Vipul's™

Environmental Studies - I

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Syllabus

No.	Modules / Units	No. of Lectures
1	**Environment and Ecosystem:**	**13**
	Environment: Meaning, definition, scope and its components; concept of an ecosystem: definition, Characteristics, components and types, functioning and structure; Food Chain and Food Web- Ecological Pyramids - Man and environment relationship; Importance and scope of Environmental Studies.	
2	**Natural Resources and Sustainable Development:**	**13**
	Meaning and definitions; Classification and types of resources, factors influencing resource utilisation; Resource conservation- meaning and methods-conventional and non-conventional resources, problems associated with and management of water, forest and energy resources- resource utilization and sustainable development.	
3	**Populations and Emerging Issues of Development:**	**13**
	Population explosion in the world and in India and arising concerns-Demographic Transition Theory - pattern of population growth in the world and in India and associated problems - Measures taken to control population growth in India; Human population and environment – Environment and Human Health – Human Development Index – The World Happiness Index.	
4	**Urbanisation and Environment:**	**13**
	Concept of Urbanisation – Problems of migration and urban environment-changing land use, crowding and stress on urban resources, degradation of air and water, loss of soil cover impact on biodiversity, Urban heat islands – Emerging Smart Cities and safe cities in India - Sustainable Cities.	
5	**Reading of Thematic Maps and Map Filling:**	**08**
	Reading of Thematic Maps: Located bars, Circles, Pie charts, Isopleths, Choropleth, and Flow map, Pictograms - Only reading and interpretation. **Map Filling:** Map filling of World (Environmentally significant features) using point, line and polygon segment.	04 04
	Total	**60**

Chapter 1

Environment and Ecosystem

"A tree is alive, and thus it is always more than you can see. Roots to leaves, yes-those you can, in part, see. But it is more-it is the lichens and moss and ferns that grow on its bark, the life too small to see that lives among its roots, a community we know of, but do not think on. It is every fly and bee and beetle that uses it for shelter or food, every bird that nests in its branches. Everyone an individual, and yet every one part of the tree, and the tree part of every one."

— Elizabeth Moon, Oath of Fealty

Environment: Meaning, Definitions and Scope – Components of Environment – Ecosystem: Definition, Characteristics and Components – Structure of the Ecosystem, Food Web and Ecological Pyramids. **Ecosystem:** Types – Functioning and Structure: Energy Flow and Biogeochemical Cycles – Man and Environment Relationship – Importance and Scope of Environmental Studies – Review Questions

ENVIRONMENT

Meaning, Definition and Scope:

Meaning:

The meaning of 'Environment' in dictionary is "surrounding". It is defined as the sum total of all the external conditions which influences man, animals, plants etc. during his lifetime. It is a complex of physical, chemical and biotic factors (such as climate, soil and living things) that act upon an organism and ultimately determine its form and survival. If we look around at the area where we live, we find that it consists of natural factors like hills, soil, plants, animals, air, water and also manmade structures like

buildings, roads, factories etc. Environment also incorporates the aggregate of social and cultural conditions that influence the life of an individual or community. It is a complex and wider concept. All these factors together constitute our environment. They all are interconnected and interrelated functionally.

Survival of all living being depends on their surrounding environment. It is known that men and animal are dependent on nature for fulfilling their basic needs, such as, food, water, air, etc. For conducting the economic activities like – agriculture, mining, industrial activities etc., man is entirely dependent on environment. All processes of commerce associated with production, distribution, consumption and exchange are linked directly or, indirectly with various components of environment.

Definitions:

Following are some important definitions of environment:

- **Tansley (1926)** defined environment as *"sum total of those effective conditions in which organisms live."*
- **Park C.C. (1980)** explained that environment is the sum total of all conditions which surround man at a given point in space and time.
- **Douglas and Holland** defined that *"The term environment is used to describe in aggregate, all the external forces, influences and conditions, which affect the life, nature, behaviour and growth, development and maturity of living organisms."*
- According to **K. R. Dikshit** (1984), *"the space we live in, the air we breathe, the food we eat, the water we drink and the other sources we need, constitute our environment."*
- According to **B. K. Sharma** (1994), *"Environment consists of an inseparable whole system constituted by physical, chemical, biological, social and cultural elements, which are interlinked individually and collectively in myriad ways."*

Components of Environment:

On the basis of origin, the components of environment is divided in two categories - Physical and Human environment. Fig. 1.1 shows the components of environment.

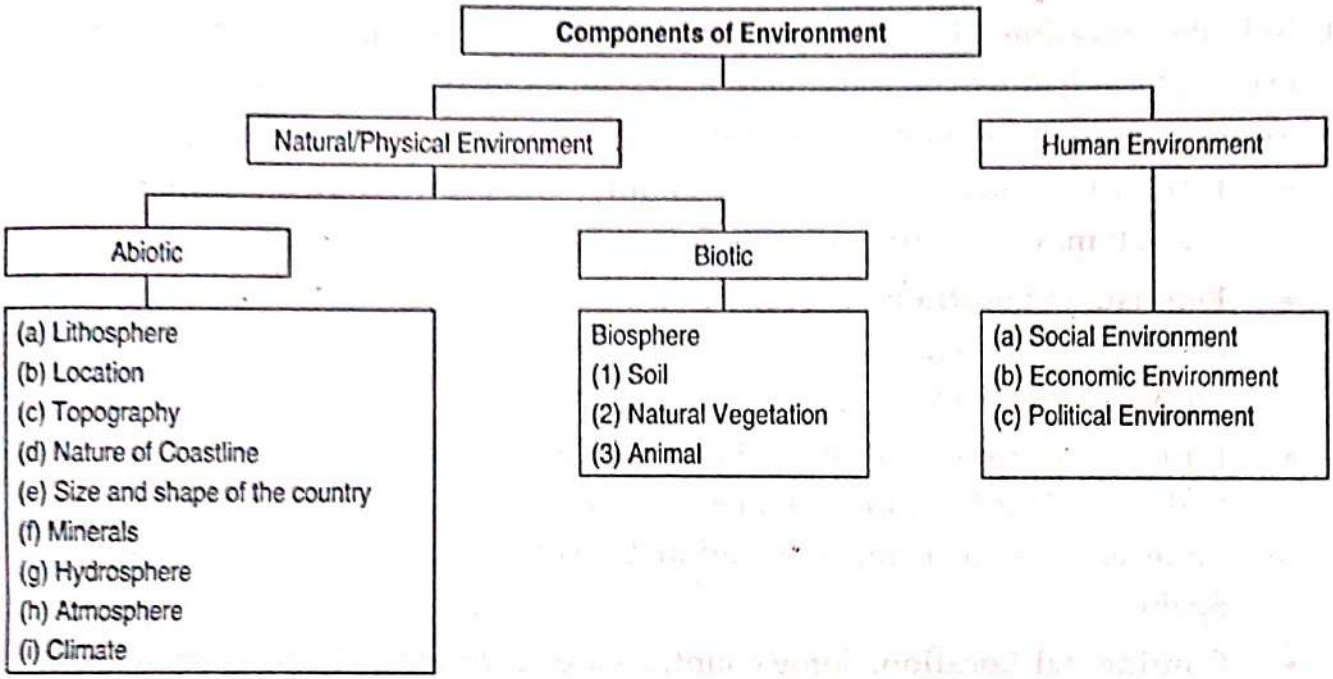

Fig. 1.1 Components of Environment

Natural or Physical Environment:

The Physical components of environment are further sub-divided in a biotic and biotic components:

(A) Abiotic Components: Abiotic or, non-living components, include:

(a) Lithosphere: 'Lithos' means rock. The solid outer crust of the Earth is called as lithosphere. It consists of minerals occurring in the earth's crusts and the soil e.g. minerals, organic matter, air and water.

(b) Location: The location of a country is one of the most important factors that influence the climate and also various types of human activities that will develop in that country. It is of two types:

(i) Absolute Location: Absolute location of a region in terms of latitude and longitude. It is fixed location. This type of location provides the idea about the countries climate and level of economic development. For e.g. in Fig. 1.2, the absolute location of a place A is at the intersection of 25° N latitude and 45° E longitude.

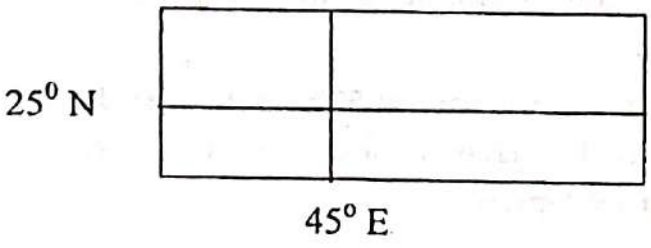

Fig. 1.2 Absolute Location

(ii) **Relative location:** Location of a place or a region, with reference to geographical features or water bodies, landmass or transport routes is called as a relative location. Following are some of its types:

- **Insular Location:** A location of a country when surrounded by water on all sides. It may be a group of islands, e.g. Japan, U. K. Australia.
- **Peninsular Location:** A location of a country when surrounded by water on three sides, e.g. India, Italy etc. Such locations are beneficial in the growth of the country.
- **Littoral Location:** A location that has a substantial portion of land adjacent to the sea. This location provides such countries access to sea. Thus, foreign trade is possible using navigation by sea or ocean. E.g. China, France, Spain.
- **Continental Location:** Some countries are surrounded by land on all sides. They are located away from sea in the interior of a continent. Such countries are also called as landlocked countries, e.g. Nepal, Afghanistan. Such locations are considered to be unfavourable in the growth of the country.
- **Isthmian Location:** A location of a country on an Isthmus. Such country enjoys strategic location which influences the geopolitics of the world. E.g. Suez and Panama.
- **Focal location:** These locations are man-made location. Such locations are well connected with nearby areas. They are connected by railways, roadways, airways and waterways, e.g. – Mumbai.

(c) **Topography:** Nature of land of a region/country, like mountains, plains, plateaus etc. form the topography:

- **Mountains:** World over mountainous areas are found to be under developed. The mountainous terrain does not support development of agriculture and industry easily. Although rich in some natural resources like - rivers, minerals, forests, natural beauty etc. There are problems posed by slope, heavy rains, thin soil layer etc. in development of human settlements, e.g. Himalayan region, Alps, Rockies etc.
- **Plains:** Plain area occupies about 55% of the total land surface and support 90% of the population. The river valleys have fertile rich plains which has always attracted human settlements.

- **Plateaus:** Plateaus are tablelands. When located in the interior of the continents, they are less developed. They support the primary activities like mining, grazing or agriculture, e.g. Tibetan plateau. Plateaus located close to the sea are easily accessible and therefore, they develop large number of activities like – plantation agriculture, mining, industries, trade etc. For e.g. Deccan Plateau in India, Brazilian Plateau etc.

(d) **Nature of Coastline:** Water transport is the cheapest mode of transport mainly used for world trade. An indented or broken coastline is ideal location for development of harbours and ports. Africa and India have smooth coastline, therefore, limited numbers of natural harbours and ports. Countries like Great Britain, Japan, and Norway have been successful in using the broken coast for development of ports and therefore, activities associated with it, like fishing industry. (Fig. 1.3).

Smooth Coastline *Broken Coastline*

Fig. 1.3 Nature of Coastline

(e) **Shape and Size of a Country:**

Size attributes of a country is one of the important physical factors which affect the activities of the man.

- **Large Size:** Countries with large size like Russia, USA, China, India etc. enjoy various types of climate, soil and other resources available in their different areas. They become self-sufficient by producing variety of goods.
- **Small Size:** Countries with small size like Japan, UK etc. have to import various raw materials and food stuffs for their survival.

The shape of a country also influences the development process. They can be of following types:

- **Fragmented Shape:** Countries having fragmented shape have scattered land masses which are poorly connected. Thus, they do not create favourable

environment for overall development process. E.g. Indonesia, Philippines, Japan.

- **Elongated Shape:** Even countries having elongated shape e.g. Chile in South America, does not create a favourable environment for development.
- **Compact Shape:** Countries having compact shape tend to have all round development, e.g. USA, France etc.

(f) **Minerals:** Minerals are unevenly distributed resources on the Earth's surface. Availability of minerals influences the development of industries. Some countries possess large amount of minerals and power resource while others are completely devoid of those particular minerals. e.g. 90% of the world oil reserves are found in USA and middle eastern countries. Countries like South Africa, Australia have attracted large number of people, from distant places to inhospitable areas with rich minerals deposit. The economies of Saudi Arabia, Kuwait, and Iraq are entirely dependent on oil export.

(g) **Hydrosphere:** 71% of the Earth's surface is covered by water which is called as hydrosphere. It comprises of all types of water resources oceans, seas, lakes, rivers, streams, reservoirs, polar icecaps, glaciers, and ground water. Oceans represent 97% of the earth's water and about 2% of the water resources is locked in the polar icecaps and glaciers. Only about 1% is available as fresh water as surface water in rivers, lakes, streams, and as ground water for human use.

Ocean serves as the highways for all international trade and commerce. Warm and Cold Ocean current affect the local weather conditions near the coast line. Ocean is a vast store house of sea food and various minerals. Seafood like fish, lobsters etc. and minerals like sodium chloride, bromine, magnesium etc., are harvested from sea water.

(h) **Atmosphere:** The envelope of gases surrounding the Earth is called as Atmosphere. The Atmosphere forms a distinctive protective layer about 100 km thick around the earth. It protects the surface of earth from the Sun's harmful, ultraviolet rays. It sustains life on the earth. It also regulates temperature, preventing the earth from becoming too hot or too cold. The atmosphere is composed of nitrogen and oxygen besides, argon, carbon dioxide and trace gases.

The atmosphere has a marked effect on the energy balance at the surface of the Earth. It absorbs most of the cosmic rays from outer space and a major portion of the electromagnetic radiation from the sun. It transmits only ultraviolet, visible, near infrared radiation and radio waves.

(i) **Climate:** It is the most fundamental factor influencing human habitation. Climate influences human life, right from man's physical and mental ability to the choice of his activities. Physical capacities to do work, soil, vegetation, crops to be cultivated etc. are affected by climate. The people in the cool temperate region are more energetic and are capable to undertake hard work and for longer hours on the contrary, people living in hot climatic conditions don't have that ability. The types of animals found in a region are also influenced by climate.

(j) **Biosphere:** Indicates the realm of living organisms and their interactions with environment, viz. atmosphere, hydrosphere and lithosphere. From the surface, it is extended few kilometres up in the atmosphere and few kilometres down in the marine water. It is a narrow stretch which supports life.

(B) **Biotic components:** It consists of living beings, which are as follows:

(i) **Soil:** The top layer of the Earth is called Soil. Soil consists of both organic and inorganic matter. The colour and texture of soil varies from area to area because of different bedrock, their rate of disintegration, amount of rainfall and type of vegetation. Each soil type influences the crop cultivated in a specific area, e.g. black cotton soils are suitable for cotton, sugarcane etc. alluvial soil for wheat, jute, rice, etc. Thus, the soil cover controls the agricultural practices. Soil supports the vegetation. Vegetation in turn adds organic matter to the soil which, makes it fertile.

(ii) **Natural Vegetation:** Vegetation means green cover which present on the surface of Earth. It influences man's activities directly. Forests in particular provides timber, wood, fruits, bark, leaves, herbs etc. for man's use. Industries like Paper and pulp industry, construction industry, match box industry, rayon industry, sports goods industry etc. depends on forests for their raw materials. Forests are the habitat of animals. They produce oxygen which is essential for survival of animal world including mankind.

Forests are the lungs of the Earth. Therefore, their role in the environment is indispensable.

(iii) **Animals:** Animals play an important role in the ecology of nature and activities of man. Animal life is an asset to man, providing him products like milk, meat, egg, fat, wool, horns, bones, hides and skin etc. Animals are also used for transport purposes e.g. horse, cattle, camel etc. Animal rearing has grown all over the world on commercial scale like cattle farming, sheep farming, poultry farming, pig farming etc. These are highly specialized and profit oriented industry. Thus, there is a close relationship between animal products and man.

Human Environment:

Human beings reach has increased tremendously with the development of technology. Man has created a vast and varied cultural landscape which differs from country to country. Following are the types of man-made or, human environment:

(a) **Social Environment:** The world over human beings have developed the societies with a social structure. Every society has its culture. Culture of a society is reflected in the type of economic and commercial activities they pursue. Their day to day requirement also varies. It also reflects their standards and achievements. Primitive society live in harmony with the nature. Their lifestyle is simple. They use primitive method of food gathering and hunting techniques to sustain. Therefore, they are termed as socially backward. However, they are conscious of the limits of the environment.

On the other hand, there are advanced societies who try to achieve everything in order to make their living comfortable. Their use of technology has brought a change in the methods of production. Such societies believe in the doctrine that ever increasing consumption of goods and services forms the basis of a sound economy. In that process they have altered the environment to serve their needs, thus disrupting the systems of environment.

(b) **Economic Environment:** Economic environment consists of all the components which makes the development possible in a country. It consists of economic policies, trade policy, economic planning models, economic systems etc. Formation of trade blocs in a region helps in the development by resolving the trade issues between countries and creating a congenial environment for trade between them.

(c) **Political Environment:** The Political environment consists of the type of government (democratic or, communist or, dictatorship), and the allied agencies associated with it. It also depends on, whether the government is stable or, unstable. The unstable govt. is barrier to the development of a country. A stable government together with its institutions can protect and safeguard the environmental conditions of the country by framing suitable environment protecting policies, strategies and the mechanism to implement those policies effectively. For ex.- USA, a highly developed country, is not interested in curbing the emission of Greenhouse gases. Russia does not want to join the group of nations for banning the killing of whales.

Countries all over the world need to join hands to combat the global environmental problems. They should adopt a unitary approach in finding solutions of various problems.

Ecosystem: Definition, Characteristics and Components:

Definition:

The term 'Ecosystem' was first coined by A. G. Tansley in 1935. According to him it is "the system resulting from the integration of all the living and non-living factors of the environment." Hence, it consists of organism and the inorganic components, which are in a state of equilibrium, interacting and sustaining. In simple words, ecosystem is a fundamental functional unit on the surface of the Earth.

Characteristics:

Following are the characteristics of ecosystem:

(a) Ecosystem represents sum total of living organisms and physical components in a given spatial and temporal dimension.

(b) There are interactions between the biotic elements and also between biotic and abiotic factors. They are intimately related through a series of large scale cyclic mechanism. Thus, it is a functional unit.

(c) It is open system as it is characterised by continuous input and output of matter and energy. Thus, it has its own productivity which is powered by solar energy.

(d) It has scale dimension. It may be small like a tree having micro-organisms. A large unit can be Marine ecosystem. Thus, it shows large variations in their size, structure, composition etc.

(e) It is a structured, well defined natural resource system in which biotic and abiotic components have been put together in a single framework, thereby making it easy to understand and study.

Components:

The components of ecosystem can be divided in two major categories:

(A) **Abiotic Components:** It consists of physical and chemical factors that are required by living organisms for survival. Sunlight, soil, wind, temperature, rainfall, water, ocean currents etc. are some physical factors which influence the functioning of ecosystem. Chemical elements like carbon, nitrogen, hydrogen, oxygen, phosphorus etc. are present in air, water and soil, largely influence the ecosystem.

(B) **Biotic Components:** Plants, animals and micro-organisms constitute the biotic components of the ecosystem. These various life forms have different nutritional needs and status in the ecosystem. Biotic components consists of three categories described below:

(1) **Autotrophs or Producers:** 'Auto' means self and 'troph' means food. This category consists of the living beings which synthesise their own food. Green plants mainly come in this category. They synthesize their food by taking carbon dioxide, water and sunlight, and they make carbohydrates ($C_6H_{12}O_6$). They process it in their leaves which have green pigments called chlorophyll.

(2) **Heterotrophs or Consumers:** 'Hetero' means multiple and 'trophs' means food. All organisms, which get their food directly or, indirectly from autotrophs, constitute this category of consumers which are of following types:

(i) **Herbivores or Primary Consumers:** They feed directly on the plants, so they are called as primary consumers. All the grazing animals or, herbivores come in this category, e.g. giraffe, deer, rabbit, etc.

(ii) **Carnivores:** They feed on other consumers. If they feed on herbivores animals, they are called secondary consumers, e.g.- frog etc. If they feed on other carnivores, they are known as tertiary consumers, e.g. big fishes, snakes, wolf, lion, etc.

(iii) **Omnivores:** The organisms feeding on both plants and animals constitute this category, e.g. bear, fox, man, etc.

(iv) **Derivores or Saprotrophs:** They feed on the parts of the dead animals. They are also called as scavengers, e.g.- vultures, hyenas, earthworms etc. These animals help in cleaning the ecosystem.

(3) **Decomposers:** Bacteria, Fungi etc. constitute this category. These organisms derive their nutrition by breaking down complex organic matter into inorganic nutrients.

In all the ecosystems, this structure of abiotic and biotic factors prevails. However, variations is seen in the structure.

Structure of the Ecosystem:

(A) Food Chain:

Food chain is the transfer of food energy from the producers to other organisms by the process of eating and being eaten. In the environment there is Prey – Predator relationship which establishes a continuous pattern to the various trophic levels. It determines how energy and nutrients move from one organism to another through an ecosystem. Green plants (producers), commonly initiate food chains; they are eaten by herbivores, which may in turn be eaten by carnivores. Other consumers, such as, plant and animal parasites, may also form the intermediate links in the chain. The chemical

energy in food flows through various trophic levels or energy transfers. Food chains rarely have more than four trophic levels. Some examples of food chain are:

(1) Green plants → insects → frogs → snakes → hawk

(2) Aquatic insects → small fishes → large fishes

In nature there are two types of food chain:

(i) **Grazing Food Chain:** It starts from the green plants reaches the grazing herbivores animals and finally to carnivores animals. This type of food chain depends on the incoming solar radiation.

(ii) **Detritus Food Chain:** It goes from dead organic matter to organisms feeding on detritus and their predators. They depend chiefly on the influx of organic matter produced in another system, e.g. in the mangrove areas, the fallen leaves are eaten by small animals like crabs, insect larvae, molluscs etc. These animals form primary consumers. They are in turn eaten by small fishes and, small fishes are eaten by larger fishes and fish eating birds.

(B) Food Webs:

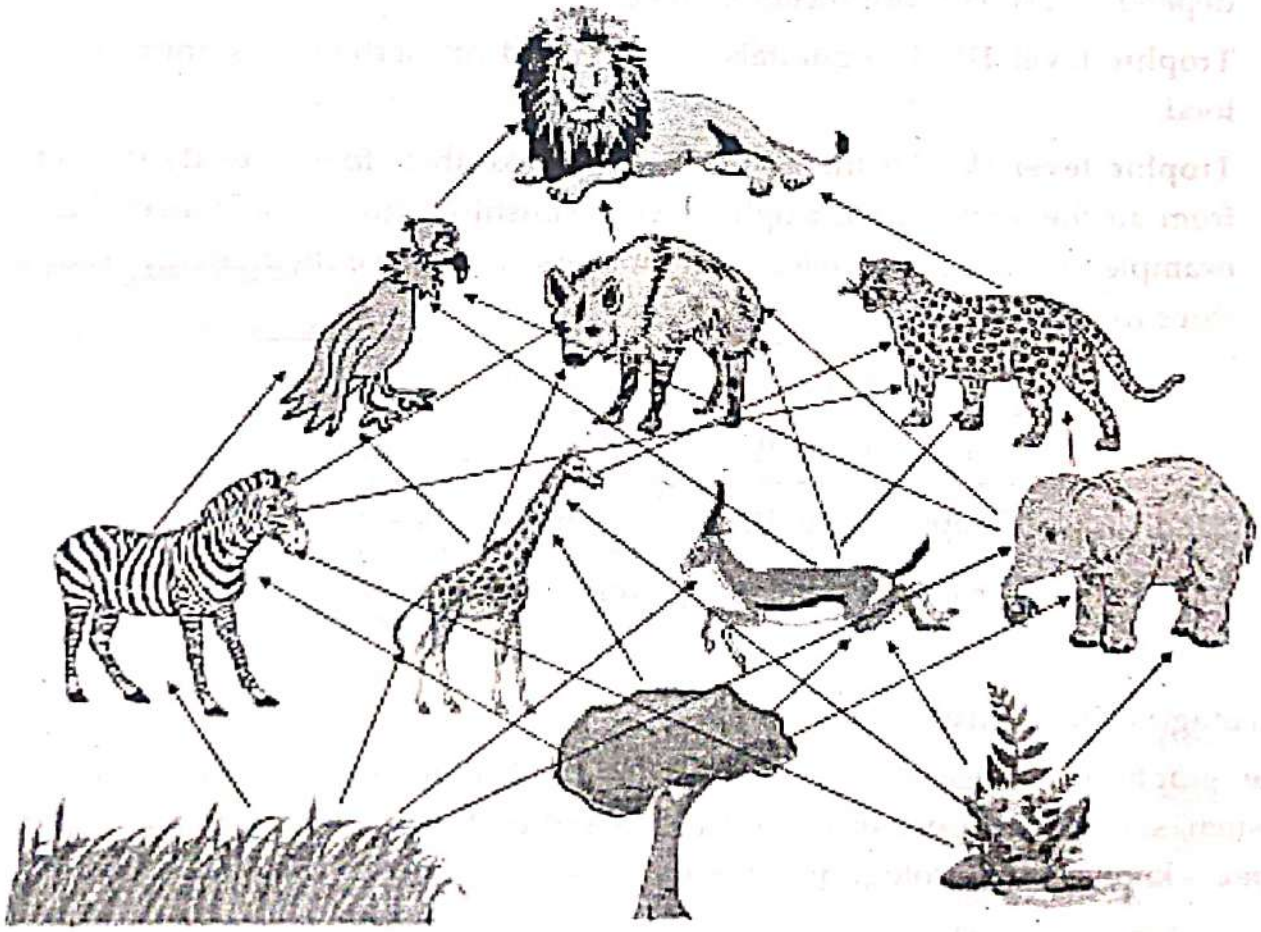

Fig. 1.4 Food Web

The above stated food chains seems to very simple, but food chains in the nature are not simple and they do not function in isolation. Most consumers feed on more than one type of organism and most organisms are eaten by more than one type of consumer. Because most species participate in several food chains, the organisms in most ecosystems form a complex network of interconnected food chains called a food web. Trophic levels can be assigned in food webs just as in food chains. A food web may involve a few aquatic organisms and land organisms feeding on each other. An example is represented through the diagram (Fig. 1.4).

