. Coal occurs as layers of varying thickness between beds of sedimentary rocks. The quality of coal varies depending on the carbonisation of the plant remains. The best quality of coal is called Anthracite which contains 90 to 95 per cent of carbon content. The most common variety of coal is called Bituminous coal containing 70 per cent carbon. This is used for the manufacture of coke used for smelting iron. Peat and lignite, also known as brown coal, are low grades of coal containing carbon content of about 50 per cent and high content of moisture.

The distribution of known deposits of coal is highly uneven. The major deposits occur in the United States, Ukraine, Russia, China and Western Europe. Coal deposits are not found in Southern Hemisphere, except for Republic of South Africa and Australia. Such uneven distribution implies that many countries do not produce coal. They depend on imports to meet their requirements.

United States, Russia and China together account for 60 per cent of world's total production of coal. Among the countries of

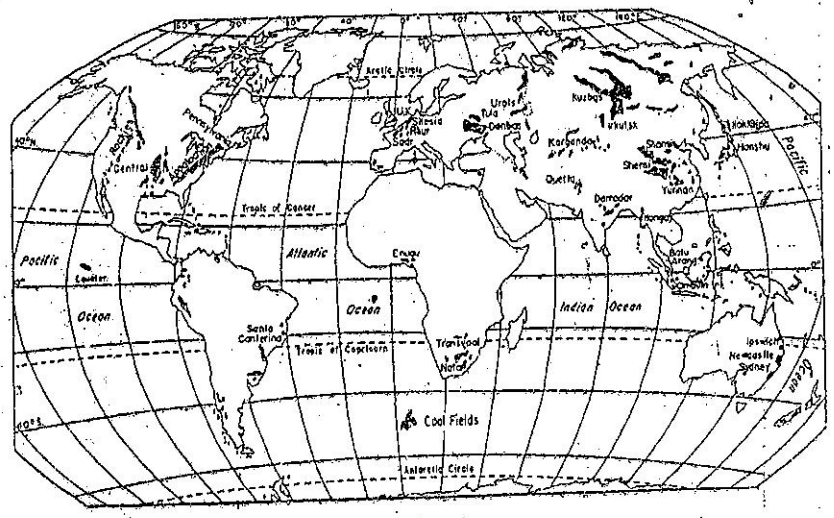


Fig. 9.2 (a) Major Coal Fields
Most of the important coal fields are found between 30° N and 60° N latitudes. Name the countries in which these are located.

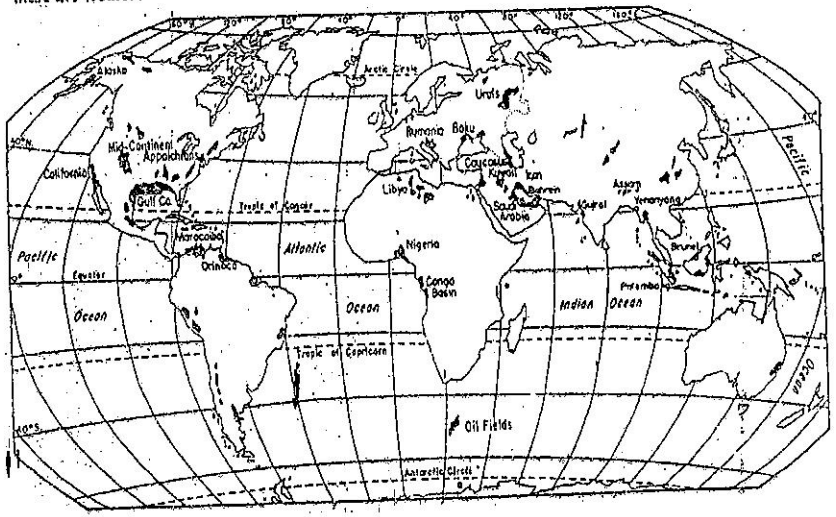


Fig. 9.2 (b) Major Oil Fields
Mark the countries or their parts having oil bearing strata in Americas, Eurasia and Africa.

countries of Europe, the United Kingdom, Germany are the major producers together accounting for 15 per cent of world's total production of coal. The world has abundant reserves of coal which would last more than 100 years at the present rate of consumption.

Coal is used for steel making and for generation of electricity. It is also used as a raw material in chemical and other industries.

Petroleum: Petroleum or mineral oil is derived from organic materials trapped between layers of sedimentary rocks. Oil seeps through pore spaces in rocks and occurs in association with water and natural gas. As oil is lighter than water, it floats above water and natural gas may occur above oil. Oil accumulates in anticlines or upfolds owing to its low density. Major oil fields are located along the margins of recently folded mountain ranges, coastal regions and in the off-shore regions such as the continental shelves.

Crude petroleum is refined to yield various products like petrol, diesel, kerosene, etc. Most important use of oil is for transport purposes on land, sea and air. Oil is also used for generation of electricity. The by-products of oil refining provide raw material for manufacturing fertilizers, lubricants, synthetic fibres and drugs. Oil is of strategic significance as oil is needed for mobility of defence personnel and for striking power. Oil refineries provide vast scope of establishment of ancilliary industries based on by-products of refining.

The world consumption of oil has been increasing rapidly until 1973, when the price of oil increased rapidly. This led to a gradual decline in oil consumption in developed nations. Attempts are also being made for more efficient use of oil by improving the internal combustion engines. Fuel efficient automobiles run more kilometres per litre of oil. As a result, the increase in world consumption of oil has slowed down in the last ten years.

The distribution of oil reserves and production are highly uneven in the world. About two-thirds of the total reserves are located in the region around the Persian Gulf in South West Asia. The main oil producing countries in this region are Kuwait, Saudi Arabia, Iran, Iraq and United Arab Emirates. These countries account for 75 per cent of exports of oil as local consumption is quite low.

United States is the largest consumer of oil in the world. Its reserves are however not large. Former Soviet Union and China are self-sufficient in their requirements of oil. The countries of western Europe and Japan depend mainly on imports of oil. Other oil exporting countries are Venezula, Libya, Algeria and Indonesia. As oil production is concentrated in a few countries, the volume of international trade in oil is much greater than that of coal.

Natural Gas: Natural gas occurs in association with petroleum. Some oil wells yield natural gas only in large quantities. Natural gas is used for generation of electricity as well as for domestic purposes. United States has the largest reserves of natural gas and leads in production. Russia and countries of Europe are other gas producing countries. Natural gas does not enter international trade like petroleum.

Electricity: Electricity is generated by using fossil fuels like coal or oil or radioactive minerals like uranium. These minerals provide heat energy which is converted into electricity. This is called thermal electricity and power generation depends on the availability of such minerals. Thermal power plants are based on non-renewable minerals.

Electricity may also be generated by using

the force of falling or running water. Waterfalls are harnessed for power generation. This is known as hydro-electricity and such power generation can be continued year after year as long as water is flowing in the rivers. This is a renewable source of power. As no fuel or other material is consumed for generation of electricity, generation of hydro-electric power is cheaper than thermal power.

The most important factor favourable for the generation of hydro-electric power is a steep gradient along the path of a river, providing sufficient 'head of water'. Copious flow of water throughout the year would enable continuous supply of power. If there is marked seasonal variation in flow in a river, dams are constructed to store the water in a reservoir and regulate the supply througout the year. The dams at Mettur (Kaveri river), Hirakud (Mahanadi river) and Bhakra (Sutlej river) regulate water supply. Water is let out through huge penstock pipes fixed along the gradient. Such falling of water rotates the turbines at the base of the slope and electricity is generated. During dry seasons, low level of water in the reservoir may not permit power generation. An integrated grid linking thermal and hydro-electric power plants would maintain uninterrupted power supply. Thermal power will be used as a stand-by to be used in dry seasons. Tennessee Valley Authority in U.S.A., and Damodar Valley Project in West Bengal consist of a number of dams and power stations. Though a number of hydro-electric power stations have been constructed in recent years hydro-electric power accounts for only 6.6 per cent of total energy production in the world from all sources. There is a lot of potential for hydro-electric power development in Africa and South America.

Electricity has advantages over coal or oil as it can be transported by wire over long distances at low cost. Transport of coal by lorries, railways or ships involves considerable expenditure. Secondly, the use of electricity does not leave any residues like ash, dust or release of poisonous gases. Electricity is widely used for transport, industrial processes and domestic uses.

Nuclear Power: Nuclear power is based on the release of energy during spontaneous disintegration of radioactive elements like uranium or thorium. This energy is used for generation of electricity in nuclea power stations. Nuclear power accounts for only 3.9 per cent of total power generated from all sources in the world. There were 345 nuclear power stations in the world in 1984; Countries of Western Europe, United States together account for 70 per cent of nuclear power stations. Other leading countries are the Russia, Ukraine and Japan.

The release of radioactivity as a result of accidents at Three Mile Island Power Station in the United States and at Chernobyl Station in Russia have raised doubts about the safety of nuclear power stations. There has been a decline in the growth of nuclear power in recent years. The disposal of nuclear waste is also creating environmental hazards.

Non-conventional Sources of Energy

The conventional sources of power like coal and oil are non-renewable and they are getting exhausted rapidly. While reserves of coal may last a few hundred years, reserves of oil will last a few decades only. The demand for power is increasing even for agricultural needs. Therefore, there is urgent need to harness new sources of power, such as the sun, winds, tides etc., which are renewable.

Solar power can be harnessed only if sun's rays are concentrated by using a series of mirrors. Solar energy has been tapped to generate electricity, heating homes, providing hot water and hot air for industries. Satellites and space stations tap solar energy. Solar energy can be tapped only during periods of sunshine. Widespread use of solar energy will depend on technological developments so as to reduce costs and enable storage of power for use during cloudy periods or night. The solar energy would then provide continuous supply of abundant power.

Wind mills have been used by humans for grinding food grains. In the Netherlands large array of wind mills have been set up to generate electricity. The working of wind mills depends on the velocity of winds. As winds are varying in velocity, continuous generation of power may not be possible. Therefore, wind mills can be set up only in areas having strong and steady winds. Wind-mills may have to be integrated with power stations based on fossil fuels or hydro-electric power stations to compensate for variations in wind velocity.

Tidal power generation depends on the harnessing of rise and fall of sea level due to tidal action. In narrow estuaries, when tide rises, sea water rushes up and then rushes down during low tides. Such power development is possible only at a few locations where the tidal range is high.

Geothermal power utilizes the heat in the interior of the earth for generation of power. This is possible in volcanic regions or where hot springs and geysers occur. In such regions, cold water which seeps through deep fissures gets heated in contact with hot rocks and rushes out as steam or boiling water. United States, Italy and New Zealand have power stations based on geothermal energy.

More than half of the world population in developing countries use fuels based on biomass derived from plants or animals. In some African countries 90 per cent of energy consumption is from biomass fuels. Gathering of firewood for cooking is one of the daily chores in rural areas. An indiscriminate cutting of trees and shrubs for firewood and for timber has removed plant cover within a few kilometres of human settlements. Scarcity of fuelwood and increasing cost has made it difficult for them to cook food even once a day. In some of the countries of Asia, like China and India, crop residues and animal residues like cow dung are used as domestic fuel.

A solution to the fuelwood scarcity in rural areas lies in planting trees in uncultivated lands and systematically cutting them and replanting such areas so as to yield a regular supply of firewood at reasonable prices. Use of more efficient *chulhas* or stoves would reduce consumption of firewood.

Other minerals: Among the other minerals, metallic minerals like iron, manganese, copper and aluminium are important as they provide basis for industrial development. Iron ore reserves available are quite large in quantity. Brazil, India Ukraine and Russia have large reserves of high grade iron ore. Brazil, India and Canada export iron ore in large quantities; countries of western Europe and Japan are leading importers of iron ores. Manufacture of iron and steel from iron ore requires high grade coal and manganese. Russia, United States, Japan, China and Germany are major producers of steel. Iron and steel industry may be located near coal fields or iron ore mining sites or at a place where iron, coal and other raw materials may be assembled by road or rail.

Manganese is used in steel making and for manufacture of alloys. Almost 50 per cent of manganese produced in the world comes from Russia. Other major producers are Republic of South Africa, Brazil, Gabon, China and India.

Aluminium is obtained from bauxite ore. Bauxite is a product of weathering of rocks

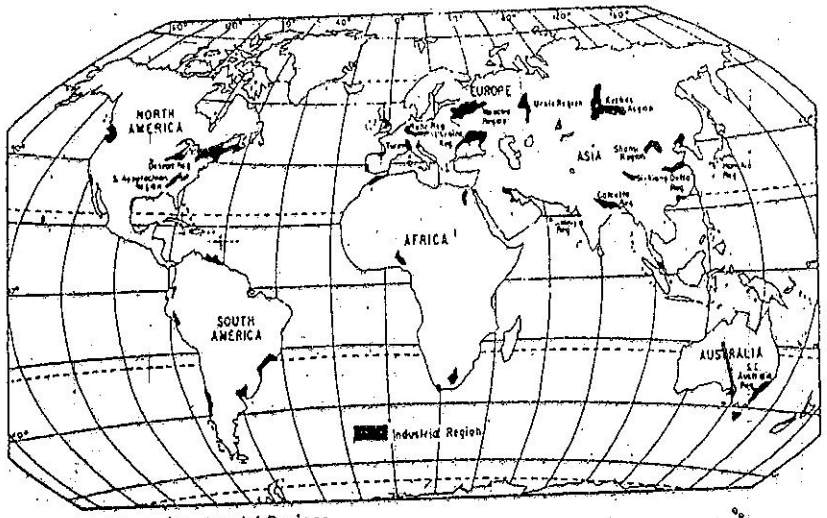


Fig. 9.3 Principal Industrial Regions
Name the parts of the countries and the important industrial centres included in each region.

Australia, Guyana, Jamaica, Brazil and Russia are the major producers. Except Russia, these countries export bauxite. The refining of bauxite to produce aluminium needs large quantities of electricity. United States, Russia and Canada are major producers of aluminium.

Copper is an important metal used for transmission of electricity. World's reserves of copper are not adequate to meet the ncreasing demand. Chile, United States, Russia, Canada, Zambia and Congo are leading producers of copper.

Industries: We have examined in an earlier chapter that industries are based on processing of primary raw materials. Such industries may be based on agricultural, pastoral or mineral raw materials. Processing of raw material requires abundant supply of power. Industries have not developed in countries which lack power resources. Transport facilities by road, rail and air are also essential for development of industries in a region. Ports located along the coast favour industrial development as they enable import of raw materials and export of finished products. The availability of skilled labour is also another important factor for industries like diamond cutting, watch making, etc. The labour cost becomes quite high if such industries are shifted from the areas of skilled labour.

Major industrial regions are located in North-eastern United States between the Atlantic Coast and the Great Lakes, Western Europe including United Kingdom, Ukraine, Russia, China and Japan. Industries such as iron and steel, textiles, oil refineries produce products which serve as raw materials for other industries. For example, textile mills which produce yarn and cloth may give rise to hosiery industry, dyeing and processing and printing of cloth and garments industry. Name other industries which are associated

together. Industrialization favours growth of large towns and cities.

Conservation of Resources

The growth of population in recent decades and increasing per capita consumption has resulted in great demand for the limited resources available on the earth. Economic development has brought with it increasing consumption of all types of resources leading to increase in prices. Developing countries find it difficult to purchase scarce resources needed for economic development.

Land has become a scarce resource in densely populated countries. Valuable cultivated land is being taken up for construction of houses or industries. Forest land is being cleared for other uses. It is necessary to put the available land for optimum use. Soil erosion, gullying, dumping of waste from mines, solid waste from cities, etc., is rendering land unfit for any other use. We have already seen the urgent need for conserving the soil resources.

Water resources need to be conserved by tapping the available surface water. Rivers may be linked up so that surplus water from one river may be diverted to another. For example, waters of Periyar river in Kerala have been diverted to Vaigai river in Tamil Nadu. Lowering of water table due to excessive use of ground water may be checked by improving surface storage so that water table gets recharged by seepage. Irrigation by open channels from rivers and tanks is inefficient as only 30 per cent of water is used by plants. Rest of the water is lost by seepage or evaporation. Modern methods of sprinkle irrigation or drip irrigation will consume less water. Wastage of water can be checked in distribution and use by industries. Iron and steel, paper and other industries which consume large quantities of water may explore the possibility of recycling it.

Biotic resources may be conserved by afforestation of waste land and protecting forest areas from encroachment. National Parks and sanctuaries will preserve wild plants, animals and birds in their natural habitat. The wild plants are useful in breeding high yielding and pest resistant varieties of crops.

Non-renewable resources like minerals are in great demand. One way of conserving them is to recycle the scrap to make metals. For example, scrap iron and other metals may be refined to yield metals. Such refining needs less energy than refining metal from ores. For some uses, metals may be replaced by wood, plastic, rubber or other substitutes.

Conservation of power resources may be effected by making use of renewable sources of power to a greater extent. Conservation is possible by improving the efficiency of automobile engines, electrical motors and other machinery. More efficient use would enable less consumption of power for specific purposes. With dwindling reserves of oil and depletion of forest cover, the world is facing an energy crisis. It is imperative that energy is conserved by reducing losses in transmission, handling and usage by both domestic and industrial consumers.

SELF-STUDY

Review Questions

1. Answer the following questions briefly:
   - (i) What are resources?
   - (ii) Examine the importance of human resources.
   - (iii) What problems are involved in utilizing underground water?
   - (iv) Name the factors which favour agriculture in an area.
   - (v) Which countries are major exporters of dairy products?
   - (vi) Describe the importance of forest resources.
   - (vii) Name the major fishing grounds of the world.
   - (viii) Examine the conditions which favour mining.
   - (ix) Indicate the relative importance of different power resources.
   - (x) Name the renewable sources of power.
   - (xi) Examine the need for conservation of resources.
2. Distinguish between
   - (i) Renewable and Non-renewable resources.
   - (ii) Thermal and Hydro-electricity.
   - (iii) Rocks and ores.
   - (iv) Resources and Reserve.
3. Give a technical term for each of the following:
   - (i) Resources which get exhausted after a few years.
   - (ii) That portion of resources which can be developed economically.
   - (iii) Rock in which a particular mineral occurs in concentrated form.
   - (iv) Coal which contains 90 per cent to 95 per cent carbon content.
4. Discuss the factors which influence land-use in an area.
5. Examine the significance of water resources.
6. Discuss the need for conservation of resources.

Do it yourself and find out

1. Find out from your own neighbourhood the local natural resources that are being exploited.
2. Make a field study and identify the changes in land-use which have taken place in the area around your school.
3. Identify the sources of water supply in your area and asses their adequacy for growing needs.
4. Collect data relating to production of coal, petroleum and hydro-electricity in India for the last 10 years and prepare bar graphs.
5. Draw a map of the world showing the distribution of major coal fields and oil fields.

Book to Read

Joseph M. Moran and others, *Introduction to Environmental Science*, San Fransisco: W.H. Freeman.

CHAPTER TEN

Human Life in Natural Regions of the World

IN THE EARLIER CHAPTERS, we have examined the various aspects of the natural environment and man's impact on the environment. Though there appears to be a wide diversity in the environmental conditions, one can identify certain patterns of distribution, which get repeated in different continents. The basic elements of the pattern are the climatic conditions. Climate in turn has an effect on the type of soils and vegetation cover in an area. The distribution of major climatic types provides a basis for division of the world into major natural regions.

Natural Region

A natural region is one in which climate, soils and natural vegetation are homogeneous. Environmental conditions are relatively uniform within each region. The variations within the region are much less than those between the regions. Minor variations caused by relief features are not taken into account in determining natural regions. High mountain ranges and plateaus such as the Himalayas and Tibet are considered as a separate region, as environmental conditions vary with height. Though there are striking contrasts between adjoining regions, such as the Equatorial forest and tropical grassland, the line of demarcation is not abrupt or well defined. The boundaries between regions are broad transitional zones in which dominant features of one region gradually disappear giving place to those of the adjoining region. The aim of dividing the world into major natural regions is to provide a frame of reference for comparative study. The large variety of environmental conditions on the earth are reduced to a few major natural regions.

The division of the world into major natural regions is based on climate, as climate influences soils, flora and fauna. Modes of life of the people is also related to climate, especially when large number of people depend on primary occupations only. Each climatic region provides suitable conditions for cultivation of certain crops only, as each crop tolerates certain range of temperature and needs a minimum of water supply. As the natural vegetation is a visible index of climatic conditions, major natural regions are named after the prevalent natural vegetation.

Human Response to Environment

Earlier it was thought that as environment is the dominant factor, similar environments would produce similar if not identical human response. Human activities were thought to be influenced by the constraints of the environment. With the developments in science and technology, humans have learnt to overcome the limitations imposed by the natural environment. Humans are no longer entirely dependent upon the environment. For

example, environmental limitations of tropical desert region in Saudi Arabia have been overcome by airconditioning of buildings, conversion of sea water into fresh water and import of foodgrains and other needs from other parts of the world. Modern methods of irrigation have increased the area under cultivation in the Nile Valley. The limitations imposed by the environment may be overcome by human effort. However, economic, social and other considerations limit our options. Though glass houses may enable us to cultivate vegetables in polar regions, such cultivation is not widespread owing to the high cost. It is cheaper to get vegetables from other regions.

The natural environment offers a number of possibilities and man has the freedom to choose the most suitable one according to their needs and aspirations and his level of technological development. Though humans are physiologically the same every where, their needs and aspirations and patterns of consumption are different depending on the social and cultural background and standards of living. Therefore, human response is not the same in all areas included in the same natural region. For example, human response to the tropical rain forest environment ranges from food gathering, hunting and fishing in parts of Congo basin, to plantation agriculture in Malaysia and Indonesia.

Human response to environment also changes with time. The Aborigines of Australia leading a nomadic life were the only occupants of the continent. The resources of the continent had no value for them. Migration of people from Britain and other countries of Western Europe led to the development of agricultural, pastoral and mineral resources. This is due to the fact that the needs and aspirations of the people who migrated, the technology and skills known to them were quite different from those of the Aborigines. While the natural endowment has remained the same, human beings have given value to them and utilized them for their own use and for export.

The natural environment and the varying human response to that environment in each one of the major natural regions is described in the following pages. The major natural regions correspond with the major climate and vegetation belts of the world.

1. Equatorial Region

Natural Environment

The Equatorial Region has uniformly hot and wet climatic conditions throughout the year. There is no dry season during the year. Annual range of temperature is low. Seasonal contrasts are minimum. The combination of high temperature and high humidity makes the climate unfavourable for sustained human effort.

The region has red and yellow soils of low fertility as they get leached by heavy rainfall. In low lying areas such soils get waterlogged. The natural vegetation consists of tropical evergreen forests containing a variety of species. Tall hardwood trees form a continuous cover at a high level. There are small plants forming a second layer and a thick undergrowth of bushes.

Human Response

The Equatorial region remains mostly in its natural state except in some accessible tracts. Malaria, yellow fever and other tropical diseases are widespread. Insects and pests attack animals and cultivated plants as well. Dense forests have remained inaccessible except along navigable rivers and a few major roads. Construction and maintenance of roads and railway lines involve huge cost. Human settlements are small and scattered.

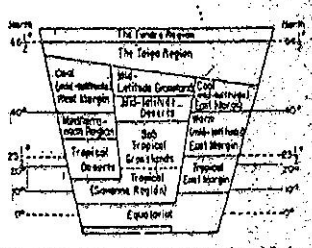


Fig. 10.1 Schematic Diagram Showing Major Natural Regions of the World

This illustration is the key for pointing out the location of major Natural Regions on World Map.

The Amazon basin in South America and the Congo basin in Africa are inhabited by tribes. They live in small clearings in the forests. Food gathering, fishing and hunting is practised along with shifting agriculture. As the forest cover gets reestablished in the clearings made, they have to shift to another area and clear the forest. The density of population is low as a large area is needed to support each tribal group.

The Island of Java in Indonesia stands in striking contrast to other Equatorial areas. This island has been inhabited by farmers for several centuries owing to its fertile volcanic soils. Intensive subsistence agriculture is common in the lowlands and terraced hill slopes. Density of population exceeds 1000 persons per sq km.

Development of plantation agriculture in parts of Malaysia, Sri Lanka and Indonesia represents another response to the same environment. European colonization was responsible for the development of plantations to provide rubber, tea and other products for European markets.

2. Tropical East Margin Region

Natural Environment

This region includes eastern margins of continents between 10°N to 30°N and 10°S to 30°S. Parts of this region such as India, South east Asia, East Africa and Northern Australia experience a typical monsoonal climate having seasonal reversal of winds. In these areas, Trade winds prevail in winter and Monsoon winds blowing from the opposite direction prevail during summer. Other areas such as Eastern Brazil and Central America and Natal Coast of South Africa experience trade winds throughout the year. Rainfall is generally moderate except in coastal regions and mountainous tracts. Rainfall is generally limited to the summer season. Laterite soils occur in the region except in river valleys where alluvial soils are found. Natural vegetation consists of Tropical deciduous forest which is less dense than Equatorial forests.

Human Response

The lowlands and river valleys have fertile soils and abundant water supply. They are intensively cultivated with some tracts producing more than one crop during the year. Besides rice, wheat and other food grains, commercial crops like sugarcane, cotton, jute, etc., are also cultivated. The river valleys and deltas, in India are densely populated. Mountainous tracts are forested and yield timber, bamboo and other forest products. Some forests have been cleared for plantations of tea, coffee and rubber. Various tribes inhabit inaccessible forests.