Trophic Structure:

In the food chain all the producers and consumers are arranged in a sequential manner and their interactions with the population size is called as trophic structure. Each food level is called as trophic level and the amount of living matter in each of trophic level is called standing biomass.

- **Trophic level I:** Consists of autotrophic primary producers i.e. green plants.
- **Trophic level II:** Consists of primary consumers or, herbivores animals. They depend on primary producers for food.
- **Trophic level III:** The animals who depend on herbivorous animals for their food.
- **Trophic level IV:** All the animals which take their food directly or, indirectly from all the above three trophic levels, constitute this trophic level. Man is an example in this trophic level. Decomposers also derive their energy from all the three trophic levels.

Trophic Level I	Producer
Trophic Level II	Primary Consumer
Trophic Level III	Secondary Consumer
Trophic Level IV	Tertiary Consumer

Fig. 1.5 Trophic level

(C) Ecological Pyramids:

The graphical representation of structure and function of tropic levels of an ecosystem, starting with producers at the top and each successive tropic level forming the apex is known as an ecological pyramid.

In a food chain starting from the producers to the consumers, there is a regular decrease in the properties i.e., energy, biomass and the number of organisms. Since some energy is lost in each tropic level, it becomes progressively smaller at the top.

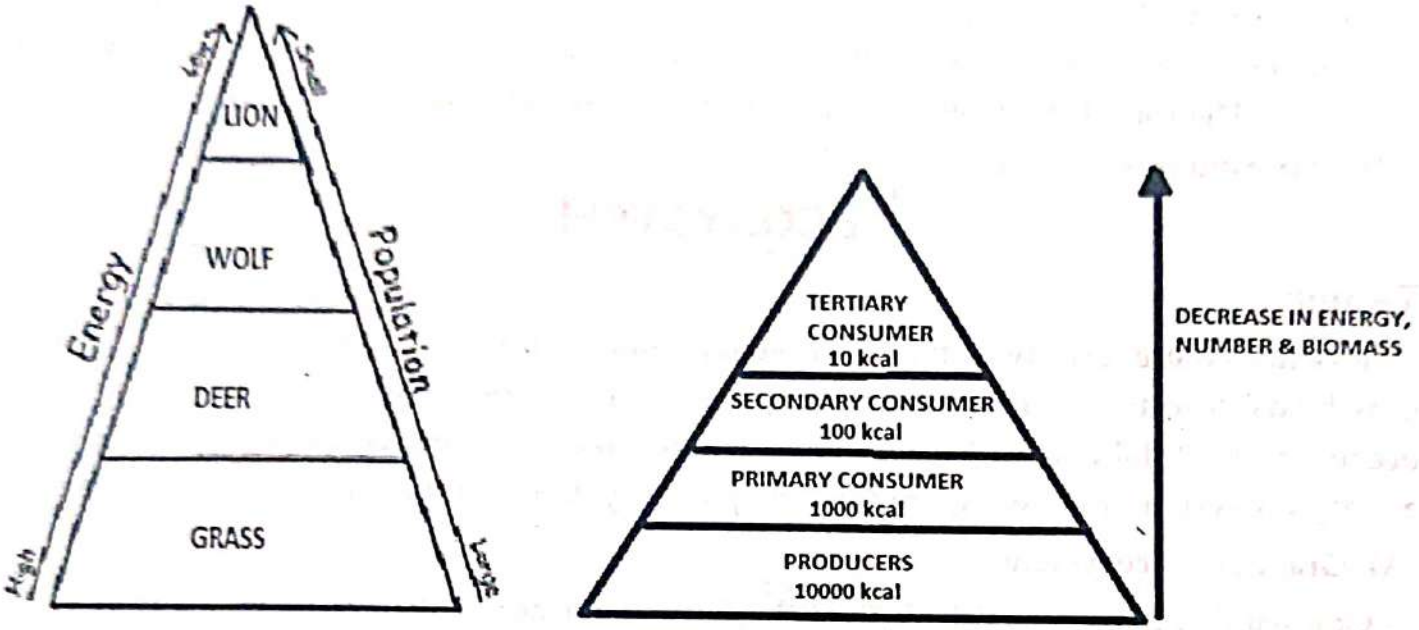

Fig. 1.6 - Ecological Pyramid

Ecological pyramids are of three types:

(1) Pyramid of Numbers

(2) Pyramids of Energy and

(3) Pyramid of Biomass

(1) **Pyramid of Numbers:** It represents the number of individual organisms present in each tropic level. For example: A grassland Ecosystem Producers are grass which are small in size and large in number. Hence they occupy the first tropic level. The primary consumers are rabbits occupying the second tropic level. It is to be noted that rabbits are less in number than grass. Secondary consumers are snakes which occupy the third tropic level and they are lesser in number than rabbits. Tertiary consumers are Eagles that occupy the next tropic level. This is the last tropic level where the number and size of the tropic level is the least.

(2) **Pyramid of Energy:** It represents the amount of energy present in each tropic level. The rate of energy flow and the productivity at each successive tropic level is lost at every successive tropic level. Almost 90% of energy is lost in the form of heat. Thus, at each tropic level only 10% of energy is transferred. Hence, there is a sharp decrease in energy at each and every successive tropic level as we move from producers to top consumers (carnivores).

(3) **Pyramid of Biomass:** It represents the total amount of biomass (mass or weight of biological material) present in each tropic level. There is a steady decrease in the biomass from the lower tropic level to the higher tropic level. For example- a forest ecosystem. The trees are producers which contribute a major amount of the biomass. The next tropic levels are the herbivores like- birds, and carnivores like foxes. The top of the tropic level consists of very few tertiary consumers e.g. Lions, whose biomass is very low.

ECOSYSTEM

Types:

Broadly, there are two types of ecosystems – terrestrial and aquatic. Deserts, grasslands, forests and mountains are some broad examples of terrestrial ecosystems; ocean, creeks, tidal zones, coastal zones, rivers, lakes and ponds are some examples of aquatic ecosystem. Following are three major ecosystems, of the Earth, discussed below:

(A) Grassland Ecosystem:

Grasslands occupy roughly 19% of the Earth's surface. They are mainly found in the areas where rainfall is less or, soil layer is thin. For example, Savanna in the tropical region, and Prairies, Steppes, Veld etc. in temperate areas.

Many of the grasses become dormant in unfavourable season say, hot season or, very cold season. However, they appear again in favourable season and show increased growth conditions. These grasslands are used as pastures for cattle rearing. It supports primary consumers like rabbits, deer, cows, buffaloes, mouse etc. Carnivores like fox, jackals, snakes etc. feeding on herbivores.

Most grassland ecosystem is highly modified by human activities like overgrazing and changed land use for agriculture. A large part of grasslands have disappeared and with that several species of plants and animals have also disappeared, for example, Cheetah is extinct in India; Wolf is on the brink of extinction etc. Grassland species need to be protected otherwise, we will lose a highly specialised ecosystem. The genetic pool of plants and animals needs to be preserved.

(B) Forest Ecosystem:

Forests occupy nearly 30% of land area on the Earth. The forest ecosystem consists of two parts:

(i) The non-living aspect of the forest, i.e., whether the forests are on mountains, hills or, river valleys. Forests are influenced by rainfall and temperature regime which varies with latitude and altitude.

(ii) The plant and animals are closely dependent on each other and are specific to each of the forest type. Plants include trees, shrub, climbers, grasses flowering plants and non-flowering plants, fungi etc. Animals include birds, reptiles, amphibian, insects, mammals, invertebrates etc.

In the tropical belt evergreen and deciduous type of forests are found. These forests are known for their richness in biodiversity. Temperate deciduous forests are found in eastern North America, parts of Europe, Japan, Australia, etc. Coniferous forests are found in northern parts of Europe and North America.

The forests are shrinking rapidly due to increased use of timber by mankind. We know that natural forest ecosystems greatly control local climate and water regimes. Therefore, its overexploitation will lead to degradation and finally changes the quality of the ecosystem into wasteland.

(C) Aquatic Ecosystem:

The aquatic ecosystems are classified into fresh, brackish and marine ecosystems:

(i) **Fresh Water Ecosystem:** Fresh water ecosystem consists of rivers, streams, ponds & lakes. Wetlands are special ecosystems in which the water level fluctuates. In pond and lake ecosystem a large amount of plant material is algae, which derives energy from sun. Microscopic animals feed on algae. Small fishes and crustaceans feed on microscopic animals and big fishes eat the smaller fishes. Streams and rivers are flowing water ecosystems. The flora and fauna of this ecosystem depends on the clarity, flow, oxygen level in water and nature of their beds.

(ii) **Marine and Brackish Water Ecosystem:** Marine ecosystems are highly saline. Brackish areas have less salinity such as in the river deltas. The producers in this ecosystem vary from microscopic algae to large seaweeds. They are eaten by zooplanktons and a large variety of invertebrates, which in turn are consumed by fish, turtles, mammals etc.

The aquatic ecosystems are under great threat, because of increasing levels of pollution in the water sources, deforestation, dam construction, contamination of heavy metals etc. In rural areas excessive use of fertilizers in the fields has resulted in the increased level of nitrogen in the aquatic systems through surface run off, which is causing eutrophication. Eutrophication, leads to decline of oxygen level in the waterbody, thus, killing the aquatic life. Gradually, the flora and fauna of the ecosystem is destroyed.

Functioning and Structure: Energy Flow and Biogeochemica Cycles:

Functions of the ecosystem are:

(1) It balances the rate of biological energy flow.

(2) It balances the nutrients cycle through biogeochemical cycles.

Sun → Producer → Consumer → Decomposers
(Animals) (Microorganisms)

(A) Energy Flow:

Flow of energy in the ecosystem takes place through food chain. The most importan characteristic of energy flow is that it is unidirectional or, it moves in one direction only It follows two laws of thermodynamics:

(i) **First Law of Thermodynamics:** It states that energy can neither be created nor destroyed. It can transform from one form to another, e.g. light energy to chemica energy in plants, and so on.

(ii) **Second Law of Thermodynamics:** Energy gets converted from more concentrated to dispersed form. As energy flows through the food chain, dissipation takes place from one trophic level to another. The loss of energy takes place through respiration, working, walking, functioning of internal organs etc. At every trophic level 90% of energy is lost and only 10% is transferred to the next trophic level. The percentage of usable energy transferred as biomass from one trophic level to the next is called ecological efficiency. For ex.- With 10% ecological efficiency (90% loss at each trophic transfer, if green plants in an area manage to capture 10,000 units of energy from the sun, then only about 1,000 units of energy will be available to support herbivores and only about 100 units to support carnivores and the top carnivore or, omnivore will have only 10 units of energy available.

(B) Biogeochemical Cycles:

The terms "Bio" refers to living organisms, "Geo" means Earth and chemical refers to the chemical elements which circulate in a circular path. Biosphere is a giant system in which several ecosystems operate. Various chemicals are found in the bodies of organisms in the form of nutrients. These nutrients are released from their bodies which changes into abiotic form and again from abiotic elements to biotic phase. Thus, it is a cyclic phase which sustains the life on the Earth.

(1) Hydrological Cycle:

"Hydro" means water, thus, hydrological cycle pertains to movement of water within and between systems. The water cycle at global level involves following mechanisms:

Evaporation, Transportation, Precipitation, Transpiration, Infiltration and Transfer of water, from the surface run off and rivers, back to the ocean (Fig. 1.7).

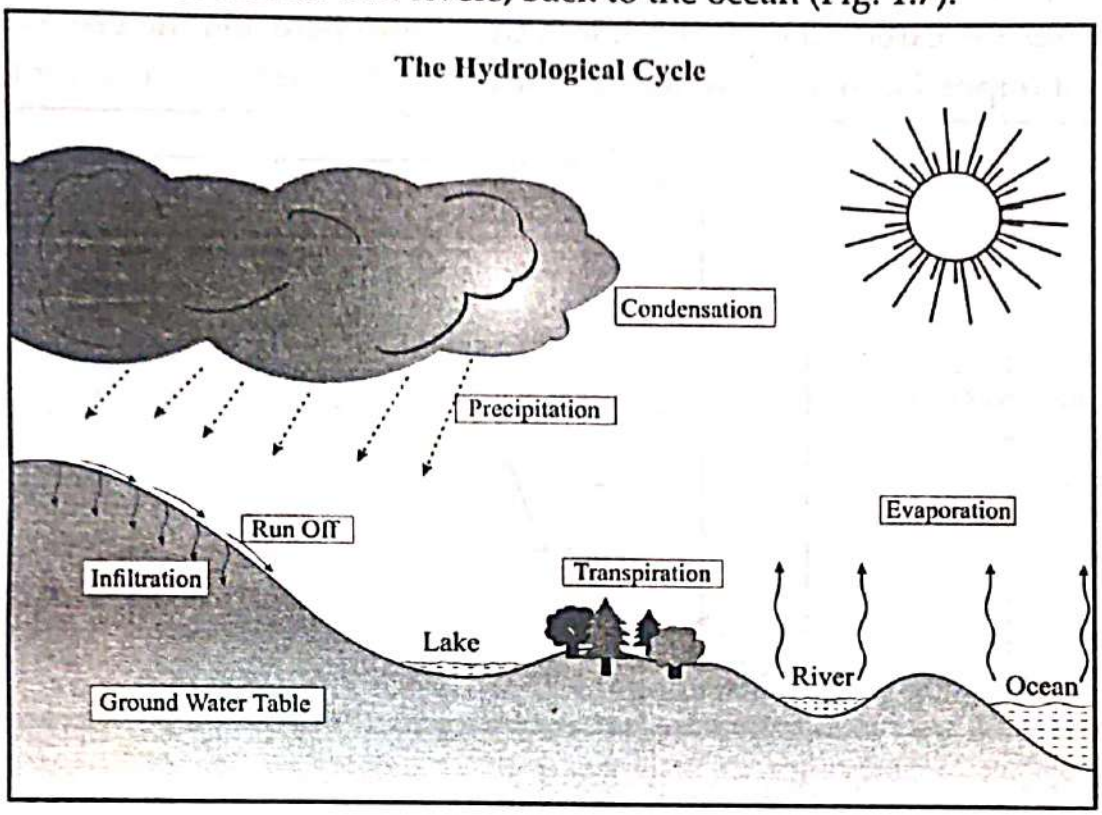

Fig. 1.7

Due to the process of heating by the sunrays, oceanic water and other sources of water is transformed into water vapour. This water vapour is transported over the continents and oceans by wind system. In the process of transport (especially ascent) of vapour, cooling takes place and precipitation or, rainfall occurs. Rainwater reaches the ground and it becomes surface run off, reaching the rivers, streams and lakes. Some portion of rainwater seeps into ground called as infiltration. This process helps in recharging of underground water table.

The vegetation on the surface also intercepts rainwater and it releases the water, in the air, through respiration and this process is termed as transpiration. These processes go on continuously in the environment, making hydrological cycle essential, because, through this mechanism fresh water sources are recharged. Thus, it supports all kinds of life on the Earth.

(2) Carbon Cycle:

The carbon cycle involves the circulation of carbon as carbon dioxide which is found in the atmosphere. Only Carbon dioxide constitutes 0.03 % of the atmospheric gases. It enters into the biota through the process of photosynthesis. The plants make carbohydrate ($C_6H_{12}O_6$) which is consumed by herbivores animals and then it reaches

into the bodies of carnivore animals. Animals release carbon dioxide through the process of respiration (Fig. 1.8). The burning of vegetation (fuel wood, forest fire) and animals releases the carbon dioxide back into the atmosphere. On the ground when the vegetation got trapped into the sedimentary rock formation, it transformed into coal.

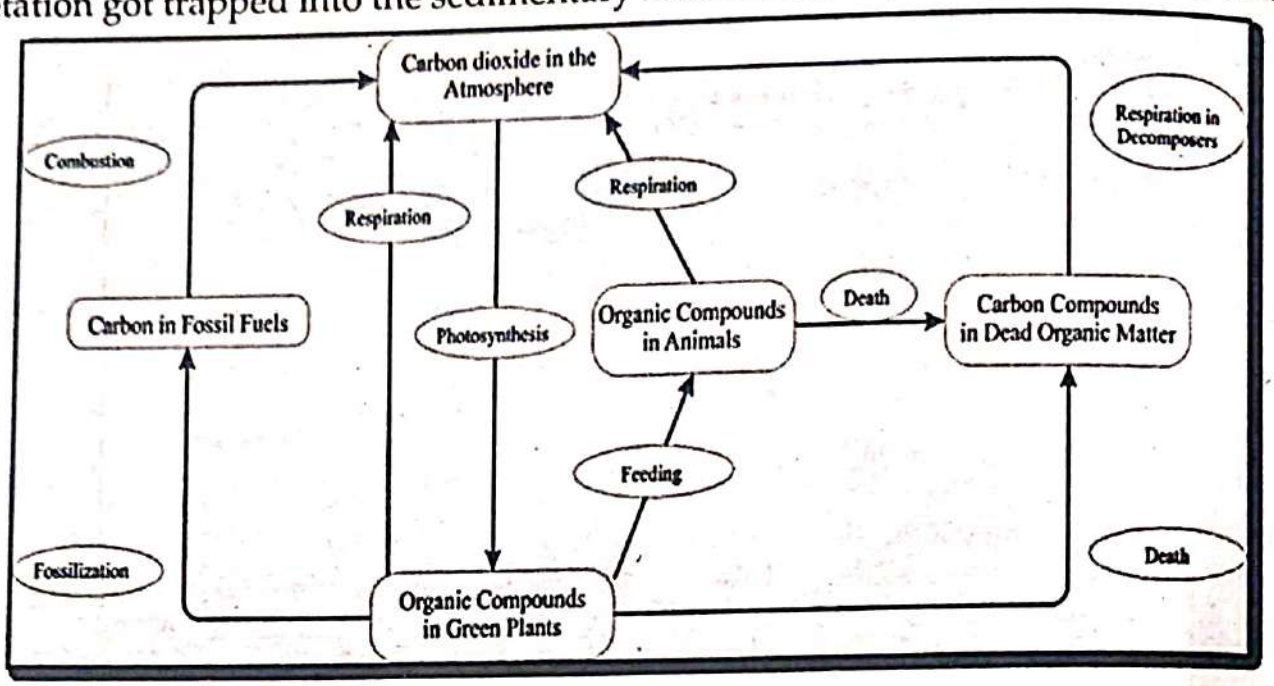

Fig. 1.8

The movement of carbon in the marine ecosystem starts with marine phytoplankton. They prepare carbohydrate. Phytoplanktons are consumed by zooplanktons and then fishes and other bigger fishes. Some portion of carbon is released during respiration which goes back into the atmosphere. Some portion of carbon stored in planktons, gets transformed into petroleum and natural gas, when they are trapped into the process of sediment deposition.

Volcanic eruptions contribute a great deal of carbon dioxide into the atmosphere. The main source of release of CO_2 comes from the burning of fossil fuels- coal, petroleum and natural gas by man. Off late the use of fossil fuel in transport, industry, agriculture and domestic sector has increased so much that, it has resulted in the global increase of temperature. This increasing trend will affect the living organisms on the Earth.

(3) Nitrogen Cycle:

Nitrogen is an element available abundantly in the atmosphere, constituting 78% of all the gases present. Nitrogen is very important for all the life forms because, it is an essential part of protein. Although nitrogen is available in plenty, the living beings cannot use it directly. Nitrogen cycle begins with "Nitrogen fixation". The natural process of nitrogen fixation is lightning. By this method nitrate formation takes place in the soil which is used by plants in making their food. The other method of nitrogen fixation is through nitrifying bacteria. In the roots of leguminous plants nitrifying

bacteria live which trap nitrogen from the atmosphere and enrich the soil. The artificial method of nitrogen fixation includes application of chemical fertilizers.

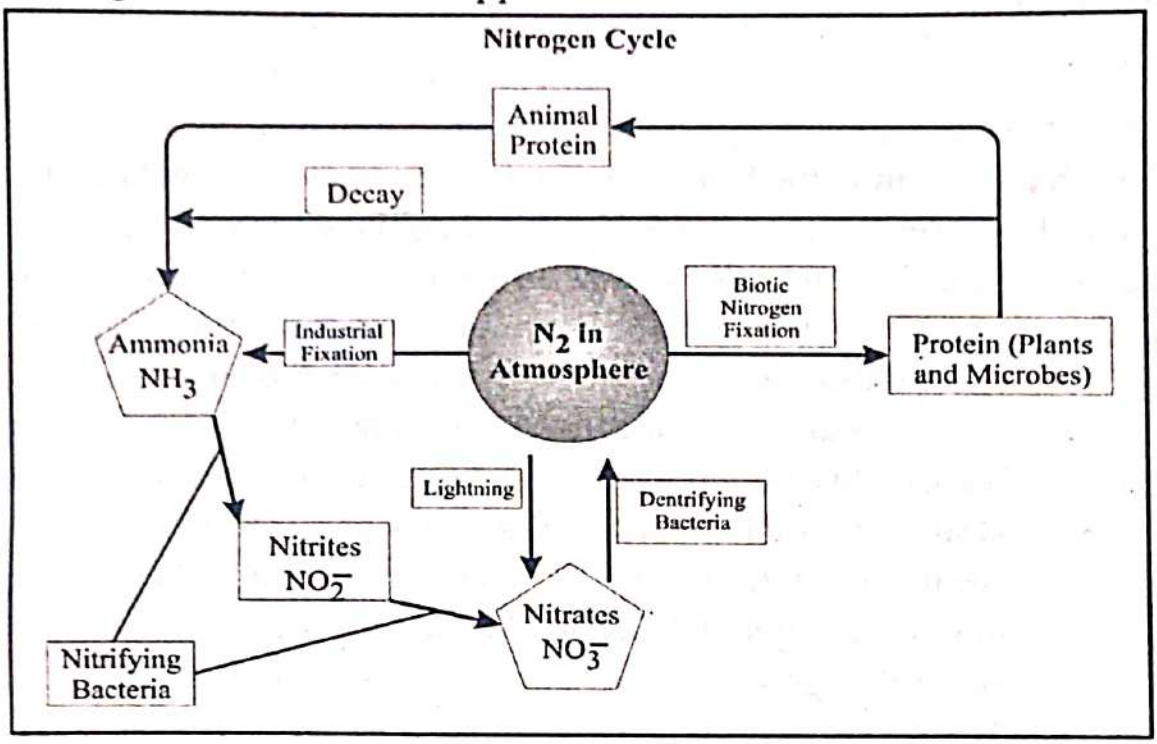

Fig. 1.9

Soil, plants take up nitrogenous compounds through their roots and through food chain; it goes into the bodies of heterotrophs. The protein disintegrates into the bodies of organisms and is released as waste products like, urea. On the death and decay of plants and animals, nitrogenous compounds enter into soil. The denitrifying bacteria present in the soil simplify these complex nitrogen compounds into simpler ones. Thus, they release it back in the atmosphere.

The problem of nitrogen cycle is that excessive amount of nitrogen is available in the soil due to the increased use of chemical fertilizers. It is causing disturbance both in aquatic and terrestrial ecosystem.

Man and Environment Relationship:

The relationship between man and environment has changed with time. In the early stages of growth, man was a wanderer. He was dependent on the flora, fauna, climate, water and terrain. His needs were food and security. Therefore, he was a physical man and his wants were limited. As man progressed, slowly he created his own social and economic systems. With the development of technology his life improved. There was improvements in food, shelter, access, and comfort. Development in all these areas changed the relationship of man and environment over a period of time. There are three approaches to study man-environment relationship:

(A) Determinism

(B) Possibilism

(C) Probabilism

(A) Determinism:

Meaning: Determinism is the belief that the environment (most notably its physical factors such as landforms and/or climate) determines the patterns of human societies, culture and its development. It is also known as environmental determinism. It believes that it is these environmental, climatic, and geographical factors alone that are responsible for human cultures and individual decisions and/or social conditions have virtually no impact on cultural development. Environmental determinism is not a recent ideology. Ancient scholars like Strabo, Plato, and Aristotle have explained the influence of climate on physical and social characteristics of people. Similar contributions also came during medieval period from Al-Jahiz and Ibn Khaldun. In modern period, Friedrich Rätzel and his disciple Ellen Semple made a significant contribution to deterministic school of thoughts. Huntington developed a subset of environmental determinism, called climatic determinism.

Man-Environment Relationship in Determinism: The main argument of environmental determinism states that an area's physical characteristics like climate have a strong impact on the psychological outlook of its inhabitants. These varied outlooks then spread throughout a population and help define the overall behaviour and culture of a society. For instance, it was said that areas in the tropics were less developed than higher latitudes because the continuously warm weather there made it easier to survive and thus, people living there did not work as hard to ensure their survival. Another example of environmental determinism would be the theory that island nations have unique cultural traits solely because of their isolation from continental societies. The idea believed that the physical environment of a region provides a dominant force in shaping cultures. As if, humans were clay to be moulded by nature. They overestimated the role of environment. Following are good examples:

Region	People's Characteristics
Mountains	Backward, conservative, unimaginative, freedom loving
Deserts	Likely to believe in one god, Lived under the rule of tyrants
Temperate Climates	Inventiveness, industriousness, democracy
Coastlands with inlets/ creeks	Produced navigators and fishers

Criticism: Environmental determinism's popularity began to decline since 1920s as its claims were often found to be wrong. In addition, critics claimed it was racist and perpetuated imperialism. Carl Sauer, for instance, said that environmental determinism led to premature generalizations about an area's culture and did not allow for results based on direct observation or other research. As a result of his and others criticisms, geographers developed the theory of environmental possibilism to explain cultural development. By the 1950s, environmental determinism was almost entirely replaced in geography by environmental possibilism, effectively ending its prominence as the central theory in the discipline. Regardless of its decline however, environmental determinism was an important component of geographic history as it initially represented an attempt by early geographers to explain the patterns they saw developing across the globe.

(B) Possibilism:

Meaning: Possibilism was developed as reaction to extreme generalizations of environmental determinists in 1920s. It essentially advocated and developed by the French school of Geography. Significant contributions to possibilism came from Vidal de la Blache, Jean Brunches, Lucian Febvre, H. J. Fleur and most importantly Carl Sauer. Sauer asserted that geographer's role is to investigate and understand the nature of the transition from the natural to the cultural landscape. He showed that it was not nature that caused culture, but rather culture, working with and on nature, created the contexts of life. According to him, culture is the agent, natural landscape a medium and cultural landscape, the result.