3. Tropical Grassland (Savanna) Region

Natural Environment

This region lies in the interior of continents in the tropical belt. Therefore, the region has moderate rainfall and experiences greater annual range of temperature. Rainfall mainly occurs in the short summer season with a long dry season. Coarse tall grass which grows to a height of about 3 metres is the typical

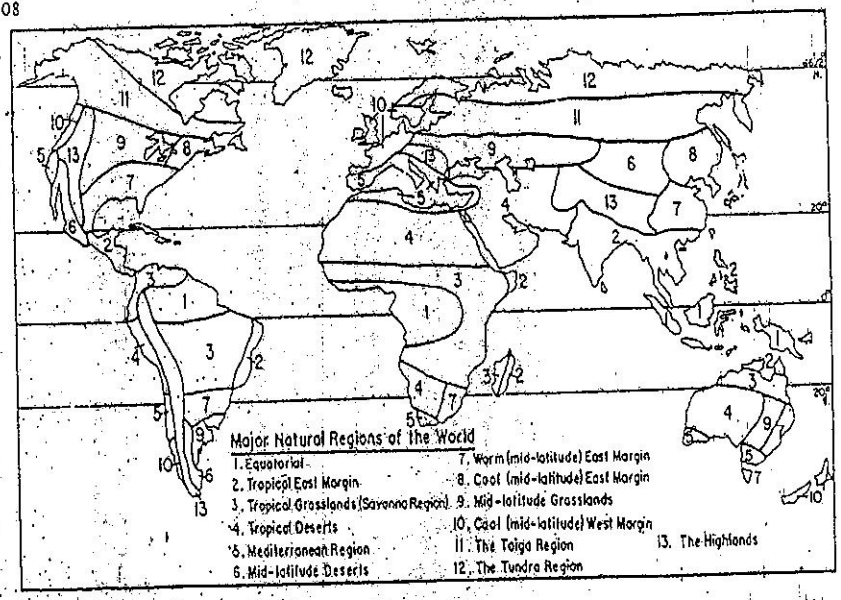


Fig. 10.2 Major Natural Regions of the World
Although this map shows as if straight lines divide one such region from the other, there are transitional zones in place of boundary lines between one and the other region. What can be the reason ?

vegetation. The tropical grassland has been known as "the big game country" as carnivorous animals like lion, leopard and tiger abound in this region. These animals feed on the deer, zebra and other herbivores. In order to protect wild life, national parks have been established as sanctuaries. These national parks in East Africa attract many tourists.

The tropical grassland regions occur extensively in Africa as a belt around the Equatorial region. Other areas are parts of Brazilian plateau and Orinoco basin in South America and Northern Australia.

Human Response

In East Africa, the Masai people practice animal rearing in these grasslands. They rear cattle, sheep and goats and migrate from place to place. Meat, milk and other animal products are used for local consumption only. There is scope for development of pastoral industry on a commercial basis, as has been done in a similar region in Queensland in Australia.

The Hausa tribesmen in the Savanna region of Nigeria are mainly agriculturists and cultivate rain-fed crops like maize, millets and groundnuts. They also keep cattle and goats for providing milk and meat.

The Savanna region of Brazilian plateau, East African plateau and West Africa have developed commercial agriculture in selected areas.

4. Tropical Deserts

Natural Environment

Tropical deserts are located on the western

margins of continents in the Trade wind belt. Annual precipitation is generally less than 25 cm in most of the region. Clear skies favour free passage of insolation during day-time and outgoing radiation from the earth during the night. Therefore, the diurnal range of temperature is quite high. Soils are sandy with saline deposits on the surface caused by evaporation. Thorny scrub and bushes which are drought resistant occur in patches here and there. In the oases, date-palm and other trees may be grown and small areas may also be cultivated.

Human Response

The Bushmen of Kalahari desert in South Africa and the Aborigines of Australia practise food gathering and hunting. The *Bedouins* of Sahara and Arabia are nomadic herdsmen rearing camels, horses, sheep and goats. They live in tents and migrate from place to place in search of pastures for their animals.

In the river valleys passing through desert region and in scattered oases, agriculture has been developed. There are permanent rural settlements and towns in the Nile Valley and deltas. Modern irrigation methods have ensured adequate water supply. The Indus Valley in Pakistan and the Imperial Valley in California are other examples of large tracts of settled agriculture. Small mining settlements are found in some of the deserts. The drilling of vast resources of petroleum in the recent decades has resulted in rapid economic development in Kuwait, Saudi Arabia, Iran and Iraq.

5. Mediterranean Region

Natural Environment

This region lies poleward of the Tropical deserts on the western margins of continents. The region experiences warm dry summers and cool moist winters. Winter rainfall is caused by the passage of cyclones in the Westerly wind belt which lies over this area. In summer, Trade winds prevail over the area and as they blow from land to sea, there is no rainfall. The annual rainfall is moderate in amount and the dry season is long. Natural vegetation consists of short evergreen trees and evergreen bushes and scrub. Olive trees are typical of this region.

Human Response

The typical area is the coastal region around the Mediterranean sea in Southern Europe, South-western Asia and North Africa. Other areas are the coastal lowlands in California, Central Chile in South America, Cape coasts in South Africa and the South-west coast of Australia. While the coastal plains are cultivated with wheat, barley and other crops, the adjoining hill slopes are covered with fruit trees. Though crops are cultivated mainly for local consumption, a variety of citrus and other fruits are processed and exported in large quantities. Large-scale production of grapes has led to the production of different varieties of wine.

6. Mid-Latitude Deserts

These deserts are located in the interior plateaus and basins in Asia and North America. They are surrounded by high mountain regions. Tibet and Gobi are typical examples. The region receives scanty rainfall as the interior location surrounded by high mountains prevents inflow of moist air. Interior location also results in greater extremes of temperature between summer and winter. Light snowfall occurs in winter.

Human Response

The region is inhabited by pastoral nomads who migrate in search of pastures. Most parts

of Tibet and Gobi deserts have low population density. In the lowlands of Central Asia, agricultural development has taken place owing to irrigation from Amu Darya, Syr Darya and other rivers. Mining and industrial development has also taken place in this region.

In North America, mid-latitude desert conditions prevail in the basins surrounded by mountain ranges of Rocky mountain system. These regions are generally uninhabited except for isolated settlements in areas of irrigated agriculture and mining. Patagonia plateau in Argentina lying east of the Andes is also an example of mid-latitude desert. It is largely stony and rocky desert. This region is inhabited by pastoral nomads.

7. Warm (Mid-Latitude) East Margin Region

This region occurs on the eastern margins of continents in the sub-tropical belt. During summer, trade winds blow from the adjoining ocean and moderate rainfall occurs. Rainfall decreases towards the interior. During the winter, Westerly winds blow from the interior of continent towards the ocean. These land winds do not cause rainfall and, therefore, winters are dry. The main regions are Central and South China, South-eastern United States, South-eastern Brazil and Uruguay, East coast of South Africa and the coast of New South Wales in Australia. Natural vegetation consists of a mixture of both deciduous and evergreen trees in the lowlands and coniferous trees in the highlands. The forests are not dense and there is no undergrowth. Valuable trees like oak, pine and eucalyptus are common.

Human Response

This region is among the most intensively cultivated parts of the world. Mild winter conditions favour cultivation almost throughout the year, especially in river valleys where irrigation has developed. The major contrast is between oriental agriculture in China and occidental agriculture in the United States. Oriental agriculture is mainly of subsistence type based on intensive use of human labour, farmyard manure and traditional methods of irrigation and drainage. Rice is the most important crop and double cropping is common in irrigated tracts. Tea and mulberry are cultivated on the hill slopes.

Occidental agriculture in the United States is of the extensive type based on tractors and other machinery for all agricultural operations. Large farms extending over hundreds of hectares specialise in the cultivation of corn, cotton and tobacco. Corn is used as a feed crop for fattening cattle and pigs. Cotton and tobacco are exported. Sugarcane is an important crop in the east coast of South Africa.

8. Cool (Mid-Latitude) East Margin Region

Natural Environment

This region lies poleward of the warm East Margin region. The region has warm wet summers and cold dry winters. North eastern United States and adjoining parts of Canada, North China, Korea and Northern Japan are the main areas included in this region. Natural vegetation consists of mixed deciduous and coniferous forests. Deciduous trees shed their leaves during cold winter season. Coniferous trees occur mainly beyond 50°N.

Human Response

Agriculture is not possible during the cold winter season. Summer season which is warm and moist favours cultivation. Barley, oats and potatoes are the main crops in the North American region, while Soyabeans, Mulberry and Oilseeds are cultivated in the Asian region. Dairy farming is widespread near urban centres.

Soft wood trees favour lumbering on modern lines using machinery. Logs are utilized for manufacturing wood pulp and paper. Cleared areas are replanted systematically so as to give a sustainable yield.

Fishing has developed on a commercial scale along the coast of north-eastern United States and Japan. There are rich fishing grounds as planktons grow in abundance in the area of convergence of warm and cold currents. As the shoreline is irregular, there are many harbours. Fish forms a staple item in the diet of the Japanese people. Japan is also a major exporter of fish.

Industrialization has developed in north-eastern United States and Japan on a large scale based on local and imported raw materials. These areas are highly urbanized resulting in high density of population.

9. Mid-Latitude Grassland Region

This region lies in the interior of continents and, therefore, receives low rainfall. Interior location is also responsible for high annual range of temperature between warm summer and cold winter. Rainfall occurs as a result of convectional ascent of air during summer. The natural vegetation is predominantly short grasses. The grasslands are known by different local names. They include the *Steppes* of Eastern Europe and Central Asia, the *Prairies* of North America, the *Pampas* of Argentina, the *Veld* of South Africa and the *Downs* of Australia. Owing to low rainfall and cold winter, trees are generally absent. The region has fertile black soils which are rich in organic matter.

Human Response

The native Indians of North America who inhabited this region were nomadic hunters. In Central Asia, nomadic herding of animals is the main occupation of tribal people. Such nomadic way of life prevails only in isolated areas. In the United States and the Russia, the extensive mechanized agriculture has developed. Extensive level plains, large size of farms and shortage of farm labour have led to use of machinery for all types of work on the farms. Wheat is the most widespread crop cultivated in these grasslands. United States of America, Canada, Argentina and Australia are major exporters of wheat. Maize is also cultivated in warmer parts of the region.

Pastoral industry has also developed on a commercial scale in these grasslands. Cattle are reared in warmer and wetter regions, while sheep thrive in colder and drier parts. Machines are used for slaughtering of animals, packing of meat, milking of dairy cows, processing of milk and shearing of sheep. Large scale export of meat and dairy products from Australia, New Zealand and Argentina has become possible by the use of refrigerated holds in ships. These grasslands supply the food needs of the world with exports of wheat, beef, mutton and dairy products.

10. Cool (Mid-Latitude) West Margin Region

Natural Environment

This region is under the influence of Westerly winds throughout the year. As these winds blow from warm oceans towards the coast, winters are warmer and annual rainfall is higher than in the cool East Margin region. Rainfall is of cyclonic origin and occurs throughout the year with a maximum in winter. Deciduous forests is the natural vegetation of this region. Coniferous forests are found on the hill slopes.

Much of the original forests have been cleared for human settlement in North-western Europe. Other areas are coastlands of British Columbia in Canada, Southern Chile in South America and South Island of New Zealand.

Human Response

Since North-west Europe has been settled by man for several centuries, its resources have been developed fully. Intensive agriculture is common and high yields are obtained. Wheat, barley, potatoes and sugarbeet are the important crops cultivated. Mixed farming which involves both agriculture and rearing of animals is quite common. As the area is highly urbanized, market gardening is also widespread to satisfy the demand for vegetables, flowers, etc.

Mineral resources have been utilized extensively to provide power and raw material for industries. Industries have also been set up utilizing imported raw materials like cotton. Fishing has developed on a commercial scale in the North seas, as the shallow continental shelf is extensive.

Unlike North-west Europe, other areas remain sparsely populated and resources are not fully developed. Fishing and lumbering are practised in British Colombia in Canada. The resources of Southern Chile have remained almost unutilized owing to remote location. In the South Island of New Zealand, rearing of sheep has developed on a commercial scale. Wool and mutton are exported.

11. The Taiga (Coniferous Forest) Region

Natural Environment

This region occurs as a broad belt in Europe, Asia and North America between the Mid-latitude Grassland region in the South and Polar Tundra in the North. The region has short warm summer and long cold winter. Rivers remain frozen and snow-covers the ground for many months. Annual precipitation is moderate in amount with maximum during summer. Coniferous forests occur extensively. These trees are evergreen and the needle-shaped leaves prevent loss of moisture by transpiration. The forests contain soft wood trees like birch, spruce, cedar and maple. The forests are relatively free from under-growth.

Human Response

Lumbering is the main occupation of the people in areas which are easily accessible. In Scandinavia, Baltic States, Russia and Canada, forests are utilized systematically. Cleared areas are replanted so that the yield of timber is sustained for the future. The logs are used for manufacture of wood pulp, paper, newsprint, synthetic fibres, matches and furniture.

Cultivation of barley, oats and potatoes is limited to the southern margins of the region. Short growing season does not favour agriculture on a large scale. Hunting of fur bearing animals like musk-rat (musquash), ermine and silver fox, and fishing are other economic activities. Some of the fur bearing animals are reared in fur farms in Canada and Siberia. While lumbering is common during winter, fishing is practised in the short summer season, when the snow cover melts.

12. The Polar Region

Natural Environment

Greenland is an example of large landmass in north Polar region having permanent ice sheets. During the short summer season, the fringes of the ice caps melt exposing the land along the coast. The sub-soil remains permanently frozen. During summer, temperature does not exceed 10°C. Precipitation is low and occurs as snow fall during winter.

The short growing season of about three months permits the growth of flowering plants and grasses. Tundra type of vegetation such as mosses, lichens and sedges occur in scattered patches. These provide pastures for reindeer. Besides reindeer, wolves, foxes, musk-ox and seal are other animals found in this region. The continent of Antarctica in south Polar region is covered by thick permanent ice sheets. Penguins are the familiar birds of Antarctica.

Human Response

The harsh environment does not encourage permanent settlement. The Inuits of Canada and Alaska, the Lapps of Scandinavia, the Samoyeds and Yakuts of Siberia used to lead a nomadic life. They live in igloos in winter and tents in summer. Hunting and fishing were their main occupations. They also traded in fur and other animal products.

External contacts have changed the lives of the nomads. Many of them live in permanent wooden houses having all modern amenities. They use boats and modern equipment for fishing. Reindeer farms have been established in Russia. Glass houses have been set up for cultivation of vegetables to meet the needs of local population. Mining of oil and gold in Alaska, iron ore in Labrador, nickel in Siberia has resulted in the establishment of mining settlements provided with adequate transport facilities by land, sea and air. Polar Tundra region has extremely low population density. Some nations have set up scientific stations in Antarctica for further exploration.

13. High Mountain Region

High mountain regions like the Himalayas in Asia, the Alps in Europe, the Rockies in North America and the Andes in South America cover extensive areas. In these regions, climatic conditions and natural vegetation vary with altitude. In the Andes mountains, while Equatorial rain forest may be seen in the foot hill region, the peaks may have permanent snow cover. Climate and vegetation also vary according to exposure to winds. While the southern slopes of the Himalayas exposed to the monsoon winds get heavy rainfall and have a cover of forest vegetation, the northern slopes facing Tibetan plateau are dry and barren. Different climatic and vegetation types may occur within a short distance owing to change in height and aspect of the slope.

Lumbering and animal rearing are the main occupations of the people. In the valley, cultivation is also important. Mining may be important in scattered localities. Hill stations in the Himalaya and the Alps have become centres of tourist attraction, wherever adequate transport facilities are provided. The people in the region are noted for their artisanship. The scenic beauty, the natural vegetation, wild life and birds of mountain regions need to be preserved intact for appreciation by future generations.

SELF-STUDY

1. Answer the following questions briefly :

   (i) What is a natural region?

(ii) What causes differences in human response in the same environment?
(iii) Describe the natural environment in Tropical grassland region.
(iv) Give an account of human response in Tropical deserts.
(v) What are the main features of climate in Mediterranean region?
(vi) Where are mid-latitude deserts located?

2. Distinguish between.
   (i) Taiga and Tundra.
   (ii) Tropical grassland and Mid-latitude grasslands.

3. Give a technical term for each of the following :
   (i) Tropical grasslands in Africa.
   (ii) Mid-latitude grasslands in Eastern Europe.
   (iii) Mid-latitude grasslands in Argentina.
   (iv) Coniferous forest region.
4. Give an account of human response to Equatorial region.
5. Examine the special features of High Mountain Regions.
6. Compare the location and natural environment in Tropical deserts and Mid-latitude deserts.

Do it yourself and find out :

1. Collect pictures from magazines illustrating modes of life of people in different regions.
2. Draw world maps showing the distribution of major natural regions.
3. Using the climatic data given in Appendix, draw climatic diagram for each station.

Books to Read

Kazi, S.A., *Major Natural Regions*, Aligarh : Friends Book House.
Preece D.M. & Wood H.R.B., *Foundations of Geography*, London : University Tutorial Press.

CHAPTER ELEVEN

Human Impact on Environment

THE RELATIONSHIP between humans and environment has varied from the early period of human settlement on the earth to the present day. The relationship between environment and human beings has also been varying from place to place at any given period of time. For example, early humans considered the environment to be dominant. They were afraid of lightning and thunder, dense forests and wild life, vast oceans and large rivers. They had no tools at their command to overcome the hazards posed by the environment. They worshipped different aspects of nature like mountains, rivers, oceans, forests, etc. They had to adapt themselves to the environment.

When humans started making tools out of stone and metals and learnt the use of fire, their impact on the environment came to be felt. Their tools enabled them to cut the trees to fashion their houses with logs. They set fire to forests or grassland to make a clearing for themselves and their animals. Fire also protected them from wild life and cold weather. Hunting and fishing gave them some position of dominance over other animals. Their activities had very little impact on the environment.

The Industrial Revolution which provided mechanical power, the invention of steam engine and other machinery, greater use of metals, etc., gave them opportunities to modify the environment. Humans became an active agent in changing the environment to suit their needs. At the same time, agriculture provided abundant food so that they could settle down permanently instead of wandering from place to place in search of food. This gave them security; they could rear their family in safe houses. The family grew in size and people migrated to other parts of the world. Transport by road, rail and sea improved and new lands in North America, South America and Australia came to be settled by people from Europe.

Another development which enabled humans to survive was the use of preventive and curative steps taken to protect them from epidemics and diseases like plague, cholera, malaria, small-pox, which took a heavy toll of life. This resulted in gradual reduction in death rate and increase in the span of human life. The assured food supply and protection from diseases, and abundance of fossil fuels and other resources helped in the rapid growth of population in new continents from the beginning of this century.

With population crossing 5500 million and racing towards 6000 million by year 2000, people have started expressing concern with their impact on environment. The environment had already been degraded to such an extent in certain localities that people are forced to migrate. They are facing scarcity of resources like food and energy. Natural

hazards like droughts and floods, environmental pollution and accidents on busy roads and in large factories, etc., are taking heavy toll of human life. Humans are at the crossroads of choosing their future path of action. On the one hand are their insatiable needs requiring faster development of resources leading to degradation of environment and finally their own extinction from the earth. On the other hand there is the choice to develop resources at a much reduced pace taking steps to conserve resources, reduce growth of population and wasteful consumption. It will help protecting the environment for our future generation.

It is not as though degradation of environment is only a recent phenomenon. In the past also human activities have resulted in the degradation of environment, though they were not aware of it. The decline of Mesopotamian civilization in Iraq, Incas in Peru, Indus Valley civilization have been attributed to deforestation of hill slopes induced fires and felling of trees on a large scale. This resulted in soil erosion, floods and silting of irrigation canals and cultivated lands. This resulted in famines, death and desertion of villages.

Till recently we were unaware that construction of a dam across a river to regulate water supply could have serious consequences to environment. The construction of a dam results in impounding water in a large reservoir in which silt carried by the river gets deposited. Below the dam, the river is free from the load of silt. This causes erosion of the river channel, causing erosion of land on either side of the river. In some rivers, reduction of large volume of discharge below the dam causes deposition of silt brought in by tributaries in the lower reaches. The gradual rise in the level of river bed causes submergence of land in the flood season, shifting of river channel and extensive damage. The construction of Aswan High Dam across the Nile reduced the deposition of silt containing valuable nutrients in the lower reaches of the river. This resulted in reduced soil fertility and yields of crop. The dams also affect the movement of fish and other organisms in the river.

The most common factor causing soil erosion is the destruction of forests and other natural vegetation. Grazing of land by goats may also remove the plant cover. When the cover of vegetation is removed, the soil layer is exposed to the direct impact of rainfall and surface water flowing down the slope of the land. Soil particles get denuded rapidly on steep slopes by formation of gullies or ravines. This is called gully erosion. In course of time gullies become wider and deeper and develop a network of branches. A region dissected by a large number of gullies is called *badlands*, as such land cannot be put to any use. The region dissected by ravines in the Chambal Valley is an example of badlands. On gentle slopes, water flows as a thin sheet, and fine particles of soil are removed from the entire surface. This is called *sheet erosion*. In such cases, soil erosion is not obvious, though its effect may be seen in reduced fertility. Soil erosion increases volume of run-off resulting in floods and silting of reservoirs. There is urgent need to prevent soil erosion by adopting soil conservation methods. Afforestation or tree planting is an effective method of soil conservation on hill slopes and other uncultivated lands. On gentle slopes, contour ploughing, strip-cropping and bunding help in soil conservation. Terracing of hill slopes prevents soil erosion. Check dams are constructed to prevent the spread of gullies. Soil conservation methods prevent removal of soil particles and retain its fertility.

Human impact on the environment has resulted in pollution of environment. Pollution

affects not only air, water and land but also the organisms in the biosphere. The natural ecosystem has the capacity to decompose dead organisms or excreta and recycle them. When harmful substances contaminate the environment in large quantities, the ecosystem is unable to absorb them and they accumulate in the system resulting in degradation of environment.

Air Pollution

The burning of fossil fuels in large quantities during the recent decades has resulted in gradual increase in carbon dioxide content in the atmosphere. It is estimated that content of carbon dioxide has increased by 25 per cent during the last hundred years. Carbon dioxide allows insolation to pass through but absorbs outgoing terrestrial radiation. Increase of carbon dioxide in the atmosphere has the effect of increasing the temperature of atmosphere. It is estimated that global mean temperature has increased between 0.3°C to 0.7°C in the last 100 years. Increase in carbon dioxide content is also attributed to large-scale deforestation. Trees absorbs carbon dioxide accumulated in the atmosphere. If the content of carbon dioxide increases further in the next 50 years, rise in air temperature would melt polar ice caps and sea level would rise by about a metre causing submergence of coastal regions.

Fig. 11.1 Air Pollution

Sulphur dioxide is produced when fuels like coal and oil are burnt in factories and in motor vehicles in larger quantities in big cities. Note how it is added to the air through fumes of smoke. It pollutes the air and changes into sulphuric acid after dissolving in rain water.

The acid rain that falls, damages the plants, metals as well as the buildings.

Burning of coal and oil also adds sulphur dioxide to the atmosphere. Lead, carbon monoxides and Nitrogen oxides are added to the atmosphere from automobile exhaust. Inhalation of automobile exhausts causes nasal irritation and respiratory diseases. These gases are also responsible for causing acid rain in industrial regions of Europe and North America. Acid rains affect aquatic ecosystems as waters so polluted cannot support fish or other life forms. Lakes in Sweden, Norway, Canada and United States are affected by acidification. Acid rain also damages forests to a great extent. Leaves turn yellowish and drop down. Growth of trees is affected. About 6 million hectares of forests are damaged in Europe.

The ozone layer in the stratosphere is affected by exhausts from jet aircraft. Chlorofluoro carbons (CFC) are stable compounds used in aerosol propellants in sprayers, refrigeration and farm blowing. These chemicals are responsible for depletion of ozone layer to the extent of 3 per cent to 4 per cent in the last 100 years. The ozone layer in the higher atmosphere serves as a shield protecting the earth from harmful ultraviolet radiation. When the ozone layer is depleted, ultraviolet radiation enters the earth's surface and may cause skin cancer.

Gaseous effluents from factories pollute the atmosphere. Smoke, dust and particles of carbon, lead, etc., enter the atmosphere. On cool nights when fog occurs these particles remain suspended in the air. This condition is called smog. The smog over London in 1952 resulted in the death of about 4000 persons by suffocation. Accidents involving escape of

poisonous gases from industries cause illness and death. The escape of poisonous gas from pesticide plant in Bhopal in 1984 resulted in the death of thousands of people. The accident at Chernobyl Atomic Power Plant in the Russia in 1986 caused extensive damage owing to leakage of radioactive material to the atmosphere

Air pollution is of global significance unlike water or land pollution which are of local or regional effect. Air pollution transfers the pollutants to water and land or oceans as a result of rainfall. Air pollution affects plants and animal organisms as well as human beings. In urban environments, pollution of air from automobile exhausts is so high that people wear face-masks to protect themselves.

Water Pollution

Water pollution takes place when effluents from factories are let into rivers. Paper mills, sugar mills, tanneries let in effluents in rivers or allow them to stagnate on land. These effluents seep through and pollute underground water. Effluents from large number of tanneries in North Arcot District in Tamil Nadu have polluted well water in a large number of villages.

The most widespread source of water pollution is disposal of sewage of urban centre into rivers. The Ganga and Yamuna provide domestic water supply but they are being polluted by sewage disposal. Polluted water affects organic life in rivers and water-borne diseases like jaundice, dysentry and typhoid affect human population.

Water pollution also occurs owing to use of pesticides and fertilizers for agriculture. Water draining from the fields enters rivers and lakes and pollutes them. Enrichment of water by nutrients results in *eutrophication* of lakes. This results in excessive growth of algae and depletion of dissolved oxygen. Acquatic organisms including fish cannot survive under such conditions.

Ocean waters are polluted by discharge of sewage from cities located along the coast, effluents from factories along the coast and discharge from polluted rivers. Eutrophication of coastal marshes and swamps also affects marine life. In the open ocean oil spills from tankers has adverse effect on marine life. Such oil spills cause pollution over wide areas owing to spread of oil by waves and currents.

Land Degradation

We have already seen an example of degradation of land by formation of gullies and soil erosion. Dumping of solid waste from urban centres and waste material from mining centres renders the land unsuitable for any use. Surface run-off from such areas pollutes streams and groundwater by seepage. Saline encrustation of irrigated lands is another example of degradation of land. In semi-arid regions, wind action causes deposition of sand on a large scale over cultivated lands rendering them unfit for cultivation. This marks the beginning of the process of desertification. Deposition of coarse material and sand during high floods may cause irreparable damage to cultivated land.

Human Impact on Biosphere

Human is at the top of the ecological pyramid. He acts as a predator as he is an omnivore, feeding on a variety of plants and animals. Cultivation of land has had a serious impact on the ecosystem. The removal of original plant cover and its replacement by single cultivated crop reduces the biological diversity and simplifies the ecosystem making it vulnerable to pests and diseases which attack that particular crop.