Man-Environment Relationship in Possibilism: Possibilism emphasized that cultural heritage is as important as physical environment in affecting human behaviour. It considers people as the primary architects of culture. Natural environment provides options, the number of which increases as the knowledge and technology of a cultural group develop. People make culture trait choices from the possibilities offered by their environment to satisfy their needs. High technology societies are less influenced by physical environment. Environment sets limitations for cultural development but it does not completely define culture. Culture is instead defined by the opportunities and decisions that humans make in response to dealing with such limitations.

Possibilists consider nature as advisor. This involves man in the first place and not the climactic influence. Man can never get rid of environmental influences entirely. Accordingly, man utilizes their environment more or less according to what they are and take advantage more or less completely of their environmental possibilities.

Criticism: Possibilism approach was criticised by many contemporary thinkers. Though man has numerous opportunities in a given setting, he cannot go against the directions laid by the physical environment. Griffith Taylor, an Australian Geographer, criticize possibilism by stating that the task of geography is to study the natural environment and its effect on man, not all problems connected with man or the cultural landscape. Moreover, possibilism does not encourage study of physical environment and gives over significance to man. It tends to exaggerate the role of culture and neglect the importance of natural environment.

(C) Probabilism:

The school of Determinism thought that the natural environment determined the human response, while the school of possibilism thought that the environment gave people a number of possibilities, which could be followed by different groups of people. Thus, philosophies of determinism and possibilism were extremes and contradictory to each other.

The term 'Probabilism' is coined by O. H. K. Spate in mid-1950's. It was a golden mean that led to the rise of probabilism also known as voluntarism. This ideology believes that man gets benefitted by compromising with environment. Man modifies the given environmental conditions, wherever necessary, and sometimes adjusts himself according to the given environmental conditions. It means, people had freedom of choice but the choice was highly constrained, and that the environment made some human responses more probable than others.

Voluntarism emphasizes that, neither nature nor man is an absolute controller. Though man has conquered nature with his rationale and intellect, nature has influenced human activities in several ways. Nature provides an opportunity to man and man also overcomes nature with his intellect (technology). Griffith Taylor, Dudley Stamp and Brunhes were the proponents of probabilism / voluntarism.

Man-Environment Relationship in probabilism: Griffith Taylor, an Australian Geographer, criticized possibilism and argued that though certain areas like the temperate regions offer viable alternative forms of human occupations, such environments are rare. He coined the term 'stop-and-go determinism' to express his views. He argued that the limits of agricultural settlement in Australia had been set by factors of physical environment like the distribution of rainfall. According to him, man follows nature's programme only if he is wise, presuming he can act foolishly, which admits the possible contention that within broad limits set by environment man can choose, at the very least. This idea was also criticised and became less popular in later period.

According to O. H. K. Spate, man and nature both are superior in their own respect. He states that 'environment taken by itself is a meaningless phrase; without man, environment does not exist.' Equally important is his indication of the need to consider the psycho-physiological influence of the geographical environment via the social structure. Spate maintains that geographical environment is only one of the factors of territorial differentiation and it acts through society; cultural tradition has a certain autonomous influence. Recently, an Australian writer, Wolfgang Hartake, argued that while the role of physical factors might well be relatively unimportant in certain places of Europe, it is hard to belief that that extreme climate conditions not playing a direct role in any human activity which occurs in the Sahara.

Scope of Environmental Studies:

Environment is not a single subject. It is an integration of several subjects that include both Science and Social Studies. To understand all the different aspects of our environment we need to understand biology, chemistry, physics, geography, resource management, economics and population issues. Thus the scope of environmental studies is extremely wide and covers some aspects of nearly every major discipline. It deals with following areas:

(1) **Environmental perception and awareness:** The environment creates favourable conditions for the existence and development of living organisms. The survival of any organism requires a steady supply of materials and removal of waste products from its environment. Each and every individual should understand this mechanism of sustenance.

(2) **Environmental education and training:** Environmental studies involves educating the people for preserving the quality of environment. Both formal and informal education on the environment will give the interested individual the knowledge, values, skills and tools needed to face the environmental challenges on a local and global level.

(3) **Control of environmental degradation/ pollution:** The degradation of the environment has become a serious problem for the existence of human beings. Increased Pollution is harming living organisms and is also causing loss of natural resources. Therefore, control is required on pollution like air pollution, water pollution, soil pollution, solid waste pollution, noise pollution, electronic waste pollution, e-pollution, etc.

(4) **Conservation and management of natural resources:** It is also important to understand that the Earth's resources - oil, forests, water, energy, and so on -- are

finite. They do not exist in infinite quantities. They are contained within the boundaries of planet Earth, and therefore they are limited.

(5) **Conservation of bio-diversities:** The number and variety of plants, animals and other organisms, that exist on Earth, constitute biodiversity. It is an essential component of nature and it ensures the survival of human species by providing food, fuel, shelter, medicines and other resources to mankind.

(6) **Impacts of human population on the environment:** Human is the only living being on the earth that is responsible for the destruction of the environment. This is because of his ability to use modern technology to exploit the natural resources and his desire for luxurious life has increased the consumption of resources.

(7) **Environmental Impact Assessment (EIA):** The purpose of the assessment is to ensure that decision makers consider the environmental impacts when deciding whether or not to proceed with a project. Thus it require decision makers to account for environmental values in their decisions and to justify.

(8) **Sustainable development:** Resource extraction, processing and use of the products have all to be synchronised with the ecological cycle. In any plan of development our actions should be planned ecologically for the sustainability of the environment and development.

Importance of Environmental Studies:

Environmental Studies has a direct relevance to every section of the society. Its main aspects are:

Productive Value of Nature:

Environment is very rich in biodiversity. Man had been deriving a number of things from the environment. About 90% of the present day food crops have been developed from wild tropical plants. Even now agricultural scientists are developing newer strains of crop having better tolerance and hardiness from wild plants and also to increase, the nutritive value and the per unit output of the crop. Even in the animal category similar kind of research is going on, so that we can have a possible solution to solve food problem of the world.

At present, about 75% of the world's population depends on plants for medicines or, medicines derived from plants. The famous drugs *"Penicillin"* is an antibiotic derived from fungus and *"Quinine"* the famous drug of malaria is made from the bark of Cinchona, are common examples of medicines prepared from plants. Recently two anti-cancer drugs "vinblastin" and "vincristine" have been developed from Periwinkle plant. There are a large number of plants and marine organisms which are supposed to have

different properties and they have not been explored so far. Thus, the environment is storehouse of raw materials which can be used to develop a number of new drugs, industrial products. We should conserve flora and fauna. Once these treasures are lost, we cannot bring it back. Therefore, when, an ecosystem is disturbed, we should understand the loss incurred due to disturbance, is irreparable. There is growing need that we understand and act upon it.

Aesthetic/Recreational value of nature:

There is a great aesthetic value of the nature that influences our life. None of us would like to visit the areas which are barren. People prefer to experience the beauty of National parks, bird sanctuaries or, even wilderness to revitalize their lives. This helps them in understanding the fragile functioning of the ecosystem. Nature becomes the source of inspiration to the poets, writers, singers and painters. It has also helped in developing tourism industry - wildlife tourism, ecotourism etc. These facilities help in creating a deep sense of attachment with nature. In the urban area presence of green areas provide peace and tranquillity to the people.

The option values of nature:

We live in a world in which natural resources are limited. Water, air, soil, minerals and the products we get from forests, oceans and from agriculture and livestock, all constitute our life support systems. Without them, life is not possible. As we keep increasing in numbers, the quantity of resources required by each one of us also increases, which is affecting the earth's resource base. In the process of resource use we are contributing to deforestation, extinction of plants and animals & degradation of land. We waste or pollute large amounts of nature's clean water, food; we create more of unwanted material like plastic, produce garbage etc. These processes are creating adverse environmental impact, which is affecting our lives.

The earth cannot sustain this pattern of resource use. However, nature provides us options on how to use our goods and services. Whether we use the resources judiciously or, greedily, it depends on us. We can use our resources sustainably so that, resources remain there for the future use.

We cannot expect Governments alone to manage the safeguarding of the environment, nor can we expect other people to bring in the change. We need to do it ourselves. It is a responsibility that each of us need to accept and move ahead.

Review Questions:

(1) Define 'Environment'. Discuss its nature and scope.

(2) Discuss the abiotic factors of the environment.

(3) Describe the types of man- made environment.

(4) Give the definition and scope of Environment. ***(Oct. 16; Nov. 16)***

(5) Define Environment and explain its importance with examples. ***(Oct. 17)***

(6) Define environment. Explain the biotic components of environment. ***(Dec. 19)***

(7) Explain with examples various biotic or living components of environment. ***(Nov. 17)***

(8) Explain how the biotic components of environment influence the human environment. ***(Dec. 18)***

(9) Describe the dynamic role of man as both destructor and protector of environment. ***(Dec. 18)***

(10) What is Ecosystem? What are the functions of Ecosystem? ***(Nov. 16)***

(11) What is ecosystem? What are the functions of ecosystem? ***(Oct. 16; March 17)***

(12) Bring out the characteristics and types of ecosystems. ***(Dec. 18)***

(13) What is ecosystem? State components of ecosystem. ***(Oct. 17)***

(14) Define ecosystem. Explain the concept of food chain, food web and ecological pyramid with suitable example for each. ***(Dec. 19)***

(15) Write the meaning of the term ecosystem. Explain the components and characteristics of forest ecosystem. ***(Nov. 17)***

(16) Describe the functioning of the types of ecosystem you have studied.

(17) Explain the biogeochemical cycles with the help of suitable diagram.

(18) Explain the components of ecosystem. ***(March 17)***

(19) Describe the man- environment relationship. ***(March 17)***

(20) What is ecosystem? What are the functions of ecosystem? ***(March 17)***

(21) Explain the components of ecosystem. ***(March 17)***

(22) Discuss with diagrams the concept of food chain and food web. ***(Oct. 17)***

(23) Discuss with diagram the energy transfer in ecosystem. ***(Nov. 17)***

(24) State the importance of environmental studies in detail. ***(Nov. 16)***

(25) Discuss the nature and scope of Environmental Studies.

(26) State the importance of environmental studies in detail. ***(Oct. 16)***

(27) Explain the importance and scope of environmental studies. ***(Dec. 19)***

(28) Bring out the importance and scope of environmental studies. Give examples. ***(Oct. 17)***

(29) Describe the man- environment relationship. ***(March 17)***

(30) Discuss with examples the impact of human activities on environment. ***(Nov. 17)***

(31) **Write note on:**

- (a) Scope of environmental studies. ***(March 17)***
- (b) Role of biotic factors. ***(March 17)***
- (c) Food chain. ***(Oct. 16; Nov. 16)***
- (d) Ecological pyramids. ***(Oct. 16; Nov. 16)***

Chapter 2

Natural Resources and Sustainable Development

"All our efforts to defeat poverty and pursue sustainable development will be in vain if environmental degradation and natural resource depletion continue unabated."

– Kofi Annan, Diplomat & Ex-Secretary General, UN

Natural Resources: Meaning, Definition and Classification – Factors Influencing Resource Utilization – Resource Conservation: Meaning and Methods – Conventional Resources – Non-conventional Resources – Problems Associated with Management of Water Resources – Management of Water Resources – Problems Associated with Management of Forest Resources – Management of Forest Resources – Problems Associated with Management of Energy Resources – Management of Energy Resources – Resource Utilization and Sustainable Development – Review Questions

Natural Resources:

Meaning, Definition and Classification:

Materials, which are available in the nature under different environmental conditions, are termed as natural resources. Some of these materials are easily available but some are not. As an example air, water, sun-rays are easily available in the nature but at the same time resources like coal, petroleum, minerals are rarely found. All these material which is provided by the nature that can be used for betterment of human being, is known as natural resources. Proper utilization of these natural resources is possible on the availability of suitable technology. Thus land, water, minerals and forest man can transform into more valuable goods and can utilize to promote human welfare, is termed as natural resource.

An endowment is the nature's gift to mankind. According to Zimmerman resour means anything in this environment which has utility. Human beings knowledge, sk and technology help to transform the endowment (nature's gift to mankind) into natur resources.

According to Erich W. Zimmerman 'A resource is not just a thing or substance but th function that the thing or substance perform in order to satisfy human needs and wants That is to say, a thing becomes 'resource by its function in relation to man.' A lump coal is a type of resource neither because of its colour, shape and composition nor for it scarcity but because of its function for satisfying human wants.

Endowment, Potentiality, Resource:

The sum total of all substances, mass or, material possessed by nature is called a Natural Endowment or, Natural stock. When man comes to know its uses, it firs becomes potentiality. When these potentialities are brought in use, they becom resources. Endowment, potentiality and resource are the three phases of resourc development.

Classification and Types:

Resource can be classified in two ways: Natural Resource, and Human Resource:

(1) **Natural Resource:** Materials or substances occurring in nature freely and which ca be exploited for overall development of a region are known as natural resource There is huge variety of natural resources and it can be classified on the basis of th following parameters. Fig. 2.1 shows Schematic Classifications of Resources.

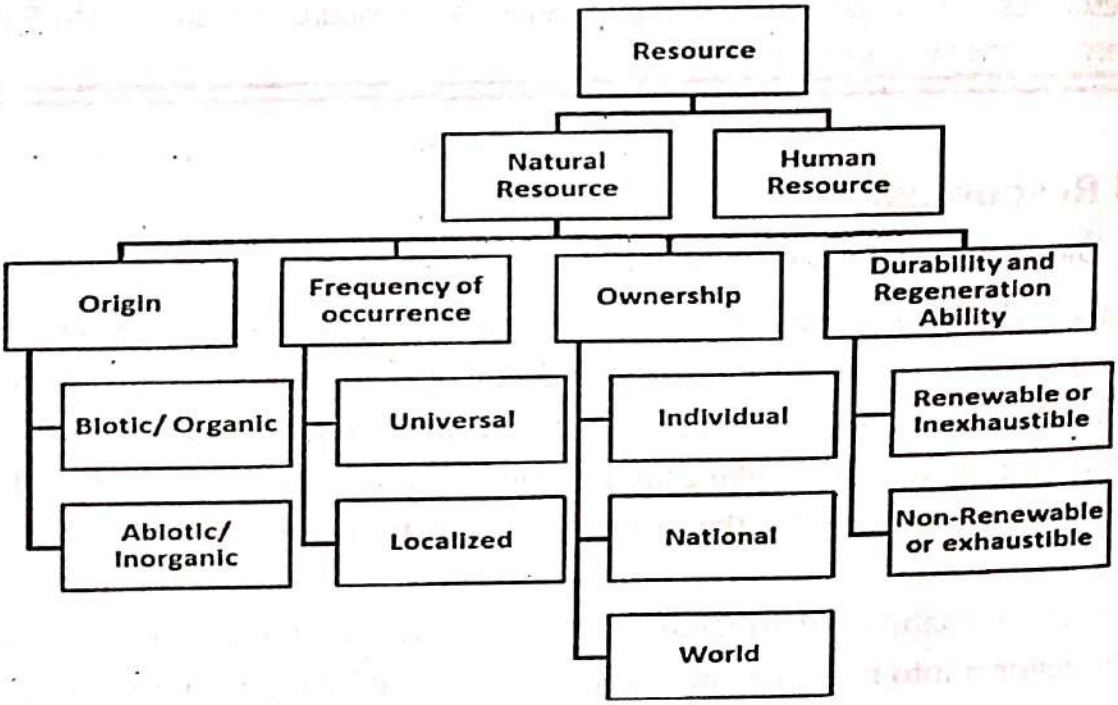

Fig. 2.1 Schematic Classifications of Resources

(A) On the Basis of the Origin:

(i) **Biotic Resources:** Biotic or natural resources are obtained from the biosphere either in raw form or through cultivation e.g. Forest, Animals, Birds, Agricultural crops etc.

(ii) **Abiotic Resources:** These resources are composed of non-living things e.g. Air, water, land, minerals, salt, sand, gravel etc.

(B) On the Basis of Frequency of Occurrence:

(i) **Universal Resources:** The resources, which are available everywhere in the world, are known as universal resources e.g. Air, Water, and Sunrays etc.

(ii) **Localized Resources:** The resources, which are available in limited places in the world, are known as localized resources e.g. Coal, Petroleum, and Natural Gas etc.

(C) On the Basis of the Ownership:

(i) **Individual or Personal Resource:** Individual or personal resources refer resources which are in one's material possession like own home land, agricultural land etc. This also includes individual's personal qualities such as knowledge, skill, etc.

(ii) **National Resources:** National resources are the sum total of all the personal resources owned by the citizens of a particular country and the government of the country e.g. forest, rivers, country's mineral deposits, etc.

(iii) **World Resources:** All material and non-material things of the world which leads to human welfare are known as world resources e.g. oceans, air etc.

(D) On the Basis of Durability and Regeneration Ability:

(i) **Renewable Resources or Inexhaustible Resources:** Renewable resources are natural resources that can be recycled or can be replenished quickly through natural cycle. These include soil, forest, air, water, wild life etc. Renewable resources are also known as flow resources.

Some of the renewable resources can automatically renew, through various bio-geo-chemical process like water, air, solar energy etc. These resources are known as Automatically Renewable Resource.

However for some resources are renewable only through human efforts like, forest, soil etc. These resources are known as Renewable with Human Efforts.

(ii) **Non-Renewable or Exhaustible Resource:** Natural resources which have finite volume and cannot be replenished or are replenished very slowly are known as Non-renewable resource. Once they have been used they cannot be easily replaced. Non-renewable resources are also known as fund resource. These include coal, mineral oil, natural gas etc.

Some of the non-renewable resources can be recycled after usage, e.g. metals (aluminium, copper etc.) These resources are known as Non-renewable- Recyclable Resource.

Some of the non-renewable resources cannot be reproduced and neither can be recycled. These resources are known as Non-Renewable-Non-Recyclable Resources. For example: coal, mineral oil, natural gas etc.

(2) **Human Resource:** Human resources can be explained in two ways, first by study of the actual quantity of the population and then the qualitative study of the same population. A quantitative study means the total population, distribution, age group, sex structure, and actual percentage of working population. A qualitative assessment would include human beings education, knowledge, skill, personality, intelligence and ethical values, all of which can determine the economic development of a country. Population becomes a resource for the economic development of a region or country only when it has some qualities like intelligence, technical skill, good health, education etc.

Difference between Renewable and Non-Renewable Resources:

Renewable Resources	Non-Renewable Resources
(1) Renewable resources are those resources, which can be renewed, replenished by nature in a short span of time.	Non-renewable resources are those natural resources, which cannot be renewed once they are completely exhausted.
(2) Renewable energy resources are clean forms of energy. These resources are available continuously like solar, wind, water etc.	Non-renewable energy resources are polluting and causes major damages to the environment. These resource are like coal, mineral oil etc.
(3) Renewable resources are infinite quantity in the earth surface.	Non-renewable resources are limited in quantity in the earth surface.
(4) These are the free gifts of nature.	These are not the free gifts of nature.
(5) Renewable resources are also known as in- exhaustible or flow resources.	Non-renewable resources are also known as exhaustible or fund resources.

6) Renewable resources do not cause any pollution.	Non-renewable resources cause pollution when used.
7) They are replaced by nature in short period of time.	They can't be replaced by nature.
8) Example of renewable resources are wind, sunlight, biomass water etc.	Examples of non-renewable resources are coal, mineral oil, natural gas etc.

Factors Influencing Resource Utilization:

Availability of Natural resources plays an important role for the development of a country. The pattern of utilization of natural resources directly influences the development of a country. But the natural resources are not evenly distributed in the world. Some continents are very rich in minerals while some are not. The availability of natural resource depends on geographical factors like terrain, climate, rock structure etc.

Factors:

The extraction and utilization of the natural resources depends on the following factors.

(a) **Cost Benefit Ratio:** Cost benefit ratio is related to production cost. If natural resources are available inside dense forest or snow covered areas or in mountainous belt, then extraction of natural resources becomes very difficult due to high cost. For example, Siberian belt is having high potential of extracting minerals resources but these resources are still not explored due to high cost to benefit ratio.

(b) **Availability of Capital:** Extraction, transportation and processing of natural resources require huge capital. Improved technology is required for exploitation of natural resources in proper way. To avail improved technology, we need to spend lots of capital. Due to lack of capital, less developed countries are unable to estimate and extract the natural resource available in their country.

(c) **Availability of skilled and unskilled labour:** The development of many resources depends upon the availability of skilled and unskilled labour. Skilled labour helps to locate as well as extract the natural resources with their knowledge and skill. For transportation and processing of resources, we require unskilled labour also. In Bihar, Jharkhand mining is carried out heavily as skilled and unskilled labour are available in plenty.

(d) **Transportation facilities:** Better transportation facilities plays an important role towards the proper exploitation of natural resources. Transportation facilities are needed to reach the areas of demand at the earliest.

(e) **Market and distribution of population:** Availability and access to market plays a important role for any marketable object and resource is no different as resource too are produced for consumption. If population density is low in certain area the extraction rate of natural resources in those areas are comparatively low.

(f) **Political Factors:** Political factors and national interests become hindrance for extraction and usage of natural recourses. For example Cauvery water sharing dispute between Karnataka and Tamil Nadu and in Jharkhand dominance of tribal population acts as hindrance to extraction of minerals.

Resource Conservation: Meaning and Methods:

Meaning:

The term 'conservation' is derived from two Latin words, 'con' meaning 'together' and 'servare' meaning to 'keep or guard'. Conservation means 'to keep together'. The conservation of natural resource is a concept that deals with the rational utilization of resources, so that synchronization between resource requirement and resource availability can be maintained.

Some important definitions of resource conservation are follows:

- *"Resource conservation is the scheduling of resource use so as to provide the greatest yield for the greatest number over the longest time period."*

– P. Haggett

- *"The optimum allocation of natural, human and cultural resources in the scheme of national development, whereby maximum economic and social security will be assured."*

– Harold. M. Rose

- *"The wise use of our natural environment, the prevention of waste and despoilment while preserving, improving and renewing the quality and usefulness of all our resources."*

– John. F. Kennedy, Special message to the Congress in 1962

In simple words conservation is the proper management of natural resources to prevent its exploitation, destruction or degradation.

Consumption of natural resources is increasing rapidly due to continuous growth of population and industrialization. This situation resulted in deterioration and depletion of cultivable lands, energy crisis, destruction of forests etc. Hence if resources are not managed properly then there will be a scarcity of resources. Therefore, we need to conserve natural resources.

Methods:

The following are some of the methods of conservation of natural resources.

(a) **Judicial Utilization of Resources:** The first and foremost need of the hour is to utilize natural resources judiciously, be it abundant or scarce in amount. Thinking about our future generation, we need to set aside some or improvise current practices that protects non-renewable resources.

(b) **Substitution:** It is well known fact that non-renewable resources (Coal, mineral oil etc.) are limited in nature. So people should use these sources very judicially for all sectors like industry, agriculture and household. Hence it is necessary to substitute their use by renewable (air, water, sunrays etc.) resources. For example we should utilize solar power, hydro-electric power, and wind power as a substitute of thermal power. Copper sheets can be substituted by aluminium as copper is relatively rare.

(c) **Recycling:** Recycling is one of the most promising and widely practiced methods by many countries to conserve resources. Rather than completely discard materials it can be reprocessed or recycled. This method can be useful for products resulting from living resources, like reuse of wood, paper etc.

(d) **Technological Innovation and Research:** Technological development will help to conserve the natural resources more economical way. Fuel and mineral resources can be easily handled transported and processed with the improved technology. For that continuous research is require. Developed countries spend lots of capital in research to get the solution of alternative use of resource.

(e) **Minimization of Waste:** More exploitation of natural resources creates more amount of waste during the process of production. If greater attention is paid to waste reduction it will automatically ensure lesser exploitation of resources. Waste minimization can be achieved by appropriate redesigning of industrial processes. Sugar industry can utilize their waste by supplying it to paper industry.

(f) **Enforcement of Laws:** Strict enforcement of laws will help to reduce random disposal of industrial waste, unrestricted mining, lumbering, dredging etc.

(g) **Create awareness among masses:** Undoubtedly, awareness among mass regarding pollution and non-renewable resources has increased. Still there are huge populations who are still not aware about the availability of conventional and non-conventional resources. Therefore, they need to get educated about the importance of conservation of resources through seminar, presentation, advertisement etc.

(h) **Government policy of conservation:** To formulate the policy of conservation related to renewable and non-renewable sources of energy, it is necessary to make

assessment of future needs. Future needs can be assessed with projection o population growth, industrial development etc.

(i) **Role of Individual:** Natural resources like air, water, soil, minerals, forest etc. are very important for the development of any country. However, excess use of these resources causing their depletion as well as other problems. To overcome this every individual can play an important role. Following are some tips, which should be initiated by human being.

- For cooking, heating drying should use solar power.
- Turn off the light when you leave the room.
- Choose recycled products.
- Use public vehicle instead of private vehicle.
- Farmers should use drip irrigation and sprinkler irrigation.
- Don't waste water.
- Plant more trees.
- Reduce the use of pesticides, chemical fertilizer.
- Use green manures in garden.
- Stop illegal cutting of trees.
- Practice mixed farming so that some specific soil nutrients will not go depleted.

Conventional Resources:

Energy, that has been used from ancient times is known as conventional energy. Coal, natural gas, oil, and firewood are examples of conventional energy sources.

(A) Coal:

Coal is one of the major conventional energy sources. It was the prime source of energy till the discovery of petroleum. Coal constitutes carbon (60% to 90%), hydrogen (1% to 12%), oxygen (2% to 20%) nitrogen (1% to 3%) and also small amount of phosphorous and sulphur. There are four grades of coal deposit in the world:

(i) **Anthracite:** Carbon content is very high approximately 95%. It burns for a long time and produce lots of heat.

(ii) **Bituminous:** A hard black compact coal. Carbon content varies from 40% – 80%. Mainly used in domestic or household purpose, iron and steel industry etc.

(iii) **Lignite:** A brown and comparatively soft coal. Moisture content is approximately 35%. It breaks easily. It produces less heat and more smoke.

(iv) Peat: This is the first stage of coal formation. Moisture content is very high. It produces lots of smoke and negligible heat.