Apart from removal of vegetation cover for cultivation and other land-uses, humans

are also responsible for introduction of new species. New species have been introduced by humans to provide food or other raw materials. For example, rubber has been introduced from the Amazon basin and cultivated on a large scale in Tropical region of Asia. Other plants may have been introduced accidently along with seeds of cultivated crops or other articles. Some weeds belong to this category. Prickly pear and parthenium grass are examples. Pollution of air and water also affect plants, and some species have become extinct. Human effort has improved the cultivated plants by selective breeding to improve yields and resist attack by pests.

Similar to the cultivation of selected varieties of crops and trees, we have domesticated certain animals to serve our needs. These domestic animals have increased in numbers as they are protected by man from their predators. We have improved their breeds so that domesticated cattle yield more milk than native varieties. Domestic breeds of sheep yield better grades of wool in larger quantity than native breeds. We have also introduced new animals, birds, fish, etc., for food, control of pests and other reasons. Increasing population and human activities have destroyed the habitats of certain animals and birds or reduced the area of their habitats. While a number of species have become extinct, others like the American bison are threatened with extinction. Pollution of environment, hunting of animals and birds, and introduction of new predators in the environment have also caused extinction of some species.

Depletion of Resources

Population growth in the recent past and the increasing consumption has resulted in rapid depletion of all kinds of resources. The most striking example of such resource depletion is the food deficit faced by about 100 countries of the world. In some of the African countries, deforestation, soil erosion and lowering of water table have been responsible for gradual decline in crop yields in the last 20 years. Lack of food for animals has resulted in loss of domestic animals in pastoral Savanna region

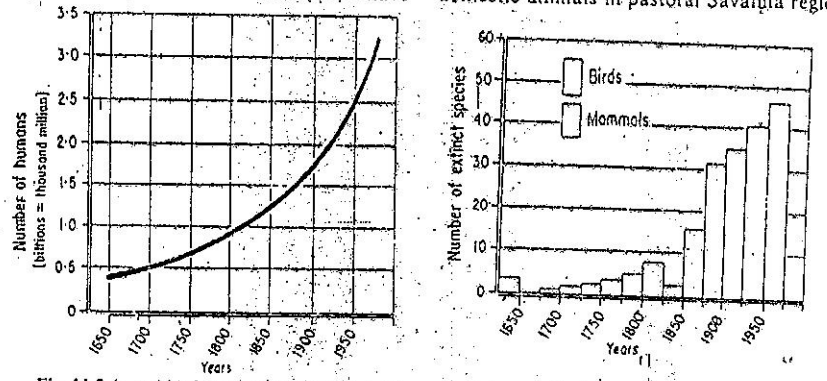


Fig. 11.2 (a and b) Graphs of Human Population and Extinct Animal Species

Note how there has been a rise in the number of extinct species with greater increase in the human population.

Why it should be so ?

of Africa. People living in these countries suffer from malnutrition and are easily prone to diseases.

Forest and soil resources are getting depleted at a fast rate owing to pressure of population. Tropical forests are getting depleted at 2 per cent per year, leading to serious consequences. Scarcity of fuelwood and its increasing cost affects the poor people. It is estimated that world is losing 7 per cent of top soil per decade. This means that in a few decades, valuable cultivated land would become degraded. Thus, excessive demand is leading to consumption of resources at a rate faster. Thus, renewable resources like forests and soil are gradually becoming non-renewable.

Depletion of resources is most significant in respect of non-renewable mineral and power resources. Mineral resources are being consumed at a faster rate owing to increasing demand. The pattern of consumption is highly uneven. The United States of America alone is consuming about one-fourth of total consumption of minerals. Mineral resources are distributed so unevenly that a few countries produce most of the world's minerals. Except for iron ore, other metallic mineral resources will last only for a few decades. Increasing demand has led to an increase in prices, leading to recycling of scrap and use of substitutes like plastic and wood.

The world is facing an energy crisis as the existing resources of oil may last only for a few decades. Though coal reserves are adequate for a few centuries, it cannot replace oil, especially for transport. Conservation of oil is an urgent need. Use of more efficient engines would reduce consumption. Use of renewable sources of energy in greater quantities would also make oil available for a longer period. Per capita consumption of power in developed countries is many times more than that in developing countries. More efficient use of energy would reduce consumption.

Conclusion

Humans have come to realise that their economic activities are threatening their survival on the earth. Their survival depends on their realisation that they have to live in harmony with the various elements of the environment which are interdonnected. An understanding of the components and processes which takes place in the environment, the relationship between different abiotic and biotic components, and the assessment of resources with reference to needs of people in a region is essential for their survival. A reduction in rate of growth of population in developing countries and a reduction in consumption of resources by developed countries would aim at a balance between population and resources. Awareness of the problems faced by environment would enable people to take appropriate decisions to make the earth habitable for future generations.

SELF-STUDY

Review Questions

1. Answer the following questions briefly :
   (i) Give examples of how humans have overcome the hazards of natural environment.

   (ii) Examine the effect of Industrial Revolution on the Environment.
   (iii) Give examples of environmental degradation in the past.
   (iv) What would be the effect of an increase in carbon dioxide content in the atmosphere ?
   (v) Give examples of water pollution.
   (vi) Explain the term 'energy crisis'.
2. Answer the following questions :
   (i) What are the causes of air pollution?
   (ii) Describe the impact of humans on the biosphere.
   (iii) Give an account of depletion of resources in recent decades.
3. Do it yourself and find out :
   (i) Make a field study of pollution of environment in your area.
   (ii) Examine the sources of pollution and indicate how pollution can be reduced.
   (iii) Collect news and pictures from newspapers and magazines about pollution of environment.

Books to Read

Joseph M. Moran and others, *Introduction to Environmental Science*, San Fransisco : W.H. Freeman.

John F. Kolars and John D. Nystuen, *Physical Geography—Environment and Man*, New York : MacGraw Hill.

CHAPTER TWELVE

Area Development— Case Studies

THE DEVELOPMENT of an area depends on the resources available in the area, the needs and aspirations of the people living there and the technological skill possessed by them. The natural endowments available in an area acquire value as a resource only when people find a use for them. There are instances where large potential resources are available, but they have not yet been developed for economic reasons. Lack of capital for investments, roads and railway lines, and other infrastructural facilities may stand in the way of resource development.

We have seen in the earlier chapter that resources are distributed unevenly among the nations of the world. There is considerable diversity even within each country in availability of resources and their development. This diversity in resource development favours exchange of goods between different areas within the country and between nations of the world. Economic factors play an important role in deciding which resources have to be developed on a priority basis. Those resources which can be developed relatively cheaply are developed first. Thus, each area specialises in the development of certain resources.

The villages and towns are thus complimentary to one another. Food grains, milk, vegetable, etc., from villages are sent to towns and cities which in turn provide manufactured goods and other services such as education, health, etc., to the rural population. Thus, there is constant interaction between rural and urban areas.

At the international level, Malaysia produces large quantities of rubber from plantations and exports it to other countries. It imports its requirement of food grains. Dem. Rep. of Congo has developed copper mines and by exporting copper, it imports its requirements. Thus, each nation has not developed all its resources at any cost to achieve self-sufficiency, as it would be uneconomical. Area development takes into account the inter-dependency among nations in the matter of exchange of goods and services. Developing nations export raw materials and import manufactured goods from developed nations.

Humans play an important and decisive role in the pattern of development of an area. We choose the types of resources which could be developed to our advantage. This depends on the tools and techniques available to us and the social, economic and political organisation of the people living in the area. The Amazon basin and Malaysia have similar Tropical rain forest vegetation as natural endowment. While the forests of Amazon basin are not easily accessible, those in Malaysia are accessible because of its narrow peninsular shape. The forests of Amazon basin remain

underdeveloped compared to Malaysia, where rubber plantations have developed on a large scale, replacing the forest cover. The development of rubber plantations is due to the external contact owing to British colonization. The British realised the increasing world demand for rubber, brought the plant from Amazon basin, cleared forests and planted rubber trees. They also brought labourers from India to work in the plantations. Thus, the area development was based on external incentive which provided capital, labour and organization with a view to export the product. The local Malay population did not have any part to play in the direction in which the area is to be developed. Thus, the decision to develop a resource or not is taken with reference to external factors such as international demand and price levels as well as the needs and aspirations of local people. The iron ores of Kudremukh region in Karnataka came to be developed mainly to meet the demands of importing countries.

Specialization in resource development, such as oil-fields in the Bombay High, has taken place to satisfy the local needs of the area in Maharashtra and also the requirements of the entire nation. Tea plantations in Assam have developed in response to not only local and regional needs but also international demand. Sheep rearing in Australia has prospered mainly due to the demand for wool in other countries as the local demand is quite less owing to low population. Japan is a good example of development based on human resources. It imports most of the raw materials like iron ore, coking coal and exports a wide range of finished products based on the technical skills of the people. Change in international demand or prices or new technology may affect resource development in an area. For example, the sudden rise in oil prices after 1973, gave fillip to oil exploration in our country and in North sea region.

The development of an area also changes in course of time. During the pre-independence period, we used to import most of our needs of manufactured goods. During the last forty years, planned development of our resources has resulted in increasing production of agricultural commodities and a wide range of industrial products. There was a time when we used to import our requirements of textiles from Britain and other countries. Now textile industry has grown up and we export textiles and ready-made garments. Political independence has enabled us to organize the development of our resources to suit the needs and aspirations of the people. Development of human resources has provided technical, scientific and administrative manpower for resource development.

Time is an important factor in area development in other countries as well. The Prairie Region of Canada retained its grassland cover till railways were built to open up the area for settlement. Tractors and agricultural machinery enabled extensive cultivation of wheat with minimum human labour. The discovery of oil resources and their development in South-west Asia has spurred economic progress. Discovery of new resources, developments in science and technology and needs and aspirations of people has changed in due course of time. In some areas, degradation of environment and depletion of resources, growth of population over a period of time has had adverse effects.

As time is an important factor in area development, we can distinguish different stages or levels of development. In the case of tribal people practising food gathering and hunting in remote areas of Tropical rain forests, human impact on environment is minimal and the resources remain underdeveloped. People

lead a simple life getting all their essential needs from the local area. This is the early stage of area development.

The developing countries may be considered as in second stage, as they have developed agricultural, pastoral and mineral resources to satisfy their needs and surplus, if any, is exported as raw materials. They have not developed manufacturing industries. Developed countries are in the third stage of area development. They have high percentage of people employed in secondary and tertiary occupations. Per capita income is high and consumption of food, power, minerals and other resources is quite high. They have a large volume of international trade. United States, countries of Western Europe and Japan are examples of developed nations.

The differences in development of resources give rise to disparities in development between different regions in our country. Special steps are being taken to reduce such disparities. Planning Commission and the Government of India are encouraging development of backward areas, hill areas and tribal areas. Similarly, special schemes are being undertaken for development of Scheduled Castes and Scheduled Tribes, physically handicapped and women in general. These steps will lead to a balanced development of all areas and different sections of population.

Case Studies—Agricultural Region

The delta of Chang Jiang river in China is a typical agricultural region. The Chinese are known as "farmers of forty centuries" and this region is inhabited by humans for more than 4000 years. The region is a perfectly level plain adjoining the Pacific coast. The Chang Jiang is a large perennial river liable to floods. Dykes have been constructed to prevent damage to the lowlands from floods. Soils are quite fertile as they are enriched by deposition of silt from the Chang Jiang and its distributaries. Rainfall is moderate during summer. Summers are warm and moist; winters are cool and dry. Rainfall is supplemented by a well-planned canal irrigation system.

Population density is quite high and the main occupation of the people is agriculture. Fields are small and most of the work on the fields is done by human labour supplemented by animal labour for ploughing. Organic manure consisting of green manure and night soil is applied to the fields. High yielding varieties of crops are cultivated. Rice is the staple crop grown in summer. Much attention is devoted to cultivation of crops at every stage of cultivation. Crop protection measures are undertaken to protect the crop from pests. In most of the fields more than one crop may be cultivated. Crop yields are quite high compared to world average.

People live in villages which are almost self-contained, in terms of education, health and other services. Both men and women work in the fields or may engage themselves in some cottage industry. The villagers are provided with transport facilities to the nearest towns.

In some villages along the coast, fishing is an important occupation. Fish are sent to the urban markets. Fishing is also common in river channels and canals. Fish culture has also spread to paddy fields, as they are inundated with water during the early period of growth of paddy. The paddy fields yield a crop of fish as well as rice. Fish provide a protein rich supplement to rice in Chinese diet.

Pigs may also be reared in villages. They eat plant and animal residues and they need very little care. They fatten quickly and yield a large litter. Pigs are also sent to urban markets for slaughtering.

With rapid increase in population in the last few decades, people have come to realise

the pressure of population on land. Government has been propagating small family norm. As a result of this awareness, population growth has slowed down from 2 per cent per year to about 1 per cent in recent years. Better health care for children has reduced infant mortality. One-child norm is encouraged with a view to reduce the pressure of population on resources and reduce consumption.

As the area has been settled for many centuries, Chinese peasants live in perfect adjustment with the environment. As chemical fertilizers and pesticides are not used excessively, there is very little pollution of water draining from the fields. Use of organic manure recycles the nutrients and yields are, therefore, high.

Mineral and forest resources are not available in this vast lowland of alluvium. There may be clumps of trees around villages. Manufactured goods are obtained from neighbouring regions and surplus agricultural products are sold in urban markets. Processing of food grains is the only industrial activity. There is no pollution from such industries.

Industrial Region—North-eastern United States

This region includes the area between the Great Lakes and the Atlantic coast. This region was the first to be settled by the immigrants from Europe. This region had a thick cover of forest. The topography is uneven with the Applachian mountains rising steeply from the Atlantic coast with a narrow coastal plain. The coast is irregular with deep narrow inlets providing good natural harbours for ships. Beyond the Applachian mountains, lies an undulating plain sloping towards the Great Lakes.

The region has warm summer and cold winters. Rainfall is adequate enough to permit

Fig. 12.1 North-East Industrial Region of United States of America

Examine how the nearness to coal, iron ore and oil fields and the development of transport routes have been responsible for favourable location of this region.

a growth of forest vegetation in the mountain region. In the interior towards the Great Lakes, grassland replaces forest. Soils are shallow and infertile in the rugged terrain. The immigrants from Europe cleared the forests on gently sloping land along the coast and cultivated them. They also maintained domestic animals to provide milk and meat. Fishing along the coast was supplementing their diet.

With migration of people in the interior, they found rich resources of coal in the Appalachian region and iron ore near the shores of the Great Lakes. Oil fields have also been discovered in the region. There are a large number of water falls along the east-coast. These have been harnessed to provide hydro-electric power. Abundance of power provided the basis for development of a wide variety of manufacturing industries. The large number of natural harbours gave rise to a number of ports along the coast. This encouraged import of

raw materials and export of manufactured goods. Roads, railways and inland water ways linked the ports with the interior. The region has excellent transport facilities.

Cotton textiles, woollen textiles, iron and steel, machinery of various kinds, chemical industry, electronics etc., developed in this area based on skilled labour. New York metropolitan region is the nerve centre of all economic activities in this region. New York harbour has 1000 km of water-front and can accommodate a large number of ships. It is the largest and bussiest port in the world. New York is the world's important centre of banking and commerce. As the headquarters of the United Nations is located here, it is also a centre of intense political activity.

In the early periods of settlement, subsistence agriculture with food grains and potatoes was the main occupation. With the development of industries and urban centres, subsistence agriculture has given place to market gardening and dairy farming along the coastal region. Market gardening refers to the cultivation of vegetables for the urban market. Dairy farming is organized on commercial lines so as to provide fresh milk and milk products to the large urban population.

This region has rich fishing grounds along the coast. The Grand Banks off Newfound land is a zone of mixing of warm and cold currents. Shoals of fish come to this region to feed on the nutrients. Large number of ports favour fishing on a commercial scale. Fish and fish products are sent to different parts of the United States.

The region is densely populated as there are large urban centres. New York and its suburbs has a population of 15 million. Skyscrapers are typical of New York and other urban centres. As the land available is limited, buildings have grown up vertically. These centres are provided with water supply, electricity and modern transport facilities. New York is linked by air with all important cities in the world.

The development of New York and its surrounding region gives an indication of maximum impact of man on the environment. This region has encouraged development of resources in other countries also, as they provide raw materials for industries in the region. The industries have polluted the environment to a great extent. Steps have been taken to control such pollution by enforcing regulations strictly. Apart from industries, automobile exhausts pollute the air very much. This industrial region having a large population is also consuming resources on a large scale. Consumption of food and power per capita is probably maximum in the world. There is scope for more efficient use of power so as to reduce wastage. High per capita income favours consumption and wastage of resources. Realising the importance of conservation of resources and environment, steps are being taken for recycling water, paper and other materials. Metals are being recycled by melting of scrap. Though population density is high, annual growth rate is less than 1 per cent. The aim is to stabilize population so as to have sustainable standard of living. Less wasteful and more efficient use of fossil fuels and change over to renewable power resources is essential, as the oil resources are likely to last for a few decades only.

The case studies have brought clearly the relationship between humans and environment at two different levels of development The Chinese farmer depends on the local environment for most of his needs. The American people living in the New York region have a high standard of living based on imports of iron ore and other raw materials from various parts of the world. This is supported by a well-developed network of transport by air and sea with other countries, as well as communication facilities for trade and commerce. Area development is thus based on international exchange of commodities to satisfy the needs of a large urban population.

Planning for area development is necessary with a view to develop resources in such a manner so as to get maximum benefit to the people. A survey of resources available in an area, cost of their development, environmental impact of such development and the international demand for such resources will help in maintaining an ecological balance with economic development. Renewable resources must be protected so that forests and soils do not get depleted at a rate faster than their rate of renewal. Non-renewable minerals may be recycled by use of scrap metals. Recycling of waste-paper, rags, etc., would reduce the need to destroy forests on a large scale. Area development should aim at protection of environment and conservation of resources to enable man to survive on the earth. This would call for international understanding among peoples and nations of the world, as pollution of air by a few nations would have its impact on others as well. Such understanding would ensure a safe and secure habitat for man on the earth.

SELF-STUDY

Review Questions

1. Answer the following questions briefly:
   - (i) Name three factors which influence area development.
   - (ii) What causes specialization in resource development?
   - (iii) Examine the role of humans in area development.
   - (iv) What steps are needed to reduce disparities in development?
   - (v) Give an account of physical environment in the Chang Jiang delta region.
   - (vi) Describe the main features of agriculture in the Chang Jiang delta.
   - (vii) Examine the causes of industrialization in North-eastern United States.

2. Answer the following questions:
   - (i) Describe how area development changes with time.
   - (ii) Give a detailed account of the nature of development in Chang Jiang delta.
   - (iii) Discuss the role of natural environment in area development in North-eastern United States.

3. Do it yourself and find out:
   - (i) Study the local area around the school and note the recent trends in development of resources.
   - (ii) Make a field trip and ascertain changes in land-use in the area visited.

Books to Read

Esmond Wright, *The World Today*, England : McGraw Hill Book Co.
Kenneth R. Sealy and Henry Rees, *Regional Studies of the United States and Canada*, London : George G. Harrap & Co. Ltd.
Harm J. DE BLu, *Man Shades the Earth—A tropical Geography*, U.S.A. : Hamilton Publishing Co.

GLOSSARY

Absolute humidity	The amount of actual water vapour present per unit volume of air
Abyssal plain	A deep sea plain lying beyond the continental slope.
Afforestation	Planting of trees in an area in order to provide a forest cover
Aggradation	Deposition of material on the earth's surface by rivers and other agents
Agriculture	The science and art of cultivating the soil, raising crops and rearing livestock. It is also called farming.
Abiotic	Non-living components
Air currents	Vertical movement of air is known as Air currents.
Alluvial plains	Plains formed by deposition of alluvium by rivers
Alluvial soils	Soils consisting of well-mixed earth waste laid down by rivers
Anthracite	A lustrous, hard, compact variety of natural coal containing 85 to 95 per cent of carbon. It burns slowly and is smokeless.
Anticline	An upfold of sedimentary rocks with beds sloping away from the crest of the fold.
Anticyclone	A region or an area of high atmospheric pressure in relation to its surroundings diminishing outwards from the centre
Arable land	Land which can be cultivated with a plough. It is also called cultivable land and includes both cultivated and temporary fallow land.
Artesian well	A well in which water flows out on its own owing to high pressure of underground water
Atlas	A collection of maps bound into a volume. Generally, these maps are drawn on small scales. The term 'atlas' first appeared on the title page of the collection of Mercator's charts in A.D. 1595. The origin of the word, however, further goes back into the past, as it relates to Atlas supporting the heavens according to mythological beliefs.

Atmosphere — The layer of air which surrounds the earth

Bad Lands — A highly dissected land surface comprising a maze of deep gullies with intervening sharp ridges and pinnacles

Bar graph — A series of columns or bars drawn proportional in length to the quantities they represent. They are drawn on a selected scale. They may be drawn either vertically or horizontally.

Biomes — Plants occur in distinct groups of communities in areas having similar climatic conditions

Biotic — Living compodents

Biosphere — Plant and animal organisms which live on the earth.

Block mountains — Mountains produced by faulting or displacement of strata

Census — Official enumeration of population along with certain economic and social statistics in a given territory

Campos — Tropical grasslands of Brazil

Climatic map — A map of world or its part showing average conditions of temperature, pressure, wind, precipitation and sky conditions over a period of time

Cloud — Condensed moisture consisting of droplets of water or tiny crystals of ice, light enough to float in the air

Coastal plain — A stretch of lowland adjoining the coast

Composite cone — A volcanic cone having alternate layers of lava and ash

Consumers — Organisms which depend on other organisms for their food

Condensation — The process by which water vapour in the atmosphere gets converted into tiny droplets of water

Coniferous forests — Forest consisting of trees with evergreen needle-shaped leaves

Coke — Solid and strong black substance with a high carbon content, left after the volatile parts have been distilled from coal

Continental shelf — A shallow stretch of sea adjoining the coast. The sea floor has a gentle slope.

Continental slope — A steeply sloping sea floor which links the continental shelf with the Abyssal plain. Continental slope is taken as the edge of the continental platform.

Contours — Imaginary lines joining all the points of equal elevation or altitude above the mean sea-level. They are also called as 'level-lines'

Contour interval — The interval between two successive contours. It is also known as vertical interval, usually written as V.I. Generally, it is constant for a given map.

Convectional rainfall — Rainfall caused by vertical ascent of air owing to intense heating of the earth's surface

Crater — A funnel-shaped hollow at the top of volcanic cone through which eruption takes place

Cross-section — A side-view of the ground cut vertically along a straight line. It is also known as a section or a profile.

Cyclone — A low pressure system in the lower atmosphere where winds tend to converge towards the centre of low pressure. Mid-latitude cyclones are better called 'Depressions'.

Cyclonic rainfall — Rainfall associated with ascent of air in cyclonic regions

Dairy farming — A kind of agriculture in which major emphasis is on breeding and rearing milch (milk) cattle. Agricultural crops are raised mainly to feed these cattle.

Deciduous forest — A forest having trees which shed their leaves during a part of the year

Delta — A more or less triangular and level tract of alluvium formed at the mouth of a river entering a relatively quiet body of water

Dew point — The temperature at which the air gets saturated with water vapour.

Density of population — The average number of inhabitants living within a specified unit of area, such as a square kilometre

Dew — Droplets of water formed when water vapour condenses on cold solid surfaces or objects even when air temperature is above dew point.

Distribution maps — Maps which, with the aid of certain symbols like dots and shading schemes, depict the location of various geographic elements and their frequency or intensity or density, as the case may be. For example, they may show distribution of crops,

Diurnal range of temperature	livestock, population, industrial output, etc., in a given area. The difference in temperature between the maximum and minimum in a day
Downs	Mid-latitude grassland regions of Australia
Earthquake	Vibrations or shakings caused in the earth's crust by sudden tectonic movements or volcanic eruptions
Ecology	The science which deals with inter-relationships between the various organisms living in an area and also their relationship with the physical environment
Ecological pyramid	Trophic levels represented in the form of a pyramid
Ecological efficiency	The percentage of energy transferred from one trophic level to another
Ecosystem	A system which comprises the physical environment and the organisms which live therein
Environment	Surroundings or the conditions under which a person or a thing exists and develops his or its character. It covers both physical and cultural elements.
Eutrophication	The results of the enrichment of waters by nutrients
Erosion	A process which gradually wears down the higher places and carries away the eroded materials from the place of its origin to its next resting place.
Estuaries	Zone of mixing of fresh and salt water
Evaporation	The process by which water gets converted into water vapour
Evapo-transpiration	Combined effect of evaporation and transpiration
Evergreen forest	Forest having trees which retain their leaf cover throughout the year
Extensive agriculture	Farming in which the amount of capital and labour applied to a given area is relatively small
Fault	A plane along which there has been a fracture of rock layers leading to displacement of strata
Fisheries	The act of catching animal life from water, viz., trapping salmon, harpooning whales, diving for sponges and pearls, digging clams out of mud, and shooting seals. Also, refers to places where fish exist in great numbers and are caught on a large scale.
Fish farm	Hatcheries of fish where more productive and useful varieties of fish are seasonally stocked, carefully fed and caught in a controlled manner
Fishing banks	Shallow ocean waters generally located on continental shelves in cool mid-latitude regions where comparatively few species of fish are present in vast numbers.
Flood plain	A plain bordering a river, formed as a result of sediments deposited by a river and is generally liable to flooding.
Fog	Mass of water droplets condensed near surface of the earth. In fog visibility is reduced to one kilometre.
Fold mountain	Mountains formed by folding and uplift of sedimentary rocks by horizontal compressional forces
Food web	Complicated networks of food chain
Food chain	The transfer of energy from one organism to another in the ecological system
Fossils	Remains or impressions of plant and animal organisms embedded in rocks
Geothermal power	Generation of power by utilizing the heat in the interior of the earth.
Glacier	A slowly moving mass of snow and ice which occurs in high mountain regions or Polar regions.
Gorge	A deep narrow valley with steep sides formed as a result of rapid down-cutting by the stream. The same as I-shaped valleys. Canyons are gorges of considerable size.
Gradation	All the processes that tend to bring the surface of the lithosphere to a common level
Grasslands	The regions of the world where the predominant natural vegetation is grass and other herbaceous plants with a few trees here and there. The Tropical grasslands are called Savannas and the Temperate grasslands are called Prairies and Steppes.
Ground water	Water in the saturated lower portion of the rocks beneath the earth's surface.
Growing season	Part of a year in a given region when the growth of vegetation or crops is made possible by a favourable combination of temperature, precipitation and freedom from harmful frost. The duration of the growing season generally decreases with the distance from the Equator.