Most of the coal fields are in the world's temperate zone. World's 3/4th coal reserves are located in the former USSR, USA and Australia. China is the leading producer of coal followed by USA, Australia, India and CIS countries. Germany, UK, Poland France Belgium are the leading producer of coal in Europe. According to World Energy Report (2015) China produced maximum coal (3747 Million tonnes) followed by China (813 million tonnes) and Australia (485 million tonnes). The coal reserves are found in India in the states of Jharkhand, Odisha, Madhya Pradesh, Andhra Pradesh, West-Bengal etc. The following Table 2.1 show the state wise coal reserves in India.

Table 2.1

Coal Reserves in India Estimated by GSI

Name of the State	Reserves in Million Tones	% of Total Reserves
Jharkhand	83152	26.06
Odisha	79295	24.86
Chhattisgarh	57206	17.93
West Bengal	31667	9.93
Madhya Pradesh	27987	8.77
Telangana	21702	6.80
Maharashtra	12299	3.86
Andhra Pradesh	1581	0.50
Others	4131	1.29

Source: GSI, https://coal.gov.in/en/major-statistics/coal-reserves

(B) Petroleum:

Petroleum is the life line of the global economy. It is convenient fuel for automobile engines, industrial boilers, furnaces and house hold purposes. There are around 40,000 oil reserves fields discovered in the world but out of that only 10% have significant impact on the world's oil production. World's largest oil fields are located in the Arabian-Iranian basins in the Persian Gulf region. Saudi Arabia alone possesses around 25% of the total global reserves followed by Kuwait, Iraq, and Iran. Some of the important oil fields in India are Digboi (Assam), Gujarat Plains and Bombay High, Deltaic coast of Godavari, Krishna, Kaveri, etc. Fig. 2.2 shows year wise crude oil and natural gas production in India.

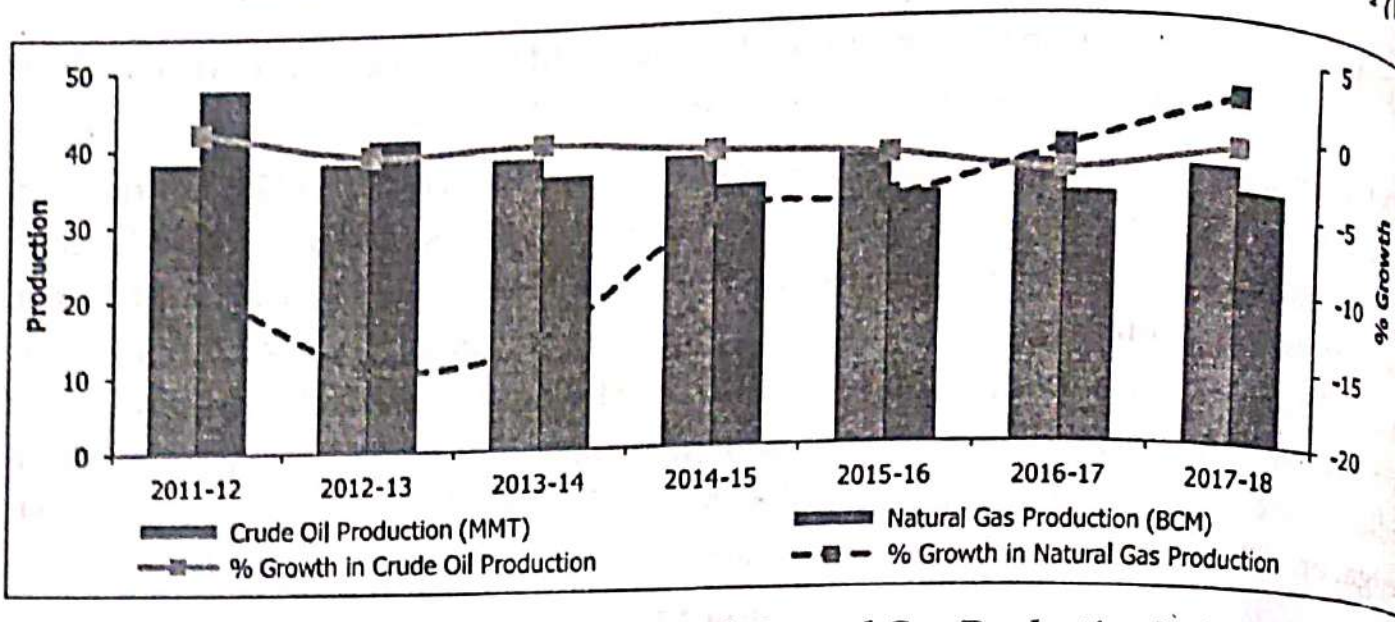

Fig. 2.2 Year Wise Crude Oil and Natural Gas Production India

Source: Indian Petroleum and Natural Gas Statistics, Govt. of India

http://petroleum.nic.in/sites/default/files/ipngstat_0.pdf

(C) Natural Gas:

Natural gas caught the attention of the world only recently. It is a gaseous fossil fuel. It can be found in the oil fields with crude oil or separately in natural gas reserves. Natural gas is formed by the decomposition of dead organic matter, buried in the interiors of the earth and is recovered by processes of compression and cooling. Natural gas contributes 23% of global commercial energy use. World's largest gas fields occur in former USSR, followed by Middle East countries. According to World Energy Report (2019) USA is the leading producer of Natural gas (914.6 Billion cubic meters) followed by Russia (638.5 Billion cubic meters), Iran (250.8 Billion cubic meters) China (194 billion cubic meters) and Qatar (171.3 Billion cubic meters). The following Table 2.2 shows Year Wise and Sector wise Demand of Natural Gas in India.

Table 2.2

Year Wise and Sector Wise Demand of Natural Gas in India (MMSMCD)

Sector	2015-16	2016-17	2017-18	2018-19
Power	189	207	225	243
Fertilizer	113	113	113	113
City Gas	39	46	47	50
Industrial	25	27	28	32
Petrochemicals / Refineries / Internal Consumption	72	72	72	76
Sponge Iron / Steel	8	8	9	9
Total Demand	446	473	494	523

Source: Annual Report, 2015-16 Ministry of Petroleum and Natural Gas, Govt. of India

In India, Assam, Gujarat, Andhra Pradesh, Rajasthan, Tamil Nadu are some of the states where natural gas reserves are present. Some new gas fields have been found in Tripura, Jaisalmer, Off Shore of Mumbai and Krishna Godavari Delta. The following fig. 2.3 shows Major Oil Refineries in India.

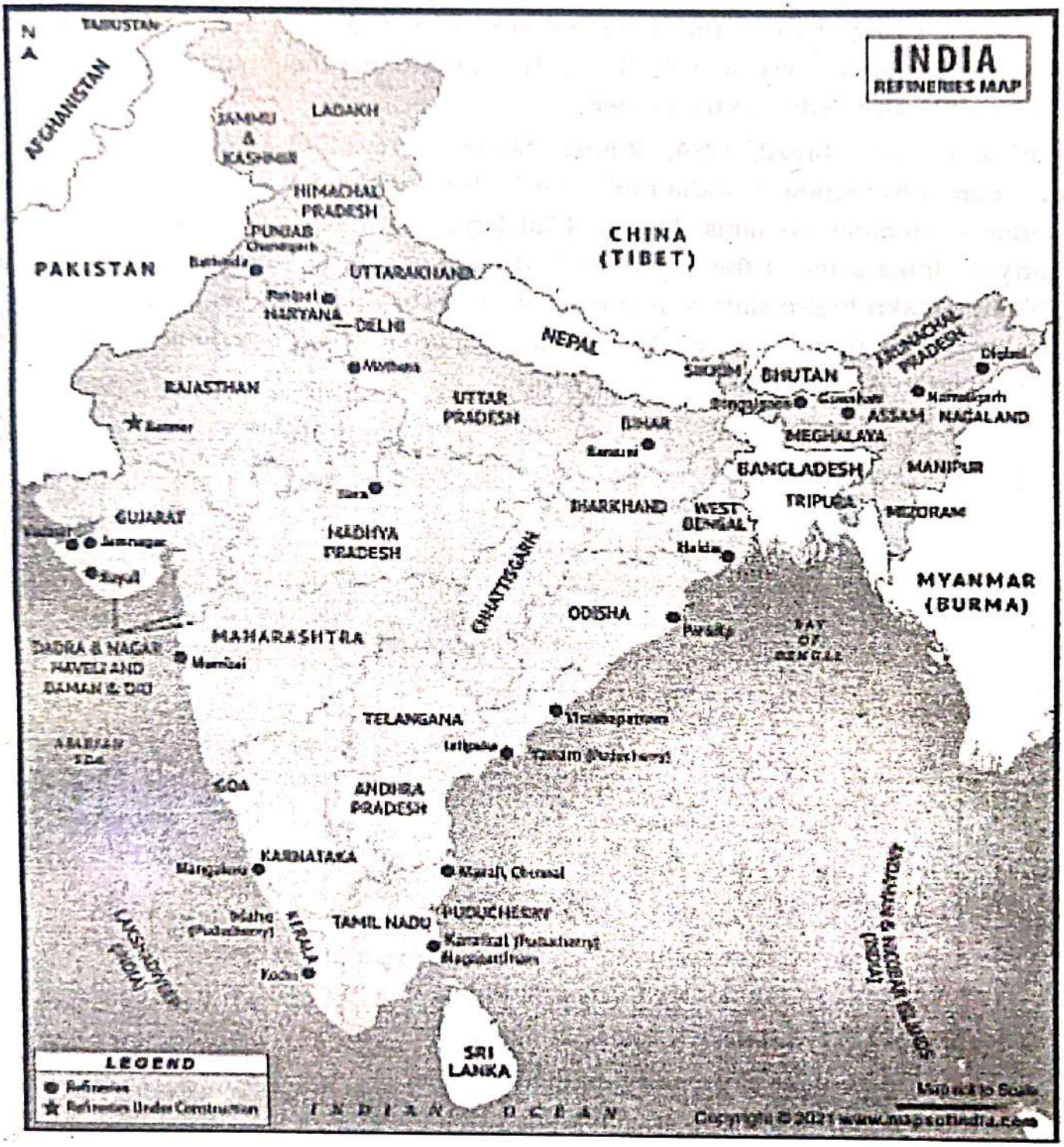

Fig. 2.3 Major Oil Refineries in India

Source: https://www.mapsofindia.com/maps/oilandgasmaps/refineries.htm

(D) Hydroelectric Energy:

Hydroelectric energy or water energy is the most important conventional energy resources. It is obtained from water falling from height. Hydroelectric power is produced, when the water of river is collected in a huge reservoir by putting a dam across the flowing stream. The dams are constructed at such a strategic point from where, water can fall very sharply (Fig. 2.4). This situation helps to move turbine, as a results it generates hydroelectric power.

China, Canada, Brazil, USA, Russia, Norway are the leading countries in the production of hydropower. India ranks third after China, USA and Russia in the world in terms of number of dams. Nearly 4720 large dams have been completed in the country. In India some of the important hydropower station which generate electricity are Nathpa Jhakri hydro station in Himachal Pradesh, Tehri dam on Bhagirathi river in Uttarakhand, Hirakund dam on Mahanadi river in Odisha, Nagarjuna Sagar dam on Krishna river in Andhra Pradesh etc.

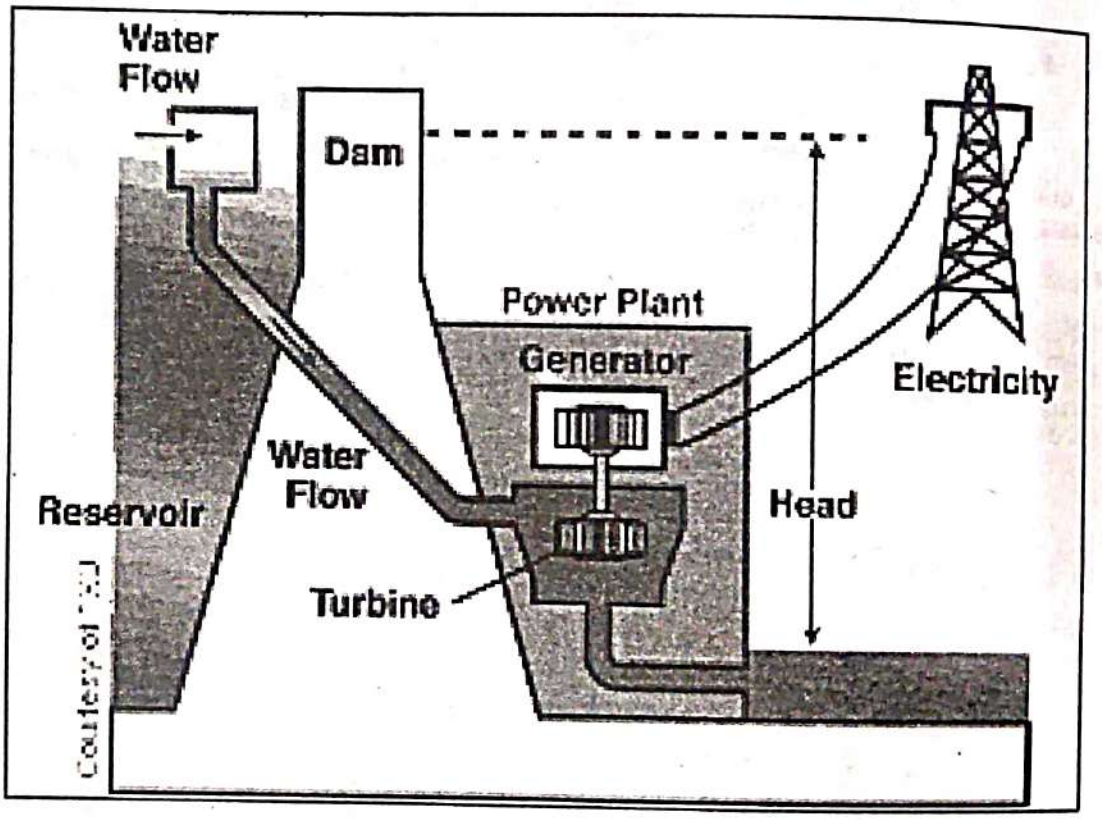

Fig. 2.4 Hydroelectric Power Generation

Advantages of Hydroelectric Energy:

(i) Hydropower is a clean non-polluting energy.

(ii) It emits very low level of greenhouse gases as compared to fossil fuel.

(iii) Hydropower has a low operating cost.

(iv) Power can be generated on demand.

Disadvantages of Hydroelectric Power:

(i) Generation of hydroelectric power is having negative impact on ecosystem. Construction of dams are require huge area as a result, we may lose forest and some species of plants and animals.

(ii) Construction of dam can causes the changes of flow of river or can cause a river channel to dry.

(iii) Construction of dam for generating electricity can cause the displacement of local people or villagers.

(E) Nuclear Energy:

Energy produced by involving the nuclei of atoms is known as nuclear energy. The first commercial nuclear power stations started operation in the 1950s. There are over 440 commercial nuclear power reactors operable in 31 countries, with over 390,000 MWe of total capacity. About 60 more reactors are under construction. There are two methods of producing nuclear energy. (I) **Fission:** It happens through splitting of nucleus and (II) **Fusion:** It happens through joining of two nuclei (Fig. 2.5)

France gets around three-quarters of its power from nuclear energy, while Belgium, Czech Republic, Finland, Hungary, Slovakia, Sweden, Switzerland, Slovenia and Ukraine get one-third or more. South Korea and Bulgaria normally get more than 30% of their power from nuclear energy, while in the USA, UK, Spain, Romania and Russia almost one-fifth is from nuclear. In India some of the important nuclear power reactors and power plants are Tarapur (Thane, Maharashtra), Kakrapar (Near Surat, Gujrat), Kaiga (Karnataka) Narora (Uttar Pradesh), Kalpakkam (Tamil Nadu), Rawatbhata (Rajasthan).

Advantages of Nuclear Power:

(i) Less emission of greenhouse gases.

(ii) With small quantity of raw material, can produced lots of energy.

(iii) Low operating cost.

Disadvantages of Nuclear Power:

(i) High installation cost.

(ii) High risk (Nuclear accidents).

(iii) Problems in the disposal of radioactive waste generated during nuclear energy production.

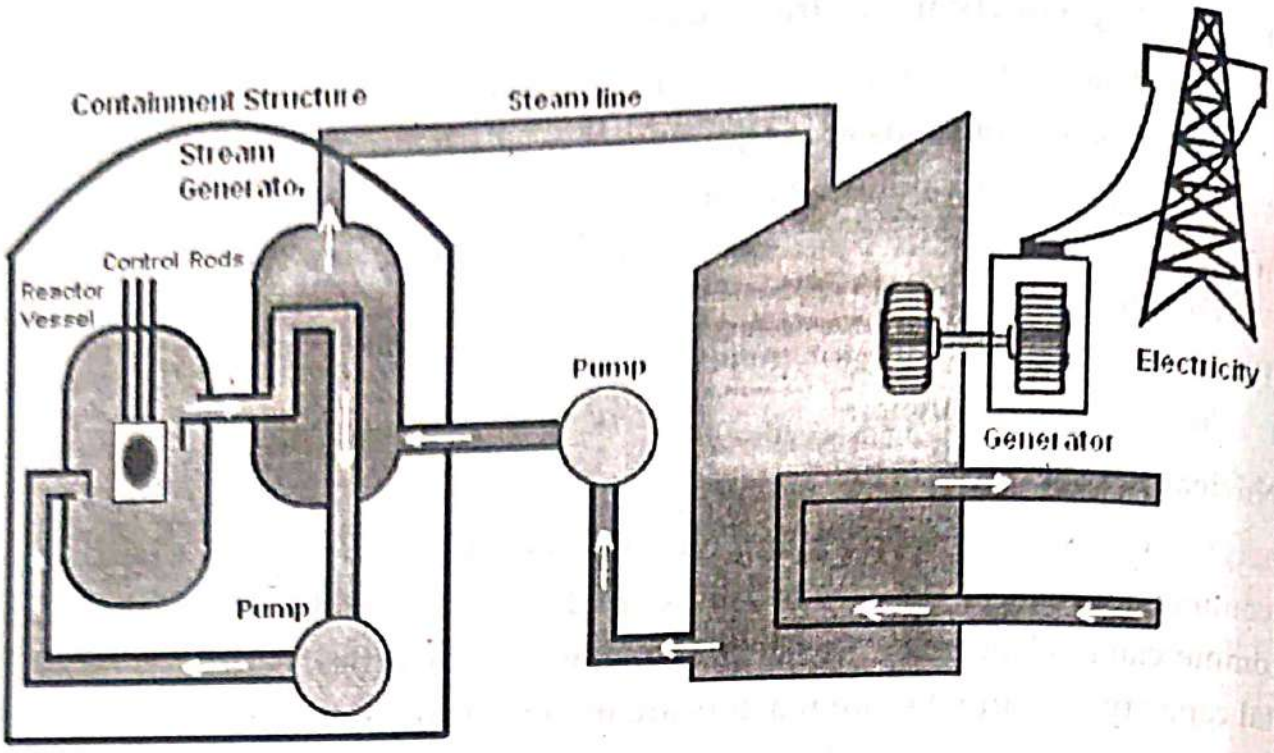

Fig: 2.5 Nuclear Power Generation

All forms of conventional energy sources like wood, coal, oil, have negative environmental effects. While mining of coal causes destruction of land and ecology, burning of coal produces greenhouse gases, and acid rain. Burning of petroleum also produces carbon-di-oxide, which is the major source of greenhouse gases. In case of natural gas, exploration, production, processing, storage, distribution and transportation are an integral part of the gas industry, and every operation can lead to a certain degree of environmental degradation. The energy crisis and associated environmental problems have forced us to think about alternate sources of energy.

Non-conventional Resources:

It is globally accepted that fossil fuels are exhaustible and nuclear fission depends on what is believed to be fairly limited supply of suitable elements. Therefore ultimate solution of the world energy crisis will be the alternate sources which are non-conventional, non-polluting, and practically inexhaustible in nature. These energy sources of the world are derived from a number of forces like sun rays, gravitational forces of the earth, rotation of the earth, heat within the earth, gravitational forces of moon and sun etc.

Some of the important non-conventional sources of energy are as follows:

(A) Solar Energy:

The earth's most important universal and potent energy source is sun. Solar energy has been reaching to the Earth in the form of solar radiation. This energy then gets

ansformed in to other forms of energy. Electricity from solar energy can be obtained in wo ways:

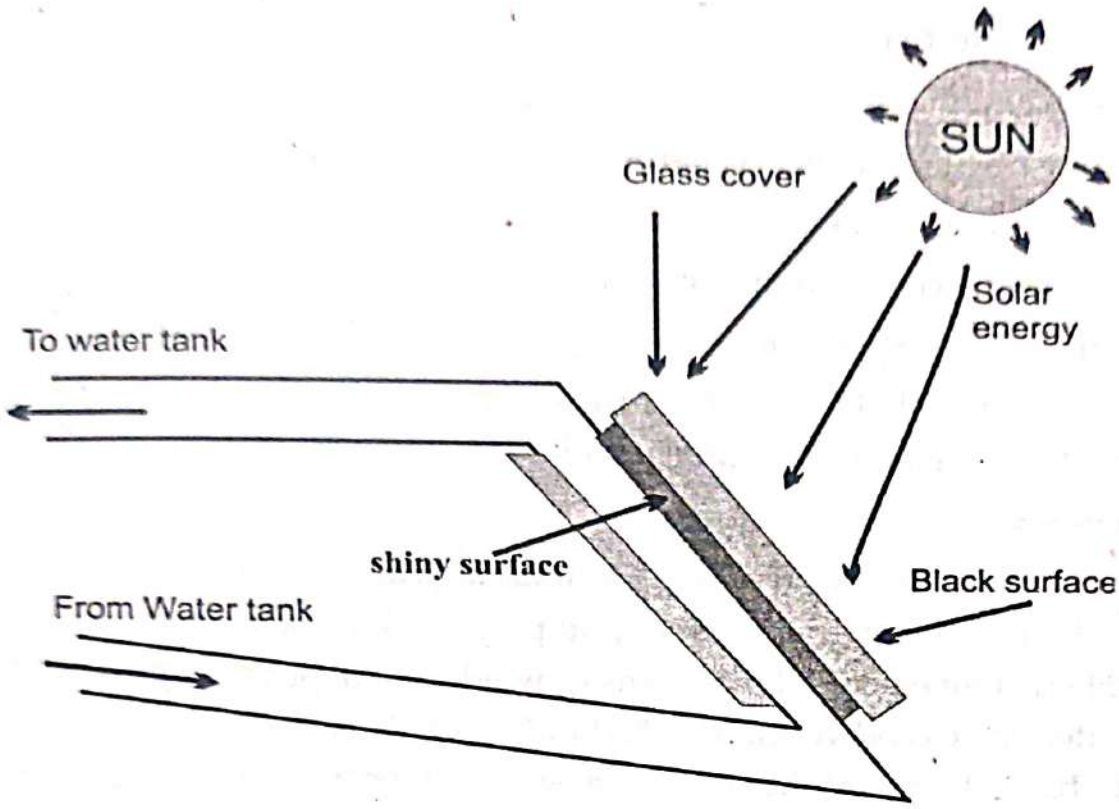

Fig. 2.6 Solar Water Heating System

(i) **Photovoltaic or Solar cells:** This technology converts the solar energy into electrical power. The application of solar cells includes- calculators, wristwatches, solar street lamps, solar lanterns, solar power driven water pumps, solar geyser, domestic electricity supply etc.

(ii) **Solar Thermal/Electric power plant:** In this system, energy is recovered from the heat of the solar radiation. It can be used both for the power generation and for heating and cooling applications. This technique is mainly applied in solar power-driven satellites orbiting the Earth, navigating facilities, satellite TV, weather forecasting etc. Fig. 2.6 show solar water heating system. Solar power is developing rapidly in India. As of 31st May 2016, the cumulative installed grid connected solar power capacity was 7,568 MW and the proposed target is 100,000 MW by 2022. Some of the potential states in India for generating solar power are Gujarat, Rajasthan, Madhya Pradesh, Maharashtra, and Tamil Nadu.

Advantages:

(i) Solar energy is free and requires no fuel.

(ii) Doesn't produce waste.

(iii) No emission of GHGs or other pollutants.

(iv) Convenient for low power usage such as solar energy driven garden lights an battery charges.

(v) It is cost effective in long run.

Disadvantages:

(i) During night solar energy, harnessing is not possible.

(ii) A large surface area is required to collect the energy at practical rate.

(iii) Initial set up cost is comparatively high.

(iv) Solar cells are expensive.

(v) Amount of sunlight-reaching earth's surface varies with location, time of a da time of year and other weather conditions.

(B) Wind Energy:

People have been using wind power for thousands of years. They have been utilizin wind to sail ships, to grind grains, water pumping etc. it is the kinetic energy associate with atmospheric movement. The patterns of wind flow depend on physical features o the Earth, water bodies and vegetation. Natural winds cause the turbines to rotate whic produce mechanical energy. Then that mechanical energy is turned into electrica energy. Modern wind turbines are of two types: The vertical axis design (VAWTs) an Horizontal Axis (HAWTs). Total cumulative installed capacity from wind powe amounted to 837 Gigawatts, in 2021. China is the leading installed wind power capacit in the world, followed by USA, Germany, India and Spain. Fig 2.7 shows Globa Cumulative Installed Wind Power Capacity 2001 to 2021.