Habitat	Immediate environment in which an organism lives.
Hail	Precipitation in the form of irregular balls or lumps called hailstones made of concentric layers of ice and snow. Hailstones fall to the ground only when they are heavy enough to overcome the resistance of rising air currents.
Heavy industry	An industry characterised by the heavy and bulky nature of raw materials and finished products and much concerned with transport costs.
Horst	The land between two almost parallel faults either raised above the adjoining areas or held in position by the surrounding area slipping down along the outer sides of the faults
Humus	Decomposed organic matter in the soil
Hydrological cycle	The continuous circulation of water among the hydrosphere, atmosphere and lithosphere. Actually, the cycle is of a very complex nature with a number of sub-cycles.
Hydrophytes	Plants which tolerate excessive moisture conditions
Hydrosphere	The water sphere, applied to all the waters on the earth's surface collectively as constrasted with lithosphere and atmosphere
Hydro-electricity	Electricity produced by the application of the motive power of water
Ice age	Geological periods when ice covered large part of the continents due to very cold climatic conditions
Iceberg	A large floating mass of ice drifting away from the Polar regions.
Igneous rock	A rock formed by the solidification of molten magma or lava. Granite and basalt are examples.
Insolation	The energy emitted by the sun which reaches the surface of the earth
Intensive agriculture	Farming in which large amounts of capital and labour are applied per unit area of land in order to obtain high yield
Intensive commercial agriculture	A type of intensive farming whose quality products such as fruits, vegetables and flowers enter into national and international trade
Interpolation of contours	Drawing contours with the help of spot heights given on the map
Ionosphere	A layer of atmosphere which extends from 80 to 300 km and has electrically charged particles known as ions.

Isobar	An imaginary line (drawn on a map) joining the places having the same atmospheric pressure reduced to the sea-level
Isohyet	An imaginary line (on a map) joining places having the same amount of rainfall.
Isotherm	An imaginary line (drawn on a map) joining places having the same temperature reduced to the sea-level.
Land-breeze	A local wind which blows from land to sea during the night
Laterite	A soil layer forming a hard crust, red in colour owing to high content of iron compounds. This is well-developed in Tropical regions having alternating wet and dry seasons.
Latitude	An angular distance of a point on the earth's surface north or south of the Equator measured along the meridian of that place as a angle subtended at the centre of the earth.
Layer colouring	A method of showing relief with the help of colour, especially in atlas and wall maps. The colour scheme is followed universally, for example, shades of blue for sea, green for low-lying areas, brown for higher lands and pink for still higher lands.
Lava	The molten material or magma extruded from a volcanic vent during an eruption. It solidifies on contact with the air.
Lignite	A variety of brown coal. It contains 40 per cent of carbon and considerable amount of moisture. It is intermediate in properties between bituminous coal and peat.
Linear scale	A method of expressing scale with the help of a line conveniently divided and sub-divided so that the distance on the map can be directly measured or read off from a map.
Line graph	A smooth line drawn through a series of points which are determined by means of two co-ordinates along the x-axis and y-axis. Change in one variable is shown with reference to another. Usually, it is used for representing data regarding rainfall, temperature, growth of population, production, etc.

Lithosphere	The relatively thin solid crust or outer layer of the earth
Loess	Extensive deposits of dust laid down by wind action
Longitude	Angular distance of a point on the earth's surface between the meridian of that place and the Prime meridian, measured along the Equator. It is measured east or west of the Prime Meridian from 0° to 180°
Lumbering	A basic occupation of cutting timber in forests. It includes varied activities, such as logging, splitting and hauling.
Map	A conventional representation of any area of the earth's surface, small or large, drawn to scale on a flat surface, as seen from vertically above
Map projection	A method of transferring the network of parallels and meridians, i.e., earth's grid, from the spherical surface of the earth to a plane surface
Meanders	Winding sections or loops of a river that swings from side to side as it flows over a level tract normally along its lower course
Metamorphic rock	A rock resulting from the sedimentary and igneous rocks changing their original character and appearance as a result of extreme heat, pressure or chemical action inside the earth's crust
Mine	An excavation made in the earth for digging out minerals, such as coal, iron ore and precious stones. A mine usually denotes underground working, except in open-pit mines.
Mineral	A substance that is found in the earth's crust and which generally has a definite chemical composition
Mineral fuel	Non-metallic minerals, such as coal and petroleum, which are used as fuel.
Mineral oil	A mixture of hydrocarbons in liquid form found in the earth. It is commonly known as petroleum. It became a commercial product only in 1859.
Mineral ore	Minerals in their raw state as extracted from the earth.
Mining	An economic activity concerned with the extraction of commercially valuable minerals from the bowels of the earth
Mixed farming	A type of farming in which cultivation of crops and raising livestock go hand in hand. Both these activities play an important part in the economy.

Monsoon	Periodic winds experiencing seasonal reversal of direction
Natural gas	Free hydrocarbons in a gaseous state usually associated with crude mineral oils and found in the earth's crust in a natural state
Natural resources	Wealth supplied by nature—mineral deposits, soils, timber, fuel, water, water power, fish, wild life, etc.
Nomadism	A way of life of the people who are required to shift their dwellings frequently from place to place in search of pastures for their animals—the mainstay of their economy.
Ocean currents	Streams of water flowing on the surface or at sub-surface levels of oceans. Warm currents are those which flow from warmer to cooler regions. Cool currents flow from cooler to warmer regions.
Oceanic islands	Islands which rise from the deep ocean floor. These are separated from the continents by wide oceans.
Off-shore winds	Winds which blow away from the shore, i.e., from the land towards the oceans
Oil field	An area where oil is drilled
On-shore winds	Winds which blow towards the shore, i.e. from the ocean towards the land
Orographic rainfall	Rainfall produced by a forced ascent of air along the slopes of mountains
Omnivore	One who eats both plants and animals
Pastoralism	An economy that solely depends upon animals. Whereas nomadic pastoralism is practised mainly for subsistence, the modern ranches present an example of commercial pastoralism.
Perennial river	Rivers which have a flow of water throughout the year.
Permeable rock	A rock which allows water to seep through pore spaces and joints
Phyto plankton	Tiny floating plant micro-organisms which provide the basic food needed by all forms of life in the sea.
Plain	A relatively flat and low-lying land surface with few inequalities
Plain, depositional	A lowland formed by deposition of material by rivers, glaciers, winds and waves

Plain erosional	A low land formed by erosion of land by rivers and other agents of erosion
Plain structural	A low land consisting of relatively horizontal strata of rocks
Planet	A heavenly opaque body of considerable size that revolves in a regular orbit around the sun
Planetary winds	The major permanent winds, viz., Trades, Westerlies and Polar winds comprising a system that would prevail on any planet rotating from west to east and having an atmosphere
Plateau	A broad relief feature which has a relatively even surface and which is conspicuously high, in contrast to some nearby low land or water surface.
Plantation agriculture	A large-scale one-crop farming resembling factory production. It is usually characterised by large estates, huge capital investment and modern and scientific techniques of cultivation and trade.
Pig iron	Iron that is solidified in oblong masses as soon as it flows from the blast furnace. It gets its name because of the moulds that look like "pigs" in which it is allowed to solidify.
Port	The commercial part of a harbour containing facilities for embarking and disembarking passengers, loading and unloading and some facilities for the storage of cargo
Primary industry	Activities concerned with collecting or making available materials, provided by nature, for example, agriculture, fishing, forestry, hunting or mining.
Producers	Organisms which produce their own food from the physical environment
Precipitation	The process by which condensed water vapour falls to the earth's surface as rainfall, snowfall and other forms
Quarry	An open-air excavation from which minerals are obtained by cutting, blasting, etc.
Rain shadow	A comparatively dry area on the leeward side of the highland which stands in the path of rain-bearing clouds
Range of temperature	The difference between the maximum and minimum temperature recorded during any given period.
Relief map	A map showing relief of an area on a flat surface by

	means of any of the methods such as contours, form lines, layer colouring, hachures, hill-shading or a combination of these
Renewable resource	Resources which are capable of being used over and over again and are capable of regeneration such as vegetation, animals, fish, etc.
Reserve	That portion of the resource which can be developed economically
Residual mountains	Mountains formed by circumdenudation or differential erosion by rivers and other agents of erosion
Rift valley	A valley with steep, parallel walls along fault lines, formed by the subsidence of a part of the earth's crust
Rocks	An aggregate of minerals that forms a part of the earth's crust
Rotation crops	A systematic succession of different crops cultivated on a given piece of land in order to avoid exhaustion of the soil
Salinity	The proportion of dissolved salts dissolved in pure water stated in parts per thousand by mass. The average salinity of sea water is 35 grams per 1000 grams of water.
Satellite	Relatively small, spherical heavenly body that revolves round a planet and follows it in its revolution around the sun, e.g., the moon
Sand dune	A mound, a hill or a ridge of sand with a crest or a definite summit
Savanna	Tropical grasslands of Africa
Scale	The ratio which a distance between any two points on a map bears to the actual distance between the corresponding points on the ground.
Sea-breeze	A local wind which blows from sea to land, during the afternoon
Secondary industry	Industry which transforms the material provided by primary industry into commodities more directly useful to man. It can be heavy industry, light industry, or even basic industry.
Seismograph	An instrument which records the intensity of an earthquake, how long it lasts, and where it takes place. (Seismogram—a record made by a seismograph)
Sedimentary rock	A rock formed by consolidation or cementation of

Sheet erosion	sediments derived from erosion of the land. As these rocks have distinct layers they are also known as stratified rocks.
Shifting cultivation	On gentle slopes, the removal of fine particles of soil by thin sheet of water A method of farming in which a patch of ground is cultivated for a period of few years until the soil is partly exhausted or overrun by weeds and after which the land is left to natural vegetation. Cultivation is carried on elsewhere. In due course, the original patch of land is cultivated again when the natural growth has restored its fertility.
Sial	Thin outer layer of the earth's crust having a density of 2.65 to 2.70. This layer consists mainly of silicate and alumina and other lighter metals and is exposed on the continents.
Smog	Conditions in which the smoke, dust, etc., remain suspended in the atmosphere when the fog occurs on cool nights
Sima	This layer consists mainly of silicate and magnesia and other denser metals. The sima layer is denser than the sial layer and lies beneath it and forms floors of much of the oceans.
Snow line	The altitude or level above which there is permanent cover of snow on land masses
Soil	The loose rock material together with humus that forms the surface layer on the earth and serves as a source of food and moisture for plants
Soil conservation	Protecting the soil from being eroded away by agents of erosion
Soil erosion	The removal of soil, especially of the fertile top-soil, either naturally, i.e., by wind and water or as a result of human action viz., overgrazing, deforestation, etc.
Soil profile	A vertical section of the soil showing the different layers or horizons from the surface down up to the bedrock
Solar constant	The radiant energy reaching the outer limit of the earth's atmosphere at a surface perpendicular to the sun's rays is estimated at 2 calories/sq cm/minute
Solar system	The family of the sun comprising planets, satellites, comets, planetoids and the swarms of meteors all

	of whom revolve round the sun
Springs	It is the form of appearance of underground water on the surface
Stratified rocks	(see sedimentary rock)
Stratosphere	The layer of atmosphere extending roughly from 20 to 50 km in which temperature increases with height
Submarine ridges	Ridges which rise from the ocean floor and lie submerged below sea level
Submarine relief	The irregularities on the beds of the seas and oceans which lie submerged beneath the surface of water or sea level
Submarine trenches	Narrow trenches lying below the average level of the ocean floor
Subsistence agriculture	Farming in which its produce is mainly consumed in the farmer's household unlike commercial agriculture whose products enter into trade on a very large scale
Syncline	A downfold of sedimentary rock with beds sloping towards the axis
Terrestrial radiation	The heat energy radiated by the earth
Terrigenous deposits	Deposits derived from erosion of the land laid down on the shallow sea floor adjoining the shore
Thematic maps	Maps which show selected features
Tide	Periodic phenomena of alternate rise and fall in the level of the seas.
Topographic map	A map of a small area drawn on a large-scale depicting detailed surface features, both natural and man-made. Relief in this map is shown by contours.
Torrid zone	The zone which lies between the Tropic of Cancer and the Tropic of Capricorn
Trade winds	Winds which blow from the Sub-Tropical high pressure to the Equatorial low pressure
Transpiration	Loss of water through the tiny pore spaces in the leaves of plants.
Trophic level	Feeding level of a group of organisms
Tropopause	The upper limit of the troposphere forming a transition zone between the troposphere and stratosphere. The height of the tropopause varies with latitude and season.
Troposphere	The lowest layer of the atmosphere in which almost all weather phenomena take place

Tropophytes	Plants which adjust themselves to seasonal variations in moisture
Volcanic island	An island formed by volcanic eruption on the ocean floor. The crest of the volcano forms the island, while the slopes are submerged below sea level.
Volcano	A vent or opening in the earth's crust through which rock fragments, lava, ash, steam and other gases rise to the surface in the course of an eruption
Volcanic rocks	An igneous rock formed by the pouring out of lava on the surface where it gets solidified
Water shed	Higher ground separating two adjoining drainage basins or river systems
Water table	The level below which the pore, spaces, joints, etc., in rocks are completely saturated with water
Weather	The condition of the atmosphere at a given place and time with respect to atmospheric pressure, temperature, humidity, precipitation, cloudiness and wind. These are known as weather elements.
Weathering	The breaking up and decay of exposed rocks, by temperature changes, frost action, plants, animals and man.
Westerlies	Winds which blow from the Sub-Tropical high pressure to Sub-Polar low pressure
Xerophytes	Plants which are able to survive in dry regions by making suitable adaptations in leaves, stem, etc.
Zooplankton	Tiny animal organisms living in the ocean waters