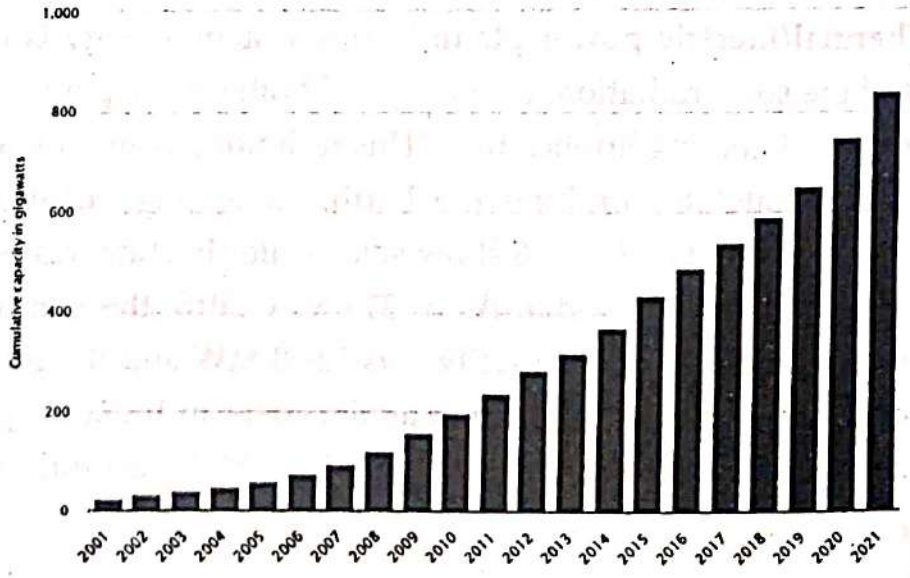

Fig. 2.7 Global Cumulative Installed Wind Power Capacity (GW), 2001 to 2021

Source: https://www.statista.com/statistics/268363/installed-wind-power-capacity-worldwide/

The Indian potential for harnessing wind energy is not as great as the size of the country would lead us to imagine. However, India is having a large coastal area as well as inland areas where wind energy can be fully exploited. Fig. 2.8 shows growing number of wind energy installations in states across India.

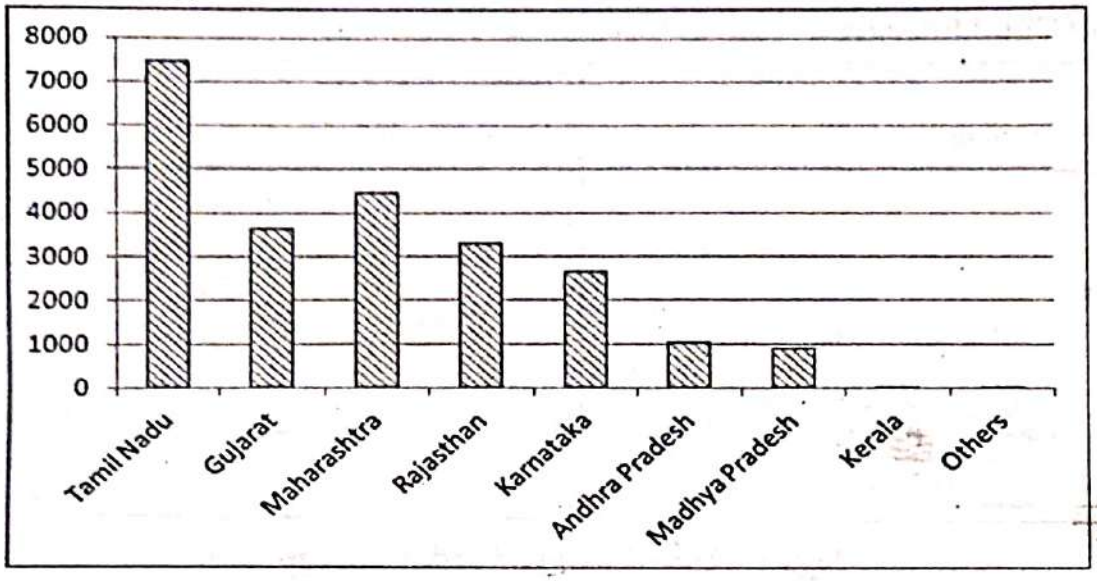

Fig. 2.8 Number of Wind Energy Installation, in States, India (as of March, 31.03.2020)

Source: http://www.inwea.org/wind-energy-in-india/wind-power-installation/

Advantages:

(i) Wind as a source of energy is clean.

(ii) It does not produce waste.

(iii) Wind farms can attract tourist.

(iv) Suitable method to supply energy in rural areas.

Disadvantages:

(i) Wind is unpredictable, as some days in a year may not be windy.

(ii) It requires huge open space.

(iii) Winds must have a speed above 12 to 14 miles per hour to turn turbines to generate electricity effectively.

(iv) It creates lots of noise.

(v) It can affect television reception.

(C) Tidal Energy:

History says the people have used tidal energy since 11th century. It's a type of oceanic energy. Tides are created due to gravitational pull of moon and sun on seawater. High tide and low tide refers to the rise and fall of water in the oceans. The difference of certain meters between high tide and low tide is required to spin the turbine. Tidal

energy can be generated by constructing barrage. During the high tide sea water enters into the reservoir of the barrage and turns the turbine and produces electricity. Whereas during low tide when the sea level is low then the sea water stored in a barrage reservoir flows out into the sea and again turn turbines and produce energy. Fig. 2.9 shows harnessing of Tidal Energy.

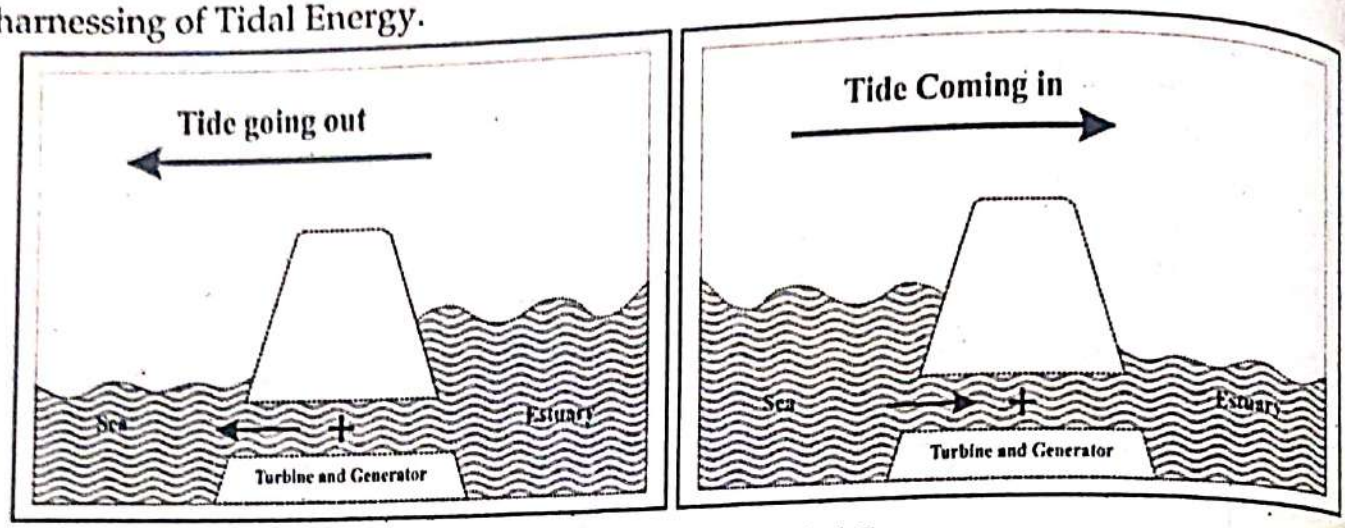

Fig. 2.9 Harnessing of Tidal Energy

There are few sites in France, Canada, South Korea, and U.K. where tidal energy is being harnessed. India with its vast coastline, bay estuaries, has enough potential to harness tidal energy. In India mainly Gulf of Cambay, Kutch, Gangetic delta of Sundarbans harness tidal energy.

Advantages:

(i) Maintenance cost is cheap.

(ii) Off shore turbines have minimal side effect.

(iii) No production of waste and other pollutants.

Disadvantages:

(i) Initial setup (construction of barrage) cost is high.

(ii) Few suitable sites are available for tidal barrage.

(iii) Tidal power station can generate power for few hours of a day, only when the tide is flowing.

(D) Biomass Energy:

Biomass is the organic matter produced by plants and animals, which includes wood, grass clippings, cattle dung, agricultural waste, sewage etc. Energy plantation, petro-crops, agricultural and urban waste biomass are some types of biomass energy. Biomass can be easily transformed into other forms of usable energy like methane or fuel like ethanol, biodiesel etc.

The current availability of biomass in India is estimated at about 500 million metric tons per year. It is estimated that surplus biomass availability at about 120 – 150 million metric tons per annum covering agricultural and forestry residues correspond to a potential of about 18,000 MW. This apart, about 7000 MW additional power could be generated through cogeneration in the country's 550 Sugar mills.

Advantages:

(i) Utilization of waste material is good for environment.

(ii) The source of fuel is cheap.

Disadvantages:

(i) Emission of greenhouse gases.

(ii) Collecting sufficient quantity of source is difficult.

(E) Biogas:

Biogas is a non-polluting, clean and low cost fuel, which is very useful for rural areas in India, due to availability of animal and agricultural waste. Biogas is mixture of methane and hydrogen, which is the result of bacterial decomposition. Biogas is produced by anaerobic degradation (breakdown of organic matter by bacteria) of animal waste in the presence of water. In India mainly two types biogas plants are available **(i)** Floating gas holder and **(ii)** Fixed gas holder. Figure 2.10 and fig. 2.11 shows Fixed and Floating Biogas Holder

Nearly 4.30 million biogas units of domestic scale have been installed in India by 2012. The states like Punjab, Andhra Pradesh, Maharashtra, and West Bengal are the leading producer of biogas.

Advantages:

(i) Non-polluting and low cost fuel.

(ii) There is no storage problem (Direct supply of gas from the plant).

(iii) The sludge left over is rich fertilizer.

(iv) Industry like sugar, paper and pulp, poultry generate a lot of waste and can meet their power demand by their own waste.

Disadvantages:

(i) It emits greenhouse gases.

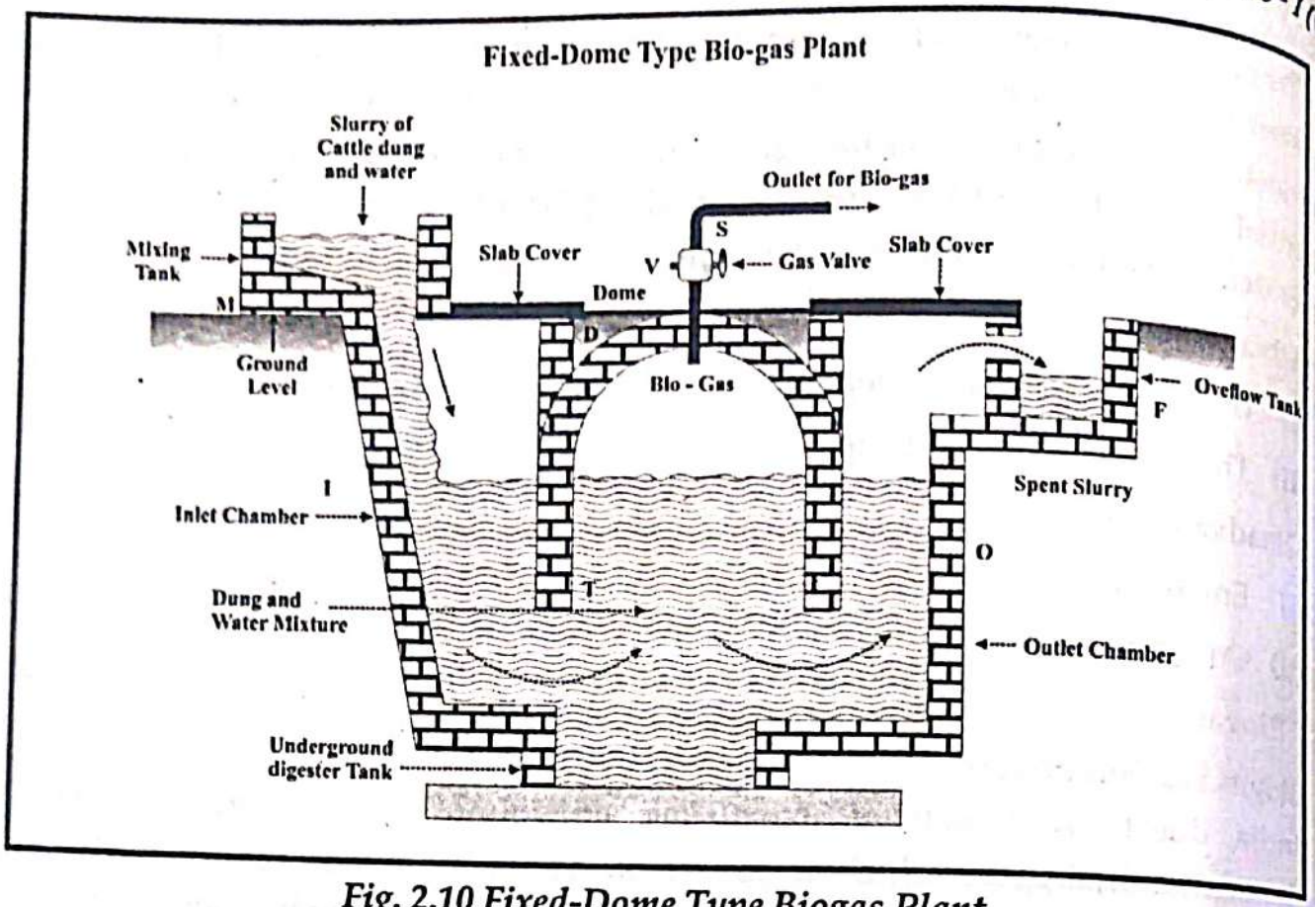

Fig. 2.10 Fixed-Dome Type Biogas Plant

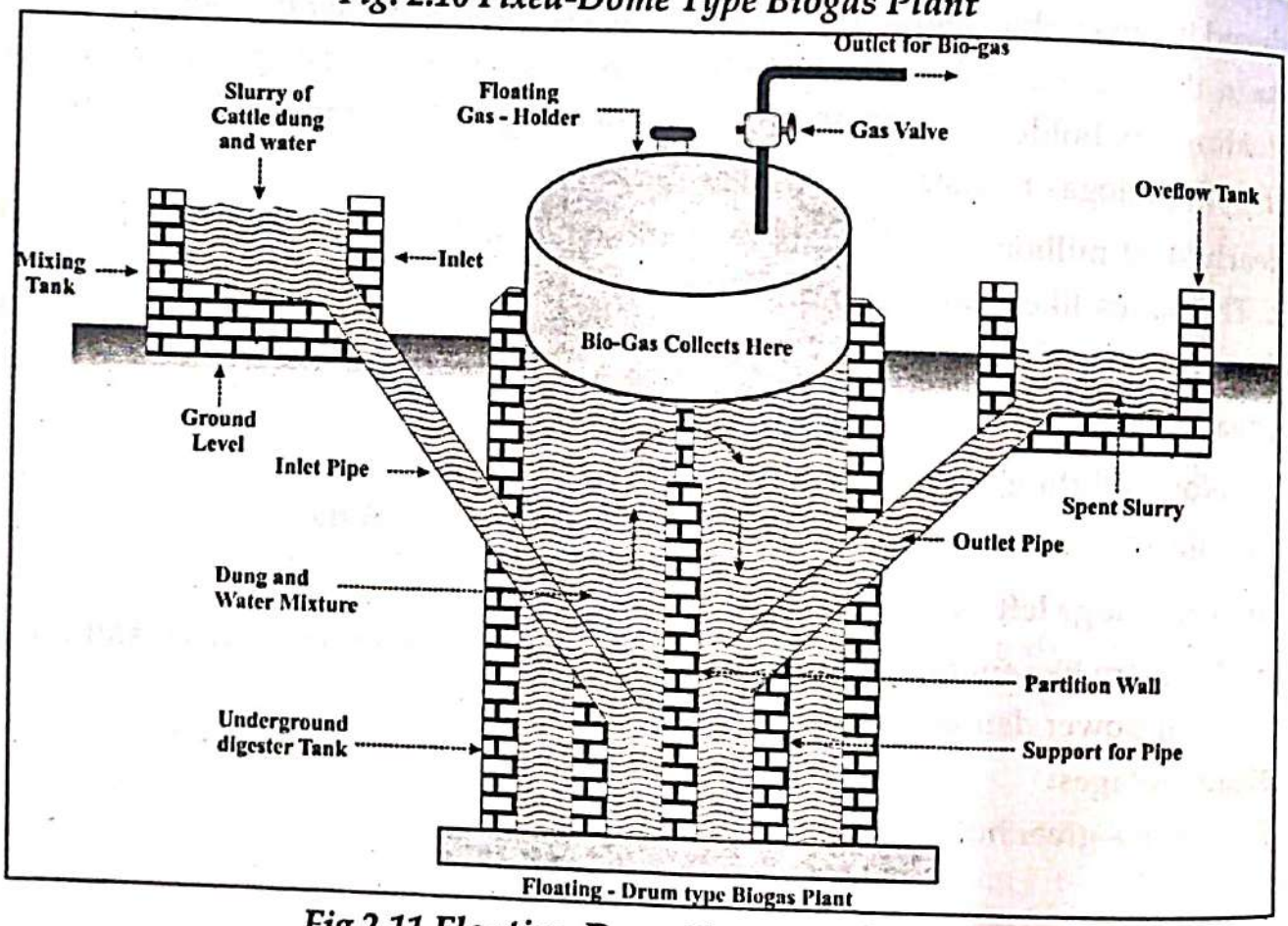

Fig 2.11 Floating-Drum Type Biogas Plant

(F) Geothermal Energy:

Geothermal energy is harnessed from the hot rock present inside the earth surface. This energy was prevalent since the existence of the earth. In some places naturally hot water comes out from the underground as a form of natural geysers. On the other side artificially we can drill a hole up to the hot rocks and by putting pipes hot water can be made to gush out, which will help to turn the turbine of a generator and can produce electricity.

Geothermal power plants worked in nearly 24 countries; some of the countries are U.S.A., Italy, New Zealand, Iceland, Philippines, Mexico, etc. In India the potential geothermal provinces can produce 10,600 MW of power. The prospective sites in India are (i) Puga Valley (J&K) (ii) Tatapani (Chhattisgarh) (iii) Manikaran (Himachal Pradesh) (iv) Bakreshwar (West Bengal) (v) Tuwa (Gujarat) (vi) Unai (Maharashtra) (vii) Jalgaon (Maharashtra).

Advantages:

(i) Impact on environment is negligible.

(ii) Extensive global distribution; it is accessible to both developed and developing countries.

Disadvantages:

(i) Difficult to find prospective sites.

(ii) Toxic gases and minerals may come out from under ground along with steam.

(G) Biofuel:

A biofuel is fuel that is produced through contemporary biological process. Crops like corn, cassava, sugarcane are used for production of ethanol. Ethanol can be used in vehicle. Biodiesel produced from used or unused vegetable oils and animal fats. The main source of biodiesel are plant species like Jatrophacurcas, Pongamiapinnata etc. In India West-Bengal, Chhattisgarh, Madhya Pradesh cultivate Jatropha for biodiesel production.

Advantages:

(i) Carbon neutral as compared to other fossil fuel.

(ii) No sulphur content, less amount of particulate matter.

Disadvantages:

(i) Large area required to grow crops for biofuels.

Problems Associated with Management of Water Resources:

Introduction:

Water is one of the most important natural resource. It plays an important role sculpting the earth's surface, moderating the climate and diluting the pollutants. Abo 71% of earth's surface is covered by water. Water is used for domestic purposes, ener production, as a source of waste disposal, agricultural production, salt makin navigation, etc. Adequate supply of water is essential for maintaining health a sanitary conditions. Water as a natural resource has influence on every aspect development. The distribution of water on the earth's surface is extremely uneven.

Table 2.3

Distribution of Water on Earth's Surface

Compartment	Percentage of total water
Total	100
Total Saline water	**(97.6)**
Ocean and saline lakes	97.6
Total Fresh water	**(2.4)**
Ice and snow	2.07
Ground water down to 1Km	0.28
Lakes and reservoirs	0.009
Saline lakes	0.007
Soil moisture	0.005
Living organisms	0.005
Atmosphere	0.001
Swamps and marshes	0.003
Rivers and Streams	0.0001

Source: Data from US geological Survey

From Table 2.3, it can be seen that about 97.6% by volume water is found in ocea and saline lakes and is not usable for drinking, irrigation and industry. 2.4% fresh wat mostly is locked up in glaciers or as ground water and only 0.1% of world's water is in form accessible to humans and to other organisms that rely on fresh water. The tot

amount of water on our planet evaporates from moist surfaces, falls as rain or snow, passes through living organism and returns to the ocean in a process known as hydrological cycle. Functioning of hydrological cycle replaces water in the environment and is made available for different activities. Water is renewable resource but with restriction of time.

Following are various problems associated water:

(a) **Improper water discharge management:** Many cities in the developing countries do not have the necessary infrastructure to collect and treat wastewater. In the absence of proper drainage systems, sewage mixes with stream water causing further pollution. It is estimated that up to 90% of all wastewater in developing countries is discharged without treatment directly into rivers, lakes or the oceans, causing major environmental and health risks (Corcoran et al., 2010).

(b) **Inadequate sewage treatment plants:** In the less developed countries of South America, Africa and Asia sewage treatment plants either totally are lacking or are not properly working. In urban areas 95% of all sewage is discharged untreated into rivers, lakes or oceans.

(c) **Lack of mechanism to monitor the water pollution:** There are different point sources of water pollution like factories, power plants, sewage treatment plant, underground coal mines and oil wells which discharge polluted water from specific locations such as drain pipes, or sewer outfall. Farm fields and feedlots, golf courses, lawn and gardens, construction sites logging areas, roads, streets and parking lots are identified as non -point sources of water pollution which are scattered or diffused, having no specific location where they discharge into a particular water body. The chief pollutants arising from various sources fall under the categories of nitrates, heavy metals, chlorinated compounds, arsenic, petrochemicals, fluorides, radioactive materials and pesticides. Many countries do not have mechanism to monitor the pollution of ground water; hence cannot assess the damage done to groundwater and surface water bodies. Water pollution affects human health and leads to waterborne diseases like Typhoid, Cholera Polio, Yellow fever, Malaria, Dysentery, etc.

(d) **Problems of water pricing policy:** Water is wasted due to government subsidies of water supply projects that create artificially low water prices and lack of subsidies for improving water efficiency. In India, the price for water in different sectors is fixed by the state governments and varies from state to state. Water rates for agriculture and domestic consumption do not cover even the working expenses of providing service.

(e) **Inefficiency in water resource management:** Water has conventionally been considered as a free commodity and government policies have provided very little incentive to encourage efficient use especially in developing countries. Excessive distribution losses of treated water in municipal water supply systems, inefficiency of supply also persists at supply end in the form of overstaffing, high administrative costs and time in the execution of projects. It thus highlights poor water resource usage practices.

(f) **Leakage of water:** During evaporation, leaks and other losses 65%to 70% water is lost as per the World Resource Institute. Irregular maintenance of water supply pipelines results in to water leakage problem. Lot of fresh water is wasted during the leakage. Leakage in water tank, in urban and rural areas, also wastes water.

(g) **Lack of access to potable water:** According to Water Organisation and World Health Organisation, 63 million people, 1 in 10 - lack access to safe water and globally 1/3rd of all schools lack access to safe water. According to UN estimates, by 2025, almost two-third of the world will face shortage of potable (fit for drinking) water. Some of the areas have a good volume of water but due to remoteness or runoff cannot supply water to agricultural lands and population centres where water is needed. For example South America has the runoff of River Amazon. Seasonal nature of rainfall with inadequate or lack of storage capacity also creates water shortage problem. In rural areas of developing countries, many women and children have to walk with heavy containers and cans for long distances each day to get water.

(h) **Growing demand of water with urbanisation and reduction in access to drinking water sources:** Global water demand is projected to increase by 55%, mainly due to growing demand from manufacturing, thermal electricity generation, and domestic use, all of which mainly result from growing urbanisation, industrialisation and increase in standard of living in developing countries. Between 1990 and 2012, in urban areas without access to an improved drinking water source has increased form 111 million to 149 million people, indicating that access to drinking water is actually deteriorating.

(i) **Excess use of water due to changing life style:** Industrial development led to economic development. Purchasing capacity of individuals has increased. Thus, the life style of people has changed and the standard of living has improved. Washing machines and dishwashers use large amounts of water but are convenient and suit the present day life style. Lot of water is used for recreational purposes like 'water parks' or 'theme parks' which are becoming extremely favourite places for people to

enjoy holidays. Water in the reservoirs is used for recreational purposes – boating, swimming and angling etc. Golf is becoming a very favourite sport and many golf courses are coming up at various places. Golf courses use excessive amount of water for its maintenance. Private and public gardens too require water for their maintenance. Public and private swimming pools require water supply and sanitation.

(j) **Over use of water:** Aquifers provide drinking water for almost one third of the planet's people. In India more than 1 million people depend on ground water for drinking. In United States 51% of drinking water and 43% of irrigation water is pumped from aquifer. Overuse of aquifers create different problems like depletion of aquifer, intrusion of salt water into aquifer, drawing of chemical contamination in ground water. Ground water depletion is found in Saudi Arabia, Libya, Tunisia, parts of Pakistan, Mexico and Thailand. In agricultural fields over use of water for different types of crops causes the problem of water logging.

Management of Water Resources:

Water resource management is the activity of planning, developing, distributing and managing the optimum use of water resources. It is a sub-set of water cycle management. Over the years rising populations, growing industrialisation, and expanding agriculture have pushed up the demand for water. Efforts have been made to collect water by building dams and reservoirs and digging wells; some countries have also tried to recycle and desalinate (remove salts) water. Water conservation has become the need of the day. The idea of ground water recharge by harvesting rainwater is gaining importance in many cities. Following are the methods of water resource management:

(a) **Integrated Water Resource Management (IWRM):** It is a process which promotes the coordinated development and management of water, land and related resources in order to maximise economic and social welfare in an equitable manner without compromising the sustainability of vital ecosystems. The IWRM approach promotes more coordinated development of land and water, surface water and ground water, the river basin and its adjacent coastal and marine environment, and upstream and downstream interest. The components of IWRM consist of equitable distribution of water for all the activities, preparing and updating of water bodies, planning on regular basis, involvement of stakeholders in decision making, management of pollution by polluter pays principle, proper financial investment with cost recovery and providing updated facts and data related to the water body plant.