APPENDIX I

ANGLE OF INCIDENCE OF SUN'S RAYS AND DURATION OF DAYLIGHT

Latitude	*September 21 or March 21*		*June 21*		*December 21*	
	Duration of day-light	*Angle of incidence*	*Duration of day-light*	*Angle of incidence*	*Duration of day light*	*Angle of incidence*
90°N	12 hours	0°	24 hours	23°30′	0	0°
66°30′N	"	23.30′	24 hours	47°	0	0°
50°N	"	40°	16th 18m	63°30′	7th 42m	16°30′
23°30′N	"	60°	13th 27m	90°	10th 33m	43°
0°	"	90°	12 hours	66°30′	12 hours	63°30′
23°30′S	"	66°30′	10th 22m	43°	13th 27m	90°
50°S	"	40°	7th 42m	16°30′	16th 18m	63°30′
66°30S	"	0°	0	0°	24 hours	47°
90°S	"	0°	0	0°	24 hours	23°30′

APPENDIX II

CLIMATIC DATA FOR REPRESENTATIVE STATIONS OF DIFFERENT CLIMATIC TYPES

(T.—temperature in degrees centigrade; Rf.—rainfall in centimetres)

Sl. No.	Climatic Type	Station	Location	Altitude (in metres)		J	F	M	A	M	J	J	A	S	O	N	D	Annual	Annual Range
1.	Equatorial type	Singapore	1°N	3	T.	26.7	26.7	27.2	27.8	27.8	27.2	27.2	27.2	27.2	27.2	27.2	26.7	27.2	1.1
			104°E		Rf.	25.1	16.8	18.8	19.3	17.0	17.3	17.3	20.1	17.3	20.6	25.1	26.9	241.6	
2.	Tropical rainy type	Manila	15°N	14	T.	25.0	25.6	26.7	28.3	28.3	27.8	27.2	27.2	26.7	26.7	25.6	25.0	26.7	3.3
			121°E		Rf.	2.0	1.0	2.0	3.3	11.4	23.4	43.8	40.6	36.3	17.0	13.2	7.9	202.0	
3.	Monsoon type	Mumbai	19°N	11	T.	24.4	24.4	26.7	28.3	30.0	28.9	27.2	27.2	27.2	27.8	27.2	25.0	27.2	5.6
			73°E		Rf.	0.2	0.2	—	—	1.8	50.6	61.0	36.9	26.9	4.8	1.0	—	183.4	
		Delhi	29°N	219	T.	14.4	16.7	23.3	30.0	33.3	33.3	30.0	29.4	28.9	25.6	19.4	15.6	25.0	18.9
			77°E		Rf.	2.5	1.5	1.3	1.0	1.8	7.4	19.3	17.8	11.9	1.3	0.2	1.0	67.0	
4.	Hot deserts	Jacobabad	28°N	57	T.	13.9	16.7	23.9	29.4	34.4	36.7	35.0	33.3	31.7	26.1	19.4	15.0	26.0	22.8
			68°E		Rf.	0.8	0.8	0.8	0.5	0.2	0.5	2.5	2.6	0.8	—	0.2	0.2	10.1	
5.	Tropical subhumid type	Aswan	24°N	99	T.	15.0	17.2	21.1	25.6	29.4	32.2	32.8	32.2	31.1	27.8	22.2	16.7	25.0	17.8
			33°E		Rf.	—	—	—	—	—	—	—	—	—	—	—	—	—	—
			18°S	1480	T.	21.1	20.6	20.0	18.9	16.1	13.9	13.3	15.6	18.9	21.7	21.7	21.1	18.3	8.4
			31°E		Rf.	19.0	18.8	11.4	2.5	1.3	—	—	0.2	1.8	2.8	9.4	14.7	81.0	
6.	Warm temperate west coast type	San Francisco	38°N	47	T.	9.4	10.6	11.7	12.2	13.3	13.9	13.9	14.4	15.6	15.0	13.3	10.6	12.8	6.2
			122°W		Rf.	12.2	9.1	7.9	2.5	1.8	0.2	—	—	0.8	2.5	6.1	11.7	54.8	
		Adelaide	35°S	43	T.	23.3	23.3	21.1	17.8	14.4	12.2	11.1	12.2	13.9	16.7	19.4	21.7	17.2	12.2
			139° E		Rf.	1.8	1.8	2.5	4.6	7.1	7.9	6.9	6.3	5.1	4.3	3.0	2.5	53.8	
7.	Warm temperate east coast type	Buenos Aires	35°S	25	T.	23.3	22.8	20.6	16.1	12.8	10.0	9.4	10.6	12.8	15.6	18.9	21.7	16.1	13.9
			58°W		Rf.	7.9	6.9	11.2	8.9	7.4	6.3	5.6	6.3	7.6	8.9	7.9	9.9	94.8	
8.	Warm temperate continental type	Tehran	36°N	1220	T.	1.1	5.6	8.9	16.1	21.7	26.7	29.4	28.3	25.0	18.9	10.6	5.6	16.7	28.3
			51°E		Rf.	4.1	2.5	4.8	3.6	1.3	0.2	0.5	—	0.2	0.8	2.5	3.3	23.8	
		Leh	34°N	3506	T.	−8.3	−7.2	−0.6	6.1	10.0	14.4	17.2	16.1	12.2	6.1	0.0	−5.6	5.0	25.5
			78°E		Rf.	1.0	0.8	0.8	0.5	0.5	0.5	1.3	1.3	0.8	0.5	—	0.5	8.5	
9	Cool temperate west coast type	valencia	52°N	9	T.	6.7	6.7	7.2	8.9	11.1	13.9	15.0	15.0	13.9	11.1	8.9	7.8	10.6	8.3
			10°W		Rf.	14.0	13.2	11.4	9.4	8.1	8.1	9.6	12.2	10.4	14.2	14.0	16.8	141.4	
10.	Cool temperate east coast type	Quebec	47°N	90	T.	−12.2	−11.1	−5.0	2.8	10.6	16.7	19.4	17.8	13.3	6.7	−1.1	−8.9	3.9	31.6
			71°W		Rf.	8.9	6.9	7.6	5.8	7.9	9.4	10.2	10.2	9.1	8.6	8.1	8.1	100.8	
11.	Cool temperate continental type	Moscow	51°N	146	T.	−11.1	−9.4	−4.4	3.3	11.7	16.7	18.9	17.2	11.1	4.4	−2.2	−8.3	3.9	30.0
			37°E		Rf.	2.8	2.3	3.0	3.8	4.8	5.1	7.1	7.4	5.6	3.6	4.1	3.8	53.4	
12.	Polar or Arctic climate	Barrow	71°N	6	T.	−28.3	−25.0	−25.6	−18.9	−6.1	1.7	4.4	3.9	−0.6	−8.9	−21.7	−26.1	−12.2	32.7
		Point	156°W		Rf.	0.8	0.5	0.5	0.8	0.8	0.8	2.8	2.0	1.3	2.0	1.0	1.0	14.3	
13.	Alpine or mountain climate	La Paz	16°S	3632	T.	10.6	10.6	10.6	10.0	8.9	7.2	6.7	7.8	9.4	10.6	11.7	11.1	9.4	5.0
			68°W		Rf.	11.4	10.7	6.6	3.3	1.3	0.8	1.0	1.3	2.8	4.1	4.8	9.1	57.2	

APPENDIX III

Country	Population estimate -1985 (in million)	Annual birth rate per 1000 population (80-85)	Annual death rate per 1000 population (80-85)	Annual Growth rate of population in per cent (80-85)	Infant mortality rate per 1000 live births (1985)
(1)	(2)	(3)	(4)	(5)	(6)
Algeria	22.0	45.1	12.3	3.28	109
Argentina	30.5	24.6	8.7	1.58	36
Australia	15.7	16.2	7.7	1.31	11
Brazil	135.6	30.6	8.4	2.23	—
Canada	25.6	16.2	7.1	0.69	11
China	1063.1	18.5	6.8	1.17	38
Cuba	10.0	16.9	6.4	0.62	20
Czechoslavakia	15.6	16.1	11.8	0.43	16
Egypt	46.8	38.4	12.5	2.52	113
Ethiopia	36.5	49.2	21.5	2.60	143
France	54.6	13.8	10.7	0.30	10
Germany FR	61.1	10.2	12.0	0.18	13
Ghana	13.5	47.0	14.6	3.25	98
India	761.2	33.2	13.3	1.99	118
Indonesia	164.9	30.7	13.0	1.76	87
Italy	56.9	12.8	10.4	0.25	14
Kenya	20.6	55.1	14.0	4.12	82
Malaysia	15.6	29.2	6.4	2.29	29
Mexico	79.0	33.9	7.1	2.59	53
Netherlands	14.5	11.6	8.7	0.40	8
Newzealand	3.3	15.6	8.1	0.75	12
Poland	37.6	18.5	9.0	0.95	21
Former Soviet Union	278.4	18.8	9.3	0.95	25
Sri Lanka	16.4	27.0	6.7	2.03	38
Sweden	8.3	10.5	11.6	0.01	7
Switzerland	6.3	8.0	10.7	0.26	8
Tanzania	22.5	50.4	15.3	3.52	98
United Kingdom	55.6	12.8	12.4	0.01	12
United States	237.7	16.0	9.3	0.86	12
Yugoslavia	23.2	16.4	8.8	0.76	29
Congo	33.0	45.2	15.8	2.94	107
WORLD	4842.0	27.3	10.6	1.67	81

Population under 15 Yrs in % (1985)	Live Expectancy at birth years (80-85) Average	Per-capita GNP 1983 (in US $)	Area 000 sq. km	Population density per sq. Km 1985	Arable land & permanent crop land (in %) 81-83
(7)	(8)	(9)	(10)	(11)	(12)
45.9	57.8	2400	2382	9.2	3
31.0	69.7	2030	2767	11.0	13
24.2	74.4	10780	7687	2.0	6
36.4	63.4	1890	8512	15.9	9
22.5	74.9	12000	9976	2.6	5
30.7	67.4	290	9597	110.8	11
26.4	73.4	1020	115	87.7	29
24.5	71.6	—	128	122.4	41
39.4	57.3	700	1001	46.7	2
45.8	42.9	140	1222	29.8	13
20.9	74.5	10390	547	99.8	34
15.7	73.3	11420	249	245.8	31
46.5	52.0	320	239	56.5	12
37.3	52.5	260	3288	231.5	57
38.5	52.5	560	1905	86.6	11
19.9	74.4	6350	301	188.8	42
52.9	52.9	340	583	35.4	4
36.7	66.9	1870	830	47.2	12
42.2	65.7	2240	1973	40.0	12
19.0	75.9	9910	37	388.8	25
24.7	73.4	8410	269	12.2	2
25.0	72.0	—	313	120.1	49
24.8	70.9	—	22402	12.4	10
34.2	67.5	330	66	250.0	34
17.8	75.8	12400	450	18.4	7
15.7	75.9	16390	41	152.3	10
48.8	51.0	240	945	23.8	6
19.3	73.7	9050	245	227.3	29
21.9	74.0	14090	9363	25.4	21
23.4	71.2	2570	256	90.7	31
45.1	50.0	160	2345	14.1	3
33.7	64.6		147922	36.2	11

BASED ON: "WORLD RESOURCES—1986"
A Report by the World Resources Institute and the International Institute for Environment & Development. Basic Books, Inc. New York (1986).

APPENDIX IV

Country	Total Area (in thousand sq. km)	Percentage Distribution (81-83)			
		Arable land & permanent crop land	Meadows & permanent pasture	Forests & woodland	Other land
Argentina	2767	13	52	22	13
Australia	7587	6	59	14	21
Brazil	8512	9	19	67	5
Canada	9976	5	3	35	57
China	9597	11	31	14	45
Egypt	1001	2	0	0	98
Ethiopia	1222	13	41	24	22
France	547	34	23	27	16
Germany	249	31	19	30	20
India	3288	57	4	23	17
Indonesia	1905	11	7	67	15
Italy	301	42	17	22	19
Japan	372	13	2	68	17
Malaysia	330	13	0	67	20
Netherlands	37	25	34	9	32
Newzealand	269	2	54	37	7
Pakistan	804	26	6	4	64
Former Soviet Union	22402	10	17	41	32
Sweden	450	7	2	64	27
Switzerland	41	10	40	26	23
United Kingdom	245	29	48	9	14
United States	9363	21	26	30	23
Congo	2345	3	4	78	15
WORLD	147922	11	24	31	44

APPENDIX V

World Distribution of Gross Primary Production
(in kilocalories per square metre per day)

Deserts	Less than 2.0
Grass Lands Deep lakes Mountain forest Dry farming	2.0-12.0
Rain forest Shallow lakes Humid Grass lands Wet cultivation	12.0-40.0
Some estuaries Springs Coral reefs Alluvial plains Annual crop like sugarcane	40.0-100.0
Continental shelf waters	2.0 to 12.0
Deep oceans	Less than 4.0