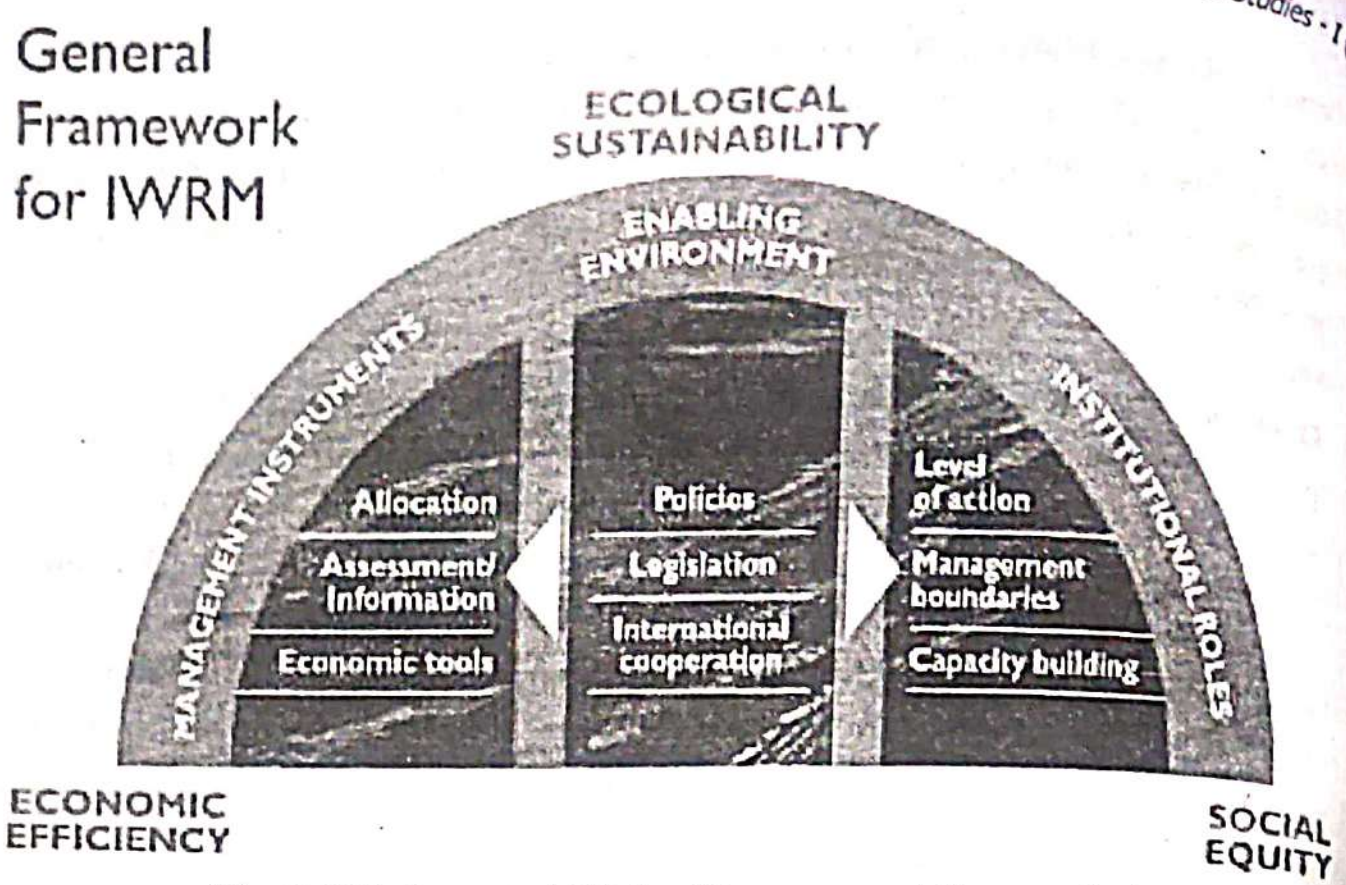

Fig. 2.12 Integrated Water Management Framework

Source: http://www.gwp.org/the-challenge/what-is-iwrm/

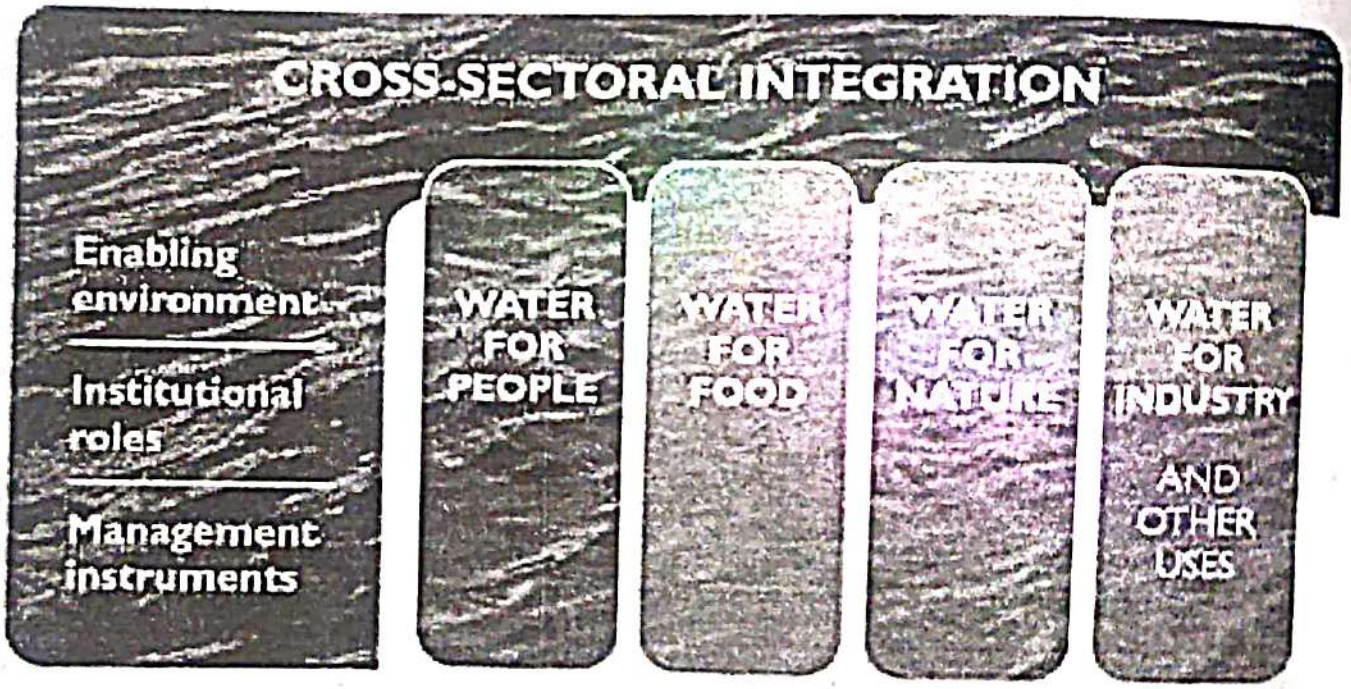

Fig. 2.13 IWRM and it Relation to Subsectors

Source: http://www.gwp.org/the-challenge/what-is-iwrm/

(b) **Recharging of groundwater:** The available groundwater is about 13-20 times as much as water available on surface. The groundwater consists of water contained in the soil or aquifers (underground natural water reservoir). Flood water may be injected into aquifers through series of deep pits or ditches. Small reservoirs and

percolation tanks can be dug to hold runoff water recharging the ground water. Storm water, used water (municipal and domestic), domestic drains can be fed into pits, trenches, depressions to be filtered and percolated through the soil for recharging ground water. De-siltation of canals and tanks should be done regularly. Pre-monsoon tillage of fields helps to conserve soil moisture.

(c) **Rain water harvesting:** Rain water harvesting means to capture rainwater when it rains, store the water above or charge the underground water and use later. In villages, percolation tanks, Kachhe Nandhre are built for rainwater harvesting. Rainwater harvesting recharge the aquifer, conserve the surface water runoff during monsoons, reduce the power consumption and arresting sea water ingress. In roof top harvesting rain water collected from the roof of the building is diverted to a storage tank. The storage tank should be designed according to the water requirements, rainfall and catchment availability. Each drainpipe should have mesh filter at mouth and first flush device followed by filtration system before connecting to the storage tank. Water from storage tank can be used for secondary purposes such as washing and gardening etc. In urban areas government has made mandatory to have rainwater harvesting especially for commercial buildings and group housing complexes. CGWB (Central Ground Water Board) is taking steps to encourage it through rainwater harvesting in Delhi which is the capital city of India.

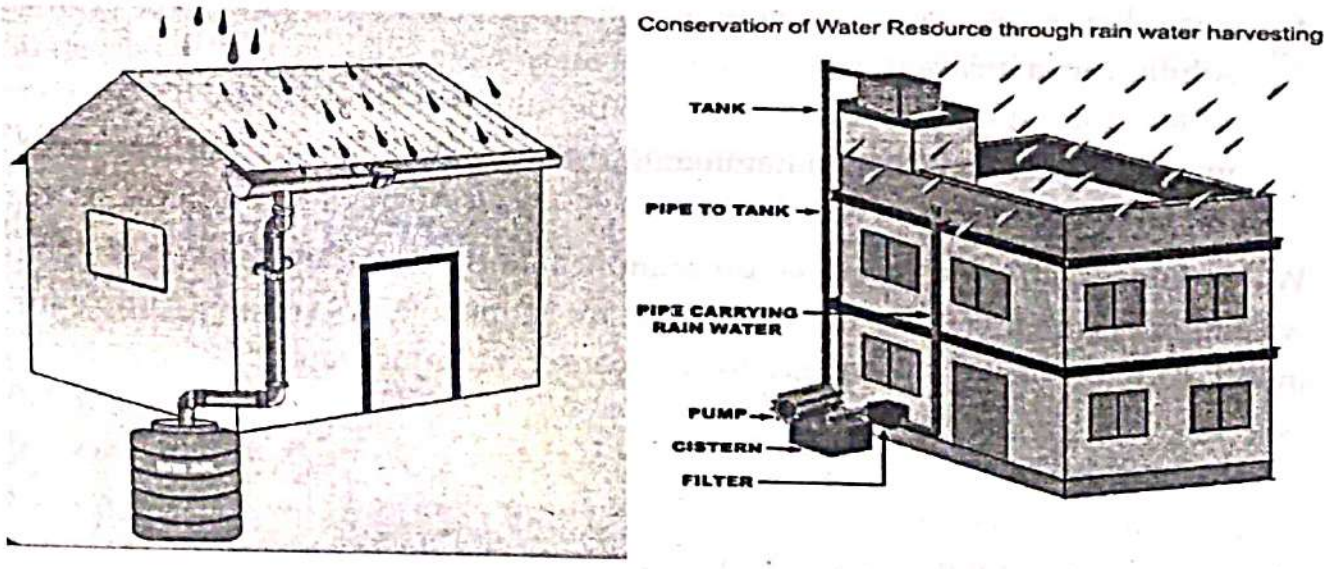

Fig. 2.14 Rainwater Harvesting

Source: http://www.mppcb.nic.in/rwh.htm

http://pradip-watercrisis.blogspot.in/2009/08/rainwater-harvesting-in-kolkata.html

(d) **Recycling of water:** Wastewater from industrial or domestic sources can be used after proper treatment for irrigation, recharging ground water and even for

industrial and municipal uses. Agricultural lands close to cities can be irrigated municipal wastewater. Household level recycled 'grey water' (untreated house water which does not come in contact with toilet waste) can be used for vari purposes. Grey water from shower, bath, washbasins, laundry troughs and wash machines can be put to various uses to reduce pure water requirement. Pure wa after used in bath and shower can be used for watering plants, In Tokyo, Japan; the water used in Mitsubishi's 60 storied office building is purified for reuse by automated recycling system.

(e) **Pollution control mechanisms:** Following are various pollution contr mechanisms:

- Effective way to reduce pollution is to avoid producing it or releasing it in th first place.
- Industries can reduce pollution by recycling or reclaiming material.
- Precise application of fertilisers, irrigation water and pesticides saves money and reduce contamination of water.
- Sewage treatment plant should be set up to avoid large amount of pollution. Developing of septic tanks, sewage primary, secondary and tertiary treatment plants can solve the problem of pollution of water.
- Remediation is a new development in environmental engineering promising solution to many water pollution problems. Containment methods keep dirty water from speeding. Chemicals can be added to toxic water to precipitate, immobilise or solidify contaminants. Many pollutants can be destroyed or detoxified by chemical reactions.

(f) **Water conservation awareness programmes and Meter system:** Reduction in wastage of water can be best achieved by launching awareness campaigns to involve all sections of the society for the conservation of water. Such awareness is possible through different media such as newspapers, radio and television. Other ways would be to organise short plays; street plays or lectures. Any agency either government or otherwise responsible for water meters and charging for water use should make it a point to install efficient meters and decide to charge a rate which will force the public to reduce use of municipal water. Tap, shower flow restrictors and low volume toilet flushes can help in reducing water use.

(g) **Reforestation:** Reforestation is the process of planting of trees in the deforested areas or of increased tree cover from re-growth and planting of trees (plantations). Reforestation increases soil fertility by preventing soil erosion, prevents run-off of

eroded soil into aquatic systems and prevents flooding. Thus, reforestation plays a major role in conservation of water.

(h) **Water Conservation practices in the agriculture sector:** Following are the water conservation practices in the agriculture sector:

- In deserts regions and water scare region dry farming practices should be promoted.
- Salt-resistant varieties of crops have also been developed recently as, these crops grow in saline areas, overall agricultural productivity is increased without making additional demands on freshwater sources. Thus, this is a good water conservation strategy.
- Use of drip irrigation and sprinkler irrigation can reduce the use of water in agriculture sector.

(i) **Tank system to collect the water during rainy season:** In India's arid and semi-arid areas, the 'tank' system is traditionally the backbone of agricultural production. Tanks are constructed either by bunding or by excavating ground and collecting rainwater. Rajasthan, located in the Great Indian Desert, receives hardly any rainfall, but people have adapted to the harsh conditions by collecting whatever rain falls. Large bunds to create reservoirs known as *khadin*, dams called *johads*, tanks, and other methods were applied to check water flow and accumulate run-off. At the end of the monsoon season, water from these structures was used to cultivate crops.

(j) **Implementation of water conservation methods at the household level:** Following are some suggestions that can be implemented for conserving water at household level:

- Remember to use only the amount actually you need.
- Encourage your family to keep looking for new ways to conserve water in and around your home.
- Make sure that your home is leak-free. Many homes have leaking pipes that go unnoticed.
- Do not leave the tap running while you are brushing your teeth or soaping your face.
- Avoid flushing the toilet unnecessarily.
- When washing the car, use water from bucket and not a hosepipe.

- Do not throw away water that has been used for washing vegetables, rice o dals use it to for watering the plants or for cleaning purposes.
- You can store water in a variety of ways. A simple method is to place a drum on a raised platform directly under the rainwater collection source.
- Lawns and gardens should be watered in the early morning or late in the evening so that water evaporation losses are minimised.

Problems Associated with Management of Forest Resources:

Introduction:

Forest means association of plants, herbs and prominently tress. Forest resource is very valuable to human life with different uses. It is an important source of raw material for industry, source of fuel wood, an agent for protection of watersheds, a place of unique natural beauty, sink for carbon sequestration, site for recreation and education, source of foreign exchange, place to hunt wild animals for food, place for settlement of poor people, a source of medicines, place of biodiversity with different unknown species of plants and animals and a place of worship.

According to FAO Global Forest Resource Assessment, world's almost one-third area is covered by forest of which 95% is natural forest and 5% is planted forest. Forests are distributed unevenly across the globe with 17% in Africa, 14% in Asia, 27% in Europe, 14% in North and Central America, 23% in South America and 5% in Oceania.

Following are the various problems associated with management of forests:

(a) **Deforestation:** Deforestation is the permanent destruction of forests in order to make the land available for other uses. Deforestation is ever increasing in environment. As per World Wide Fund for Nature (WWF), about 46-58 thousand square miles of forest are lost each year — equivalent to 48 football fields every minute. According to United Nations Environment Programme (UNEP) collaborating centre, countries with significant deforestation include Brazil, Indonesia, Thailand, the Democratic Republic of Congo and other parts of Africa, and parts of Eastern Europe. About half of the world's tropical forests have been cleared.

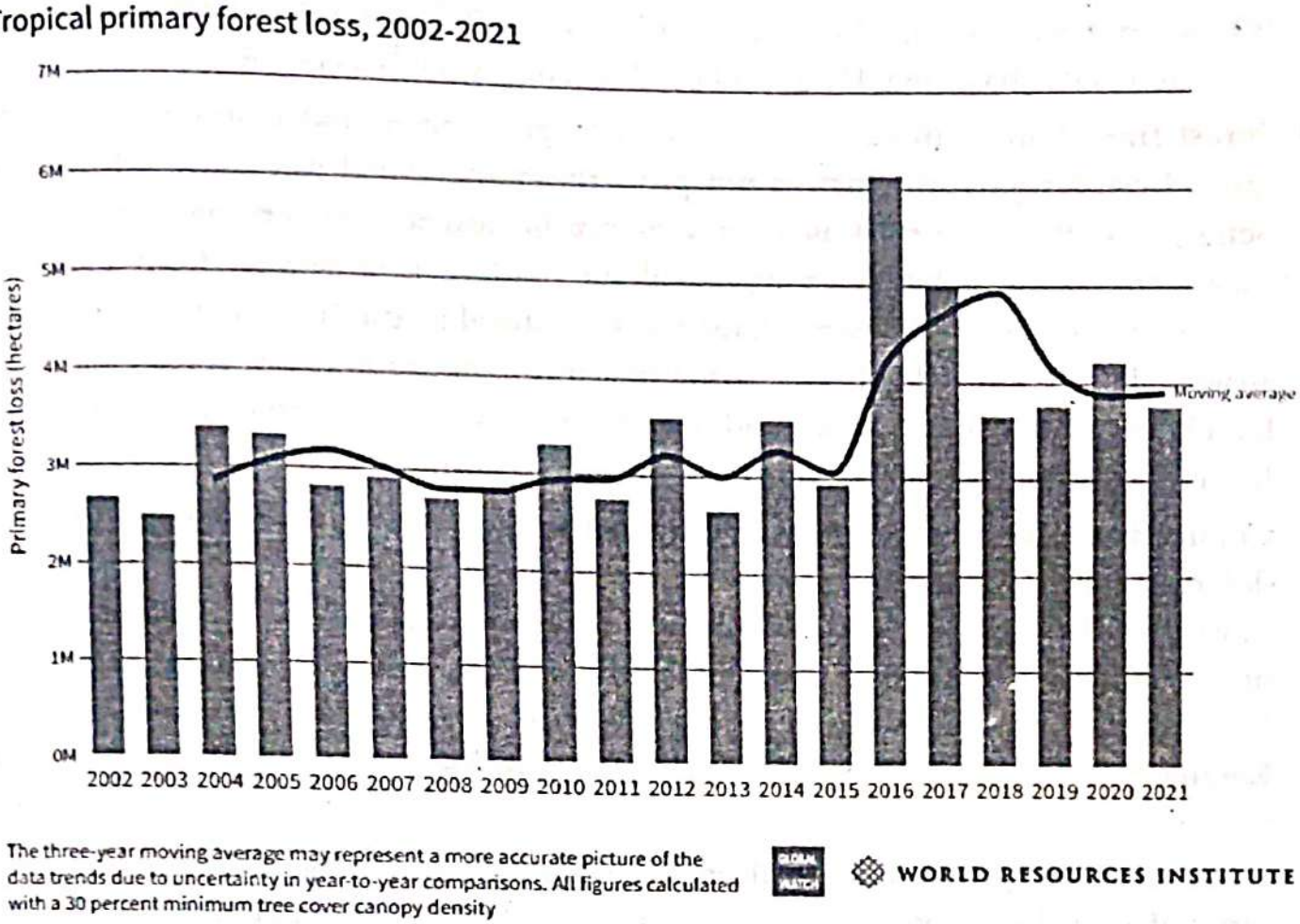

Fig 2.15 Tropical Primary Forest loss

Source: World Resource Institute

https://research.wri.org/gfr/forest-extent-indicators/primary-forest-loss

Fig. 2.15 is showing the tropical forest loss from 2002 to 2021. The rate of annual tree cover loss remains high from 2016 to 2021. Tropical forest loss is highest in year 2016 which is 6.1 million hectare and in 2021 is 3.8million hectare. The three year moving average line shows upward slope indicating increase in tropical forest loss especially after 2015.

(b) **Degradation:** Degradation of forest means reduction in the productivity of forest due to unsustainable harvesting, pollution and pests. Productivity mainly refers to production of timber, wood, fodder and industrial wood. Degradation affects the ecosystem and capacity of forests as capacity of carbon Dioxide sinks. There is always a threat of species extinction and loss of genetic resources. Desertification is also affected by forest degradation.

(c) **Clear cutting method:** Clear cutting method of deforestation is very dangerous as it causes total destruction of forest area. In the clear cutting method every tree is cut,

regardless of size and age for example Washington's Gifford Pinchot National fo in United States has been deforested by clear cutting for harvesting.

(d) **Forest fires:** Forest fires are due to use of open flames and disposable barbe grills. Even a cigarette which is not properly extinguished can cause a forest fi Some forest fires also start as a consequence of downed power lines, sparks fro trains, sparks from hedge trimmers along roadways or sparks from tools a forestry machinery doing work in the forest. Natural forest fires are due to lightni strikes. Forest fire alters the structure and composition of forest, threate biodiversity, alter water cycles and also destroy the livelihoods of the people wh live in forest and around the forest.

(e) **Commercialization of agriculture:** Commercial agriculture is the largest driver o deforestation, involving forest clearing for cropland, pastures and tree plantations In world 40% and in Latin America 68% of deforestation is due to commercialisatio of agriculture, for example soybeans cultivation in Mato Grosso state in weste Brazil part of amazon basin is deforested on large scale and Indonesia's Centra Kalimantan province and parts of Malaysia's forest has been largely destroyed fo palm oil production.

(f) **Unsustainable agriculture practices:** Hunting and gathering has been the main form of sustenance practiced in the earlier periods of human history. Shifting cultivation or *Jhoom* farming is a 12000-year old practice and a step towards transition from food collection to food production. It is also known as slash-and-burn method of farming. Annually about 5 lakhs ha (hectares) of forest is cleared or burnt for this type of farming. In this type of cultivation there is a limited use of tools without a very high level of mechanisation. However, this method of cultivation causes extreme deforestation, as after 2-3 years of tilling, the land is left to the mercy of nature to recover. Even today, shifting cultivation is practiced in the states of Assam, Manipur, Meghalaya, Mizoram, Nagaland, Tripura and Andaman and Nicobar Islands.

(g) **Urbanisation, infrastructure building and developmental projects:** Overpopulation directly affects forest covers, as with the expansion of cities more land is needed to establish housing and settlements. Therefore, forest land is reclaimed on large scale for example mangrove areas in Mumbai and Thane region have been reclaimed for real estate development and for different human activities. The construction of roads, railway lines, buildings and power projects also leads to deforestation. This is specially happening in urban areas on large scale with growing population and development of technology. For example Construction of

inter-oceanic highway connecting Peru and Brazil has resulted in deforestation in Amazon basin.

(h) **Violation of laws related to forest resources:** The laws related to forest resources can be violated in any number of ways, such as taking wood from protected areas, harvesting more than is permitted and harvesting protected species. This destruction threatens some of the world's most famous and valuable forests, including rainforests in the Amazon, Congo Basin, Indonesia and the forests of the Russian Far East. These practices also depresses the price of timber worldwide, disadvantaging law-abiding companies, and depriving governments of revenues normally generated by duties and taxes Poor communities near forests are often vulnerable when outsiders try to gain control over the timber nearby, which can lead to repression and human rights violations. In tropical area logger may take one or two large trees per hectare, but the canopy of tropical forests is often strongly linked by vines and interlocking branches, felling one tree can bring down a dozen other.

(i) **Deforestation for cattle ranching and fuel production:** Growing demand for meat at local and global scale result into deforestation for grazing or animal rearing activity. In Central America nearly two third of original moist tropical forest has been cleared within 30 years for cattle ranching. According to the Report of Global Canopy Programme, Brazil's 75% of deforestation can be linked to cattle ranching and from 1990 to 2003. Rapid population growth has caused increased demand of fuel wood from 300 to 500 million tons in 2001. In Nigeria, Sumatra and many African countries deforestation is taking place for charcoal production on large scale.

(j) **Unplanned mining:** Many forested areas are rich in minerals and therefore vulnerable to deforestation. The waste that comes out from mining pollutes the environment and affects the nearby species. The Congo basin contains vast untapped reserves of gold, colton (used in mobile phones), diamonds, uranium, manganese, and copper. The Amazon basin is rich in precious metals like, copper, tin, nickel, bauxite, manganese, iron and gold suffering from deforestation. The technological advance in extractive knowledge combined with monetary incentives from government increase rate of deforestation in both the areas.

Management of Forest Resources:

Forest management is a branch of forestry concerned with overall administrative, economic, legal, and social aspects, as well as scientific and technical aspects, such as

silviculture, protection, and forest regulation. Forest provides wildlife with suitable habitat for living along with filtering groundwater and preventing runoff.

Following are the methods of management of forest resources:

(a) **Afforestation:** Afforestation means development of forest where they did not exist in past. It includes different plantation practices captive plantation means planting the trees to meet the demand of forest based industries. It should be aimed at increase productivity of wood per unit area. Intensive plantation refers to raising the plants on all available land from farm- fields to road, rail sides, and bad lands to every available space. Such plantation will meet the need of timber fuel fodder food fibre medicine that prevents denudation of natural forest area. Afforestation along the hill slopes ensures timber supplies and also protects soil erosion.

(b) **Reforestation:** Reforestation involves development of the forest where they have been destroyed. There is need for reforestation on ecologically fragile areas like national parks, mountain etc.

(c) **Use of technology for forest assessment:** Forest assessment should use the science and technology like GIS, GPS, and Remote Sensing and aerial photography mapping. In India Forest Survey of India, under MEF, objectively assess the forest resources. The main activities are an assessment of the forest cover and preparation of forest cover maps using remote sensing data, estimation of growing stock and other land uses in different parts of the country through field inventory, preparation of thematic maps using aerial photographs and in service training to the officials of the forest departments of states/union territories in the application of remote sensing, Geographical Information System(GIS) and preparation of inventory essential for forest resource planning and management.

(d) **Reformation of national policies and legislation:** Reforming the outdated national forest policies and implementation of strict forest laws is the need of the time. It is necessary to consider the forest resources as assets. Accordingly, governments should provide better funding for the conservation projects. Certain activities, such as, shifting agriculture and grazing, can be regulated with the help of proper legislation. Similarly, stringent environmental impact assessment can also help to assess the repercussions of several projects in the forest areas.

(e) **Control over forest fire:** To save forest from fire it is necessary to adopt latest technique of firefighting. Some of the fire suppression techniques consist of three-meter-wide fire lanes around the periphery of the fire, arrangement of water spray, fire retardant chemicals should be sprayed from back tank possibly with the help of helicopters.

(f) **Protection of forest from diseases:** Forest should be protected from different diseases resulting from parasitic fungi, rust, viruses and mistletoes. Forest should be protected by use of chemical sprays or antibiotics or by development of disease resistant strains of trees.

(g) **Selective cutting method:** In selective cutting only mature trees are selected for cutting. This process should follow in rotation for reducing the rate of deforestation.

(h) **Using substitute for forest products:** Rubber or good quality plastic can be substituted for wood product wherever possible. The incentives for wood substitution and subsidies for using fuel saving devices and alternative source of energy like biogas, solar energy in India will reduce the deforestation rate.

(i) **Provide alternative to landless people:** Land reform programmes that could provide people with alternatives rather than encroachment in forests. It will also encourage them to intensify the agriculture outside the forest area and protect the forest land.

(j) **Increase logging taxes:** The government should set a high license fee on logs to discourage commercial logging. Government also should increase taxes on export of logs to favour domestic wood processing.

(k) **Promoting agro-forestry and social forestry:** Agro forestry means growing trees along with crops. Trees are supplementary to crop production which gives income. The tree species in agro forestry systems are selected as per requirement of fuel, fodder and wood for the rural economy. Agro forestry is successful in North Indian states like Haryana, Punjab and Uttar Pradesh. Social forestry means involving farmers and public in forestry. The trees which are more useful are grown on unused fallow land. In Gujarat and West Bengal marginal land is converted in to forest.

(l) **Reduce the demand for wood:** Reducing demand for wood is a direct means to slower deforestation in the world. Controlling the wastage of paper and promoting the use of recycled paper in one of the alternatives. Sensitivity towards forest itself can save them. Careful use of the products made from trees is a better practice.

(m) **Eco-Tourism:** It is the way of exploiting the economic potential of forest efficiently. Eco tourism in tropical rainforest makes minimal adverse impact on environment. Local culture and heritage while help to generate employment and income for the local people. By using forest as tourist centres the country can earn substantial foreign exchange. This practice has been adopted by many countries, both from the developed and developing worlds. The concept of 'national park' and 'game sanctuary' has now become popular and every country has developed its unique

forest area as a 'national park'. In India alone, there are as many as 92 national park and game sanctuaries. This is a good method of forest conservation.

(n) **Respecting the rights of the local people:** Local forest dwellers (mostly tribal) are most vulnerable to the impacts of forest destruction. Their existence and needs are not duly represented in the government decisions. They should be the major participants in the process of conservation. Joint Forest Management practice in India involves the local people with the state forest departments in forest conservation practices.

Problems Associated with Management of Energy Resources:

Introduction:

Energy may be defined as the capacity to do work. Energy can be transformed from one form to another form. Energy gets used up when used and accordingly energy cannot be recycled like nutrients. The sources of energy may be (i) renewable or (ii) non-renewable. However, energy can neither be created nor destroyed and cannot be recycled.

Following are the problems associated with management of energy resources:

(a) **Energy Crisis:** The term energy crisis is generally refereed to shortage in energy supply. Depleting stock of energy resources, however, is not the only reason for the shortage. The concept of "energy crisis" is concerned more with the politics of energy supply, esp. the dramatic increase in oil prices leading to shortage of energy supply. This concept was evolved when the tenfold increase in world oil prices during the 1970s forever changed the pattern and structure of trade. The way each nation could cope with the crisis depended upon the stage and state of its development. While the industrialised nations could recover quickly, the underdeveloped nations are still reeling under the impact.

(b) **High rate of consumption of energy resources:** Rising standard of living, huge growth of secondary and tertiary activities and enlargement of transport sector has resulted into high rate of consumption of energy resources in developed and developing countries of the world. Excess demand of energy resources results into rising prices of oil, natural gas and coal.

(c) **More use of non-renewable energy resources:** Almost 90% of the world's current energy supply is based on fossil or mineral resources, oil, gas and uranium. Only 10% comes from renewable sources especially hydropower and biomass, while the share of solar and wind energy is below 1%. This is due to lack of financial

investment in development of renewable energy resources. Excessive use of conventional power resources like coal, oil, and wood, results into air pollution which affects the human health and quality of the environment.

(d) **Unfavourable Government policies and energy crisis:** Energy crisis occurs due to government actions like tax hikes, nationalisation of energy companies and regulation of the energy sector a shift in supply and demand of energy takes place away from its economic equilibrium. A crisis can develop due to industrial actions like union organised strikes and government embargoes.

(e) **Shortage of energy resources due to accidents:** Pipeline failures and other accidents may cause minor interruptions to energy supplies. A crisis could possibly emerge after infrastructure damage from severe weather. Attacks by terrorists or militia on important infrastructure are a possible problem for energy consumers, with a successful strike on a Middle East facility potentially causing global shortages. Political events, for example, when governments change due to regime change, monarchy collapse, military occupation, and coup may disrupt oil and gas production and create shortages. Fuel shortage can also be due to the excess and useless use of the fuels.

(f) **Wastage of energy:** During the process of transmission and distribution of energy resources loss of energy takes place due to inefficient technology, improper plant location and poor maintenance of pipelines. In the transportation sector faulty signal system, traffic jams, improper mechanism of vehicles results into wastage of energy. In day to day life carelessness attitude of human beings about switching of fan, tube and electronic appliances after use also waste energy resources.

(g) **Accidents:** Pipeline failures and other accidents may cause minor interruptions to energy supplies. A crisis could possibly emerge after infrastructure damage from severe weather. Attacks by terrorists or militia on important infrastructure are a possible problem for energy consumers, with a successful strike on a Middle East facility potentially causing global shortages. Political events, for example, when governments change due to regime change, monarchy collapse, military occupation, and coup may disrupt oil and gas production and create shortages. Fuel shortage can also be due to the excess and useless use of the fuels.

(h) **Other Problems:** The cause may be over-consumption, aging infrastructure, choke point disruption or bottlenecks at oil refineries and port facilities that restrict fuel supply. An emergency may emerge during very cold winters due to increased consumption of energy.

Management of Energy Resources:

Energy management is a science involving planning, designing, directing an controlling the supply of energy. Energy management maximises the productivity an comfort and minimises the energy cost and pollution with conscious judicious an effective use of energy. Energy management involves policy, organisational change energy audit, energy conservation measures, training and awareness programme association of working level personnel, evaluation of present energy consumption implementing and monitoring of energy conservation efforts etc.

Following are the methods of energy management:

(a) **Energy Audit:** Energy audit is an official scientific study of energy consumption a regional, organisation or plant level with aim of reduction in energy cost and consumption without affecting productivity and comforts and suggesting th methods for energy conservation and reduction in energy cost. Energy audit should be done seriously in every sector of economy.

(b) **Formulate Energy strategy:** In each country, national level energy strategies should be adopted to ensure adequate and uninterrupted supply of usable energy to various consumers on both short term and long term basis. Energy strategy of any country, particularly in developing nations, should be designed with the following objectives:

- To become self-reliant and reduce dependence on imported fuels.
- Simultaneous growth of renewable energy technologies and conventional energy technologies.
- Conservation of fuels by substituting non-conventional energy resources for conventional energy resources.
- Improving energy efficiency.
- Rational policies of energy pricing.
- Encouraging energy conservation and maintaining ecological balance.

(c) **Energy conservation:** Energy resource conservation involves following methods:

- Reducing electrical energy consumption by switching off lights when not required.
- Engineer's measures include redesigning of machines and automobiles to reduce consumption of the fuels. For example, Honda and Toyota have low emission hybrid gas electric vehicles get up 30.3km/litre on high way. Buying energy efficient appliances also reduce the energy consumption.

- Analysis of data of energy utilisation, transmission and distribution for future planning and reducing the losses.
- Research related to alternate energy and clean energy technology should be developed. One of the methods based on clean energy technology is creation of energy from waste. For example, Landfill waste gets fermented by natural bacterial decay and release methane rich fuel gas. Obtaining the methane rich fuel gas from landfill is most economical and environmentally attractive method of extracting energy from urban waste. It can be used as fuel for burning in boilers, kilns etc. Urban municipal waste can be incinerated to generate heat as in thermal power plants and this heat also can be used for producing electricity.
- Promote the use of non-conventional energy resources like solar energy in tropical countries, wind power in desert areas and wave energy in coastal areas which can reduce pressure on conventional energy resources.
- Allocation of funds in budget for development of non-conventional energy resources.
- To use public transport system as much as possible instead of using personally owned vehicles.
- Turning off a vehicle's engine at stops rather than idling.
- Car speed should be maintained as far as possible 50 to 60km/hour - moderate driving - driving at lower speeds.
- Take care to check and mend leakage of fuel tanks and exhausts of vehicles.
- Improve and maintain signal system in different modes of transport which will reduce wastage of fuel.
- More efficient and less energy intensive industry, transportation and domestic practices could save large amounts of energy.
- Installation of energy efficient windows can save energy resources. Some of the older windows installed at our homes will not give sufficient light. Double panel windows and other vinyl frames are much better than single panel windows. Choosing correct blinds can save on your power bills.
- Try replacing incandescent bulbs in your home with CFL's and LED bulbs. CFL's and LED bulbs cost more upfront but last 12 times longer than regular incandescent bulbs. CFL's and LED bulbs will not only save energy but over time you end up saving money.

Resource Utilisation and Sustainable Development:

Natural resources and population are not evenly distributed in the world and this distribution depends on geographical factors. The utilization of natural resources has multiplied over the years and more of in an unsustainable manner. The extraction and use of non-renewable resources is responsible for environmental problems all over the world. Hence to meet the rapid economic growth of a region, countries need to have policies like estimation, systematic utilization and conservation of resources. If a country utilizes the resources in such a manner that without exerting much pressure on non-renewable resources, it is able to harness non-conventional resources then sustainable way of utilization of resource is achieved.

The term sustainable development was first introduced in 1972 in United Nations, Stockholm Conference on Human Environment. Then the concept was discussed in UN World Summit, Johannesburg, in 2002 and finally discussed in 2012 UN Conference in Rio de Janeiro. The World Commission on Environment and Development, 1987 first emphasized the definition of sustainable development "Humanity has the ability to make the development sustainable to ensure that it meets the need of the present without compromising the ability of future generations to meet their own need".

In simple word sustainable development consider present needs, growing need and need for future generations.

To maintain sustainability in utilization of resources we need to practice following:

- We should use substitute of certain resources which are limited in nature. The dependency on limited resources needs to reduce very systematically and efficiently.
- The end product of a resource should be utilized in such a manner that it can be degraded easily in nature or recycling is possible.
- Extraction of natural resources should be from well managed ecosystem. In the name of utilization it should not be over exploitation and over harvesting.
- Conservation strategies to be formed.

The following are the principles of sustainability resolved in The Rio Declaration on Environment and Development:

- People are entitled to a healthy and productive life in harmony with nature.
- Development today must not undermine the development and environment needs of present and future generations.

- Nations have the sovereign right to exploit their own resources, but without causing environmental damage beyond their borders.
- Nations shall develop international laws to provide compensation for damage that activities under their control cause to areas beyond their borders.
- Nations shall use the precautionary approach to protect the environment.
- In order to achieve sustainable development, environmental protection shall constitute an integral part of the development process, and cannot be considered in isolation from it.
- Nations shall cooperate to conserve, protect and restore the health and integrity of the Earth's ecosystem.
- Nations should reduce and eliminate unsustainable patterns of production and consumption, and promote appropriate demographic policies.
- Environmental issues are best handled with the participation of all concerned citizens. Nations shall facilitate and encourage public awareness and participation by making environmental information widely available.
- Nations shall enact effective environmental laws, and develop national law regarding liability for the victims of pollution and other environmental damage.
- Nations should cooperate to promote an open international economic system that will lead to economic growth and sustainable development in all countries.
- The polluter should, in principle, bear the cost of pollution.
- Nations shall warn one another of natural disasters or activities that may have harmful trans boundary impacts.
- Sustainable development requires better scientific understanding of the problems. Nations should share knowledge and innovative technologies to achieve the goal of sustainability.
- The full participation of women is essential to achieve sustainable development. The creativity, ideals and courage of youth and the knowledge of indigenous people are needed too. Nations should recognize and support the identity, culture and interests of indigenous people.
- Warfare is inherently destructive of sustainable development, and Nations shall respect international laws protecting the environment in times of armed conflict, and shall cooperate in their further establishment.

Review Questions:

(1) Define the term 'natural resource'. Discuss its meaning and classification.
(2) Describe the types of resources with the help of suitable example. ***(Nov. 16)***
(3) Distinguish between renewable and non-renewable resources. ***(Nov. 17)***
(4) Give detail classification of resource with suitable example. ***(March 18)***
(5) Define resource. Explain in detail about renewable and non-renewable resources. ***(April 19)***
(6) Define resources and explain factors influencing resource utilisation. ***(March 17)***
(7) Define conservation and state the methods of resource conservation. ***(Nov. 16)***
(8) What is conservation? State the methods of resource conservation. ***(March 17)***
(9) Write with examples the different methods of resource conservation. ***(March 18)***
(10) What are the different measures of coal and oil conservation? ***(Nov. 17)***
(11) What are conventional resources? Discuss various conventional resources with reference to their distribution, advantages and disadvantages.
(12) Give an account of conventional energy resources. ***(March 17)***
(13) What are non-conventional resources? Discuss various non-conventional resources with reference to their distribution, advantages and disadvantages.
(14) Explain various non-conventional sources of energy. ***(March 18)***
(15) What are the non-conventional resources? Describe any three non-conventional resources and its advantages. ***(April 19)***
(16) Explain the problems associated with water resources.
(17) Describe in details the methods of conservation of water resources ***(Nov. 18)***
(18) Discuss various methods of management of water resources. ***(April 19)***
(19) Explain the problems associated with management of forest resources. ***(Nov. 16; March 17)***
(20) Elaborate the role of forest in climate, soil and ecology of the region. ***(March 18)***
(21) Discuss various methods of management of forest resources.
(22) Evaluate the role of forest in governing climate and biodiversity of a region. ***(Nov. 17)***
(23) Describe main causes of deforestation in the world. ***(Nov. 18)***
(24) Explain the problems associated with energy resources.
(25) Discuss various methods of management of energy resources.
(26) Give an account on resource utilization and sustainable development. ***(Nov. 16)***
(27) Classify the energy resources according to their nature. ***(Nov. 18)***
(28) **Write notes on:**
  (a) Water conservation and management. ***(Nov. 17)***
  (b) Importance of solar energy. ***(Nov. 17)***

Chapter 3

Population and Emerging Issues of Development

"COVID underlines what happens when humanity's relationship with nature is broken. Our irresponsible behaviour towards nature is endangering our own health - a stark reality we've been ignoring for decades. This is our wake-up call. We must tackle our nature crisis urgently, working together with commitment at the highest political and corporate level to secure both human and planetary health."

– Marco Lambertini, Director General, WWF International

Trends of World Population Growth – Population Explosion in the World – Theory of Demographic Transition – Patterns of Population Growth in the World – Problems of World Population Growth or Explosion – Population Explosion in India – Patterns of Population Growth in India – Problems of Population Growth or Explosion in India – Measures Taken to Control Population Growth in India – Human Population and Environment – Environment and Human Health – Human Development Index (HDI) – The World Happiness Index – Review Questions.

The present is a peculiar age, in which we are working hard for our own destruction. We have caused climate change, and we are the ones who are facing the effects of it. We extract natural resources from the ecological systems for making our lives more comfortable; and on the other hand, we are polluting and wasting the same natural resources. We are cutting the branch of the tree over which we are sitting. It is like

digging our own graves! This very nature of human being's approach towards environment makes human a peculiar species. We have clearly understood, by now, that the development based on destruction is not going to last long; it is not going to be sustainable. Moreover, one of the primary reasons responsible for this destructive development is our growing numbers and a robber's attitude towards environment.

Trends of World Population Growth:

Growth of the world population was neither uniform over the time nor even over the space. Fig. 3.1 shows the trends of world population growth and the time-specific factors that affected it. Following are broad phases of world population growth:

(a) **Period of Agricultural Revolution:** About 8000 years before, population increased very modestly at the rate of about 25 people per year. Around 8000 BC, the annual growth rate increased fifty times higher than the past. Agricultural revolution was the principal reason behind this growth. With control over plant cultivation and subsequent food availability, human population started growing steadily. The Fertile Crescent, the region stretching from the edge of the Mediterranean Sea to the present day Iran, was the core of this growth. From 800 BC to 1750 AD, world population increased from about 5 million to 800 million.

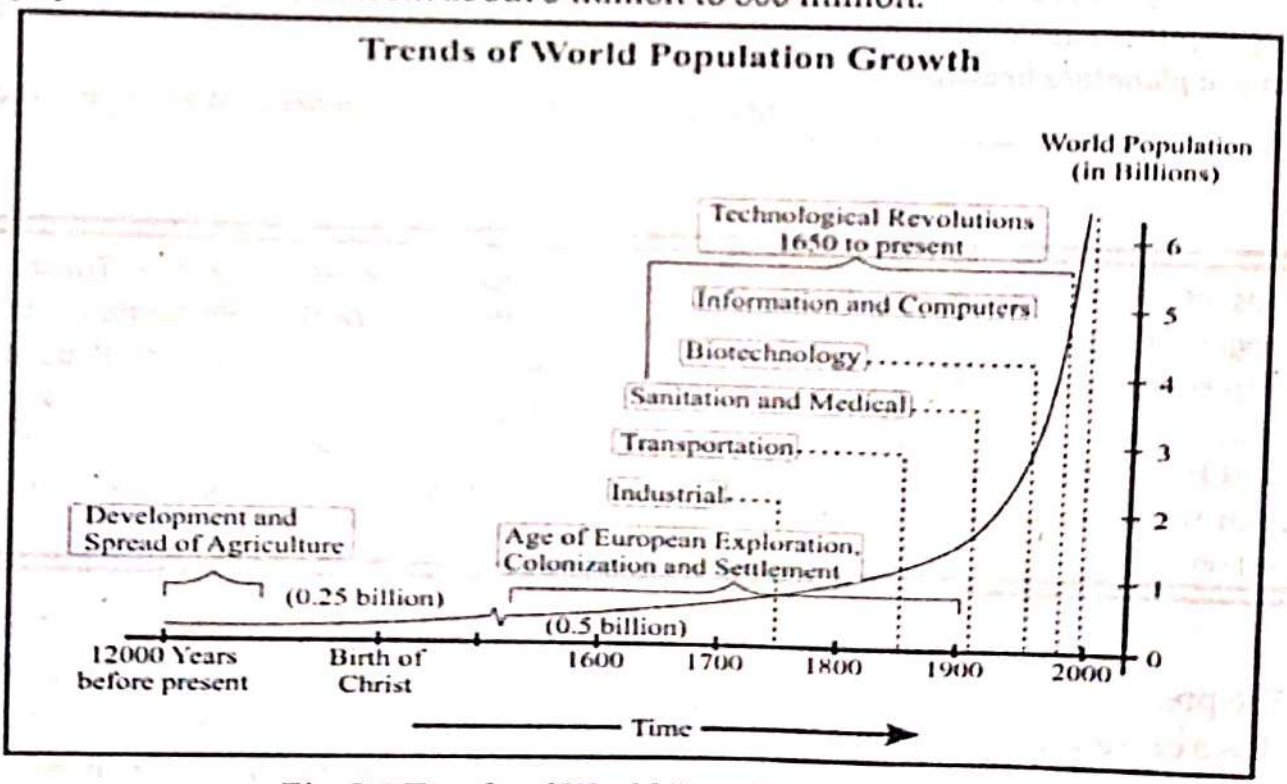

Fig. 3.1 Trends of World Population Growth

(b) **Period of Industrial Revolution:** In the mid-18th century, world population began to grow ten times faster than in the past. Industrial Revolution was the driving force

behind this population growth. It began in England in late 18th century, and then spread to Europe and North America in the 19th century. Improvements in manufacturing processes and agricultural infrastructure, such as irrigation, made it possible to feed the growing population. Overall sanitation and public hygiene also improved. At the beginning of the 19th century, the number of 1 billion people was crossed for the first time in history. Subsequently, around 1950, growth was accelerated and the number of 2.5 billion people was already added in the world population.

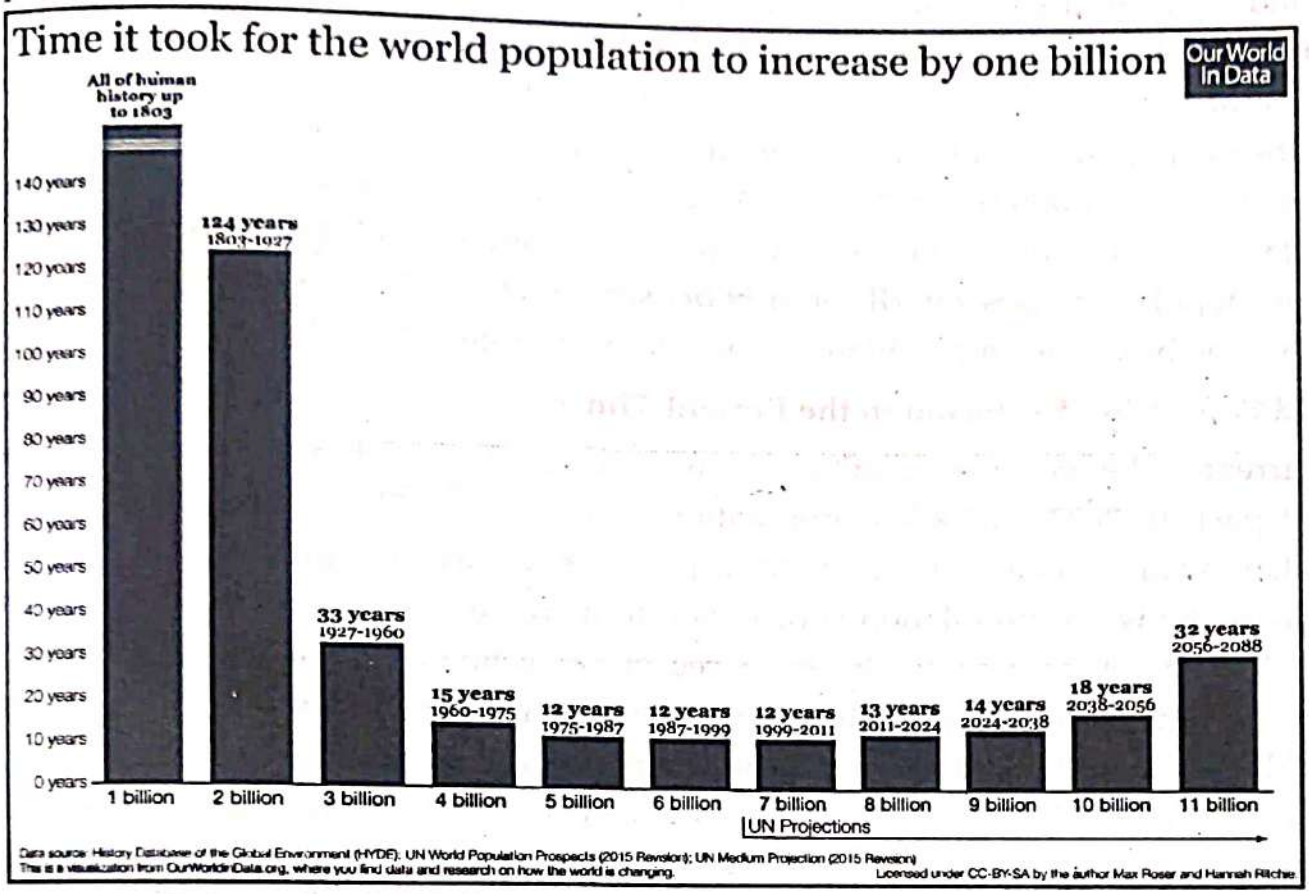

Fig. 3.2 World Population Growth: One Billion Marks

(https://ourworldindata.org/uploads/2018/11/Time-taken-to-increase-population-by-one-billion.png)

(c) **Period of Population Explosion:** World population grew dramatically in the post-World War period, i.e. in the mid-20th century. By 1960, another billion had been added to world population. It continued to grow even faster: 4 billion by 1975, 5 billion by 1988, 6 billion by 1999 and 7 billion in 2011. Approximately 7.2 billion humans inhabited the Earth in year 2013. Fig. 3.2 shows how the population increased by 1 billion in lesser number of years since 1960. This exponential growth of population is termed as 'population explosion'. As per the United Nations Population Fund, world population currently stands around 7.9 billion (2022). This

recent growth has been caused primarily by improvements in medical facilities and associated technological developments that enabled longer and healthier human lives.

Population Explosion in the World:

Concept of Population Explosion:

Kingsley Davis, an American sociologist, coined the term 'population explosion' in the mid-20th century. According to him, population explosion refers to an increase in population of some plant, insect, or animal. Such a condition leads to inability of the environment to sustain that population. In the absence of necessary environmental conditions, population groups experiencing explosion face large number of deaths. When applied to human society, such an eventuality naturally leads to serious concern. Population explosion, in terms of humans, is a negative condition in which number of human population rises rapidly in a short span of time. It is primarily a result of an accelerating birth rate and sudden decrease in death rate.

World Population Explosion in the Present Times:

Currently, the world population continues to grow, though more slowly than in the recent past. In 2022, the world population is about 7.9 billion. Ten years ago, world population was growing by 1.24 percent per year. Today, it is growing by 1.18 percent per year. The world population is projected to increase by more than one billion in the next 15 years. According to the most recent projections by the United Nations, the number of 8.5 billion will probably be reached by the year 2030. It will further reach up to 9.7 billion in 2050, and will continue to grow up to 11 billion by 2100. Notably, the human population has grown about tenfold over the past 300 years and nearly fourfold in just the last century. Table 3.1 shows the ten most populous countries in the world.

Table 3.1

World: Ten Most Populous Countries (2022)

Country	Population (million)	Country	Population (million)
China	1447	Nigeria	215
India	1404	Brazil	215
USA	334	Bangladesh	167
Indonesia	278	Russia	145
Pakistan	228	Mexico	131

Source: World Population Review (2022)

actors Responsible for Population Explosion:

Following are the factors responsible for population explosion:

) **High fertility rates:** Fertility refers to the occurrence of births or an ability to reproduce. Fertility is measured by Crude Birth Rate (CBR), which is expressed as number of live births in a year per thousand of population. As per 2021 data of the united Nations, the average global birth rate was 17.76 births for 1,000 population. Very high birth rate causes of population explosion. High fertility rate is a result of following factors:

(i) **Advances in medicines:** Due to various medical treatments, there are effective solutions to infertility problems. Due to modern medicine, pregnancies are safer.

(ii) **Low levels of education:** People, who lack education, fail to understand the need to control population growth and importance of small-family. They become reluctant to use the methods of birth control and family planning.

(iii) **Cultural factors:** Adopting birth control measures is considered taboo in certain cultures. Some cultures foster beliefs where marrying at a certain age or having a certain number of children is considered ideal. In some cultures, male children are preferred. This indirectly forces couples to give birth to children until a child of the preferred gender is conceived. There is a pressure from the family and society to have children. Early marriages also contribute to population growth as getting married at an early age increases the chances of having more children.

(iv) **Rise in Food Production:** In the last 150 years, the ability of farmers to produce food has increased geometrically. Between 1950 and 1984, for example, the amount of grain harvested worldwide increased from 631 million tons to 1.65 billion tons. This represents a gain of 2.6 times at a time when the world population increased by only 1.9 times. New kinds of seed, chemical fertilizers, pesticides, and machinery that are more sophisticated have made this possible. It is seen that population increases with more food production.

(b) **Low mortality rates:** Mortality is defined as permanent disappearance of all evidence of life at any time after birth has taken place. Mortality is measured by Crude Death Rate (CDR), which is expressed as number of deaths in a year per thousand of population. As per 2021 data of the United Nations, the average global birth rate was 7.6 births for 1,000 population. Low death rate has been an important factor responsible for the population explosion. Low mortality rate is a result of following factors:

(i) **Medical advancements** have made the curing of incurable diseases possibl Due to advances in preventive and curative medicine, diseases either have bee eradicated or have been better treated.

(ii) There are **effective ways to control epidemics** and there are better measures t treat critical health ailments, thus leading to a drop in death rates. It ha increased the average life expectancy.

(iii) **Reduction in infant and maternal mortality rates** have also contributed t lower death rates.

(iv) **Improvements in public hygiene** and sanitation are also importan contributing factors.

(c) **High in-migration flows:** Migration refers to the permanent change of residence o people from one place to another. In-Migration is a process in which people come in a region. In-migration plays significant role in increasing population in case of the urban areas. Many advantages of living in an urban area attract population to the cities. Such advantages include:

(i) **Better wages,**

(ii) **More job opportunities and availability of regular work,**

(iii) **Good health and education facilities,**

(iv) **Low population densities,**

(v) **Cleaner environments,**

(vi) **Hygienic surroundings and absence of disease prone environment,**

(vii) **Better lifestyle,**

(viii) **No water and electricity shortages, etc.**

Theory of Demographic Transition:

Concept of Demographic Transition:

The Demographic Transition Model (DTM) was put forward by W. S. Thompson in 1929, and then was fine-tuned by F. W. Notestein in 1945. 'Demographic transition' refers to a sequence of change over a period of time occurring as a result of complex relationship among birth rate, death rate and overall population change. The model is based on population changes in several industrialised countries in Western Europe and North America. It suggests that all countries pass through similar stages of demographic transition or population cycles.

The Model can be used to show how the population growth of a country changes over a period of time and also to compare rates of growth between different countries at a given point of time.

Stages of Demographic Transition:

Following are the stages of demographic transition as envisaged in the model (Fig. 3.3):

(a) **Stage of High Stationary Growth:** In this stage, both birth rates and death rates fluctuate at a high level (about 35 per 1000), giving a small population growth. Birth rates are high due to no birth control, high infant mortality (so parents tend to produce more children in the hope of more survival), need for labour in the fields, and orthodox religious beliefs. High death rates, especially among children, are due to diseases and plague, famine, uncertain food supplies, poor diet, poor hygiene (no piped, clean water, and no sewage disposal), and little progress in medical science (few doctors, hospitals, drugs, etc.). Examples: Ethiopia, Bangladesh, rainforests tribes, and UK during pre-1760.

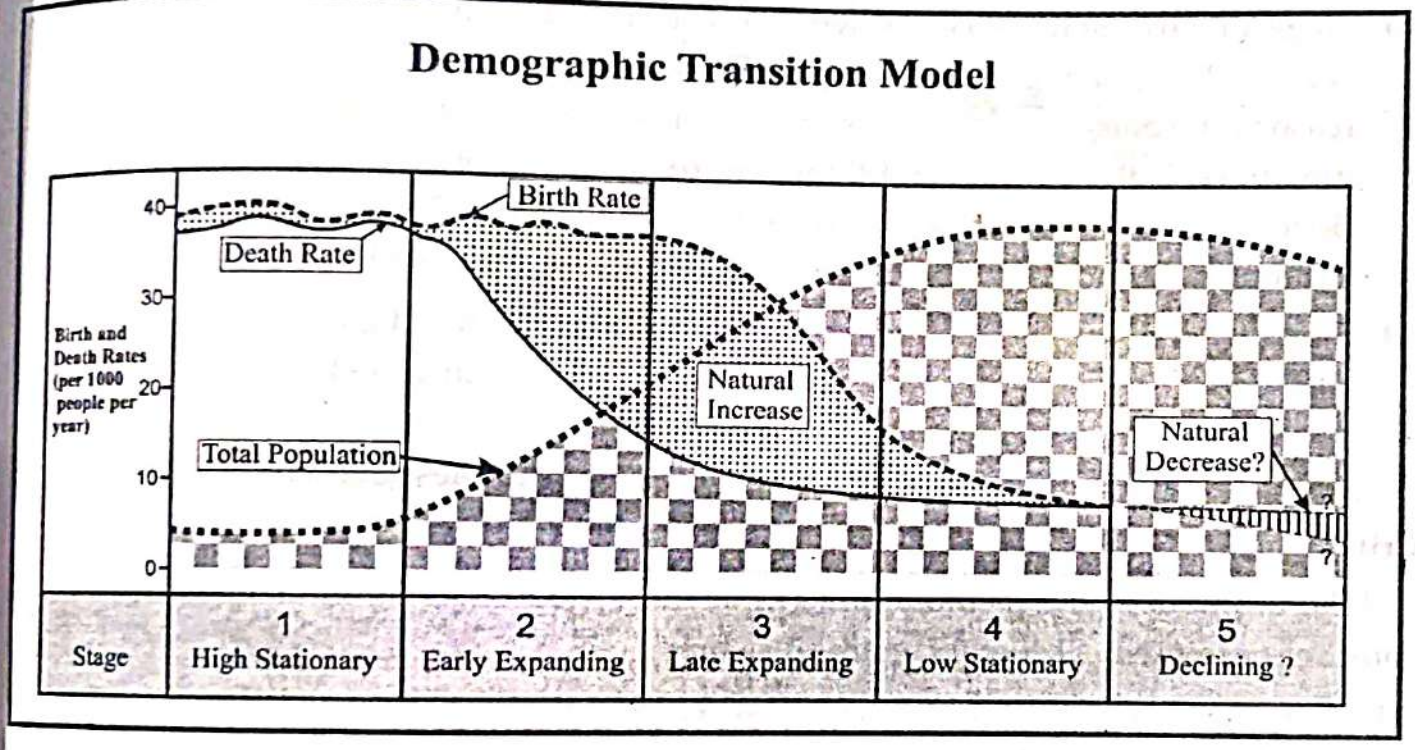

Fig. 3.3 Demographic Transition Model

(b) **Stage of Early Expanding Growth:** In this stage, birth rates remain high, but death rates fall rapidly to about 20 per 1000 people giving a rapid population growth. The fall in death rates results from improved medical care (vaccinations, hospitals, doctors, new drugs and scientific inventions), improved sanitation and water supply, improvements in food production, improved transport to move food and

doctors, etc. and decline in child mortality. The reasons responsible for high birth rates are the need for more children for working in the family farms, high instances of infant mortality, and lack of awareness and implementation of the family planning practices. Examples: Peru, Sri Lanka, Kenya, and UK during 1760-1880.

(c) **Stage of Late Expanding Growth:** Birth rates, in this stage, fall rapidly, to about 20 per 1000 people, while death rates continue to fall slightly (15 per 1000 people) to give a slowly increasing population. The fall in birth rates may be due to family planning methods (contraceptives, sterilisation, abortion, and government incentives), lower infant mortality rate (that leads to less pressure to have so many children), increased industrialisation and mechanisation (meaning fewer labourers are needed), increased desire for material possessions (like cars, bigger homes, etc.), less desire for large families, increased incentive for smaller families, and emancipation of women enabling them to follow their own careers rather than being solely child-bearers. Examples: China, India, Brazil, Cuba, Australia, and UK during 1880-1940.

(d) **Stage of Low Stationary Growth:** Both birth rates (16 per 1000) and death rates (12 per 1000) remain low, fluctuating slightly to give a steady population. The reasons responsible for lower birth rates are the success of family planning initiatives, better health conditions, improved status of women and late marriages. Better healthcare facilities and reliable food supply helped arrest the death rates. Examples: Canada, Japan, USA, France, and UK in post-1940.

(e) **Stage of Population Decline or Negative Growth:** This stage is a later addition in the Model based on the changing trends of population growth. In this stage, birth rates fall below death rates to give a declining population growth. Such a decline is occurring in some western European countries. Examples: Germany, and Italy.

Criticism:

Like all models, the Demographic Transition Model has its limitations. It failed to consider or to predict several factors.

(1) The model, being more or less Eurocentric, assumed that, in time, all countries would pass through the same four stages. It now seems unlikely, however, that many of the economically backward countries, especially in Africa, will ever become industrialised.

(2) The model assumed that the fall in the death rate in Stage 2 was the consequence of industrialisation. Initially, the death rate in many British cities rose, due to insanitary conditions, which resulted from rapid urban growth, and it only began to fall after advances were made in medicine. The delayed fall in the death rate in

many developing countries has been mainly due to their inability to afford medical facilities.

(3) In many countries, the fall in the birth rate in Stage 3 has been less rapid than the model suggests due to religious and/or political opposition to birth control (Brazil), whereas the fall was much more rapid, and came earlier, in China following the government-introduced 'one-child' policy.

(4) The time scale of the model, especially in several Southeast Asian countries such as Hong Kong and Malaysia, is being squashed as they developed at a much faster rate than did the early-industrialised countries.

Patterns of Population Growth in the World:

Meaning:

Pattern of growth means a regular and intelligible form or sequence of population growth in different geographical regions of the world. Population in different countries grows at different rates depending upon the trends of birth rates and death rates in those countries. When these variations are plotted on the world map, one finds a pattern of growth. Patterns of population growth can be understood with the help of measurements like the average annual growth of population, population-doubling time, and natural growth of population.

Table 3.2

World: Average Annual Growth of Population (1995-2050)

World / Regions	Average Annual Growth Rate (percent)		
	1995-2000	2015-2020	2045-2050*
World	1.34	1.09	0.53
More Developed Regions	0.32	0.26	- 0.07
Less Developed Regions	1.60	1.26	0.62
Africa	2.46	2.51	1.74
Asia	1.37	0.92	0.14
Europe	- 0.04	0.12	- 0.26
Latin America and the Caribbean	1.55	0.94	0.22
North America	1.18	0.65	0.34
Oceania	1.34	1.37	0.80

** Projected; Source: UN (2020)*

(1) Patterns of Average Annual Growth of Population:

Table 3.2 shows the present and projected regional variations in average annual growth rate of population. Though the world population growth rate shows a decline from 1.34 percent in 1995-2000 to the projected growth of 0.53 percent in 2045-2050, this decline is not uniform all over the region. Annual average growth rate in more developed regions indicate trends towards negative growth (or population decline) from 0.32 percent to - 0.07 percent. While in the less developed countries, the decline is not very prominent. Where Africa is showing the signs of relatively higher projected population growth rate of 1.74 percent, Europe has already moved towards negative growth from – 0.04 percent in 1995-2000 to the projected -0.26 percent in 2045-2050.

(2) Patterns of Population Doubling Time:

Population doubling time is the time that a country takes to double its population. There is a great variation among regions in doubling their population. Developed countries, for example, are taking more time to double their population as compared to developing countries. Most of the African countries double their population in about 21 to 30 years, while West European countries like Germany takes over 100 years for doubling their population.

(3) Patterns of Natural Growth of Population:

The natural growth of population is low in developed countries as compared to developing countries. There is negative correlation between economic development and population growth. Fig. 3.4 shows that the spatial pattern of rate of natural increase in the world has undergone a tremendous change. Large parts of the world have low natural growth rate. Number of countries recording a natural rate of increase of more than 3 percent per year has declined in recent decade.

Following are the geographical patterns of natural growth of population:

(a) **Regions with Negative Population Growth (less than 0%):** Eastern and parts of southern Europe (e.g., Spain, Germany, Italy) is emerging as a continuous area of natural decline of population, mainly due to relatively high mortality rates and low, stagnant fertility rates. Russia and Japan also show negative population growth.

(b) **Regions with Low Population Growth (0% – 1%):** Large parts of North and South America (e.g., USA, Brazil), western Europe (e.g., France), South Africa, south Asia (e.g., India, China), Australia, New Zealand, have registered a natural increase of less than 1 percent per year.

(c) **Regions with Moderate Population Growth (1% – 2%):** Parts of central America (e.g., Mexico), north-western parts of South America (e.g., Peru), northern and

southern Africa (e.g., Algeria, Egypt), Middle-East Asia, central Asia (e.g., Kazakhstan), parts of south Asia (e.g., Pakistan, Nepal), parts of East Asia (e.g., Indonesia) shows the range of 1 to 2 percent. The major reason for the same is high rate of urbanisation and associated decline in rural population.

(d) **Regions with High Population Growth (2% – 3%):** A higher rate of natural increase of more than 2 percent is found in the parts of central and eastern Africa (e.g., Niger, Sudan, Mozambique, Madagascar), and parts of the Middle-East and south Asia (e.g., Yemen, Iraq).

(e) **Regions with Very High Population Growth (more than 3%):** Highest rate of population increase above 3 percent is observed in South-central Africa, North-western Africa, and North-eastern Africa (e.g., Somalia, Angola, Mali, Democratic Republic of Congo). This is mainly due to very high fertility and sharply declining mortality.

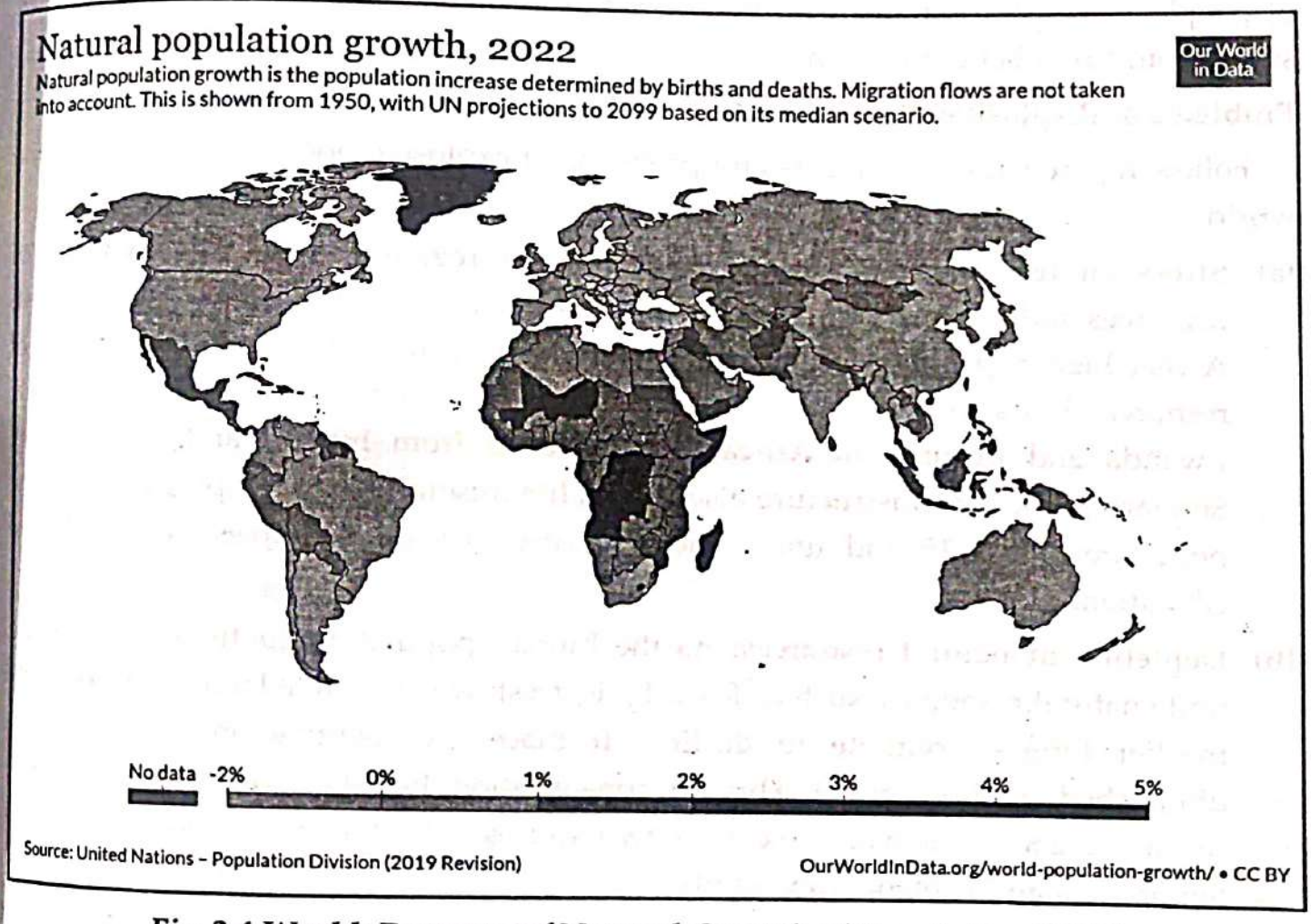

Fig. 3.4 World: Patterns of Natural Growth of Population (2012)

(https://ourworldindata.org/grapher/natural-population-growth)

Large countries like China, India, Indonesia, Bangladesh, etc. that account for about 40 percent of the world's total population determine the demographic trends in the

world. Since their rates of natural increase of population are declining, it can be said that the demographic characteristics of the world are in the process of major change.

Problems of World Population Growth or Explosion:

When Population Growth Becomes a Problem?

It will be a fallacy to say that the absolute numbers of population are the culprit of population-related problems. Population numbers in absolute terms are inadequate to determine whether population is a problem or not. Therefore, population numbers are required to be compared with the available resources to determine the level of stress created by population. Thus, the inadequacy of resources or negative population-resource ratio is the main problem. The negative population-resource ratio is reflected in the concept of overpopulation. Overpopulation is a negative state in which the number of people in an area is more than the resources available in that area. Such countries suffer from a number of problems.

Problems of (Explosive) Population Growth in the World:

Following are various concerns and problems of explosive population growth in the world:

(a) **Stress on resources and infrastructure:** Every region has a limited volume of resources and has a certain limit beyond which infrastructure cannot be expanded. A very high population leads to stress on resources and infrastructure. Shortage of resources leads to deprivation and poverty. For example, countries like Somalia, Rwanda and Burundi in Africa, people suffer from hunger and malnutrition. Similarly, lack of infrastructure also makes life miserable. A high proportion of the population aged 15 and under increases pressure on resources for health and education.

(b) **Depletion of natural resources:** As the human population continues to explode, finite natural resources, such as fossil fuels, fresh water, arable land, coral reefs and frontier forests, continue to decline. It places competitive and leading to a diminished quality of life. Human consumption had far outstripped available resources. Each person on the earth now requires a third more land to supply his or her needs than the planet can supply.

(c) **More intensive farming practices:** Intensive farming practices produce more and cheaper food per acre, which has helped feed a booming human population. However, it has grown to become the biggest threat to the global environment through the loss of ecosystem services and global warming. It is responsible for

80 percent of tropical deforestation. Furthermore, intensive farming kills beneficial insects and plants, degrades and depletes the very soil it depends on, creates polluted runoff and clogged water systems, increases susceptibility to flooding, causes the genetic erosion of crops and livestock species around the world, decreases biodiversity, and destroys natural habitats.

(d) **Urbanisation and crowding:** Increased urbanisation reflects both the growth of population in urban areas and the migration of people from rural to urban areas. Crowd, more vehicles, traffic congestion, pollution, poverty, slumming, in sanitary conditions, etc., are all the results of overcrowded cities.

(e) **Poverty and unemployment:** Overpopulation leads to unemployment, as there is less jobs vis-à-vis demand for the jobs. Therefore, a rapid growth in the numbers of working population, leads to pressure on governments to increase employment opportunities. Resources, which could have been devoted to investments, have to be used to provide social capital, e.g. schools, hospitals, etc. Nevertheless, rapid population growth does make development more difficult. The problem of poverty is not merely one of numbers of people; it also involves issues relating to quality of life and material well-being.

(f) **Increased emergence of new epidemics and pandemics:** A World Health Organisation (WHO) report shows that environmental degradation, combined with the growth in world population, is a major cause of the rapid increase in human diseases. Every three seconds, a young child dies in most cases from an infectious disease. In some countries, one in five children dies before their fifth birthday. Every day 3,000 people die from malaria. Every year 1.5 million people die from tuberculosis and another 8 million are newly infected. Overpopulation worsens a number of social and environmental factors like, overcrowded living conditions, pollution, malnutrition, and inadequate or non-existent health care, which wreak havoc on the poor and increase their likelihood of being exposed to infectious diseases.

(g) **Lower life expectancy in the fastest growing countries:** Already strained with relentless population explosion, many developing countries, such as in Sub-Saharan Africa and Southern Asia, are experiencing a degradation of their quality and length of life as they face increasing difficulties to supply water, food, energy and housing to their growing populations, which have major repercussions for public health, security measures and economic growth. These situations are especially grim for populations in Uganda, Nigeria, and Bangladesh.

Population Explosion in India:

Introduction:

India is the second most populous country in the world next only to China. As per the CEIC Data, the current estimated total population of India is 1369 million (2022). Population projection for the year 2050 shows that India will surpass China to become the world's most populous country. It accounts for 16.7 percent of the world's total population over only 2.42 percent of the world's total land area. The total population of North America, South America and Australia added together is less than the population of India. On the top of it, we are adding over 17 million people each year. It is more than the total population of Australia. In fact, the net addition to Chinese population each year is less than ours.

Table 3.3

India: Trends of Population Growth and Explosion (1901-2022)

Year	Population (millions)	Birth Rate (per thousand)	Death Rate (per thousand)	Natural Rate of Increase (percent)
Period of Stagnant Growth of Population				
1901	236	--	--	--
1911	249	49	43	6
1921	248	48	47	1
Period of Steady Growth of Population (Mortality-induced)				
1931	276	46	36	10
1941	315	45	31	14
Period of Population Explosion (Fertility-induced)				
1951	360	40	27	13
1961	439	42	23	19
1971	548	37	15	23
Period of Population Explosion with Signs of Decline				
1981	685	34	12	22
1991	844	31	11	20

2001	1028	25	08	17
2011	1210	22	07	15
2022	1369 (est.)	17 (est.)	07 (est.)	10 (est.)

Note: est. – Estimated; Source: Census of India (2011); www.ceicdata.com (for 2022 data); www.macrotrends.net (for 2022 data)

Trends of Population Growth in India:

Trends of population growth of India since 1901 show significant demographic changes (Table 3.3). These changes can be better understood with the help of following phases, as depicted in Fig 3.5:

(a) **Period of Stagnant Growth of Population (1901-1921):** Population growth during this period was, more or less, stagnant as the high birth rates counterbalanced high death rates. Both birth rate and death rate were above 40 per thousand persons. During this period, India's population grew from 236 million to only 248 million at a growth rate of 5 percent. The year 1921 registered a negative growth rate making it a year of 'great divide'. High death rate during this period was the product of epidemics like influenza, plague, cholera, etc. Food shortages caused by severe droughts and killing of soldiers during the World War I were responsible for high death rate.

(b) **Period of Steady Growth of Population (1921-1951):** During this period, population increased from 248 million to 360 million, with an addition of about 112 million people. This period registered a population growth of 47 percent. The population growth during this period is known as 'mortality induced' growth due to declining death rate and increasing birth rates. Death rate was reduced from 47 per thousand in 1921 to 27 per thousand in 1951, whereas, the birth rate remained high at around 40 per thousand. The slowdown in death rate was a result of the control over epidemics with the help of improvement in general health and sanitation conditions after 1921. Improved transportation and subsequent effectiveness in food and medicine supplies was a responsible factor.

(c) **Period of Population Explosion (1951-1981):** This is the period from when population explosion began in India. The post-1951 period has recorded an unprecedented growth in the country's population. During this period, population increased from 360 million in 1951 to 685 million in 1981, with a growth rate of about 112 percent. During this period death rate (from 27 per thousand in 1951 to 12 per thousand in 1981) declined much faster than the birth rate (from 40 per

thousand in 1951 to 34 per thousand in 1981). It led to high natural increase of population. Thus, this period is known as 'fertility induced' growth of population. The huge growth in population during this period was due to large scale developmental activities in different parts of the country, improved conditions of food supply, and improved medical services, and consequent betterment of living conditions.

(d) **Period of Population Explosion with Signs of Decline (1981-2022):** Although overall population growth was registered in this period, the decadal growth rates recorded the decline. In this period, population increased from 685 million in 1981 to 1210 million in 2011, and further to 1369 million in 2022 (estimated). The growth rate of 2.22 percent in 1981 was declined up to 1.64 percent in 2011. During this period, birth rate declined rapidly from 34 per thousand in 1981 to 22 per thousand in 2011, and further to 17 per thousand in 2022 (estimated). On the other hand, declining trend of death rate does continue from 12 per thousand in 1981 to 7 per thousand in 2011, and further to 10 per thousand in 2022 (estimated). This declining trend is a positive indicator of the population control initiatives. It shows that the country has now reached the stage 3 of its demographic transition.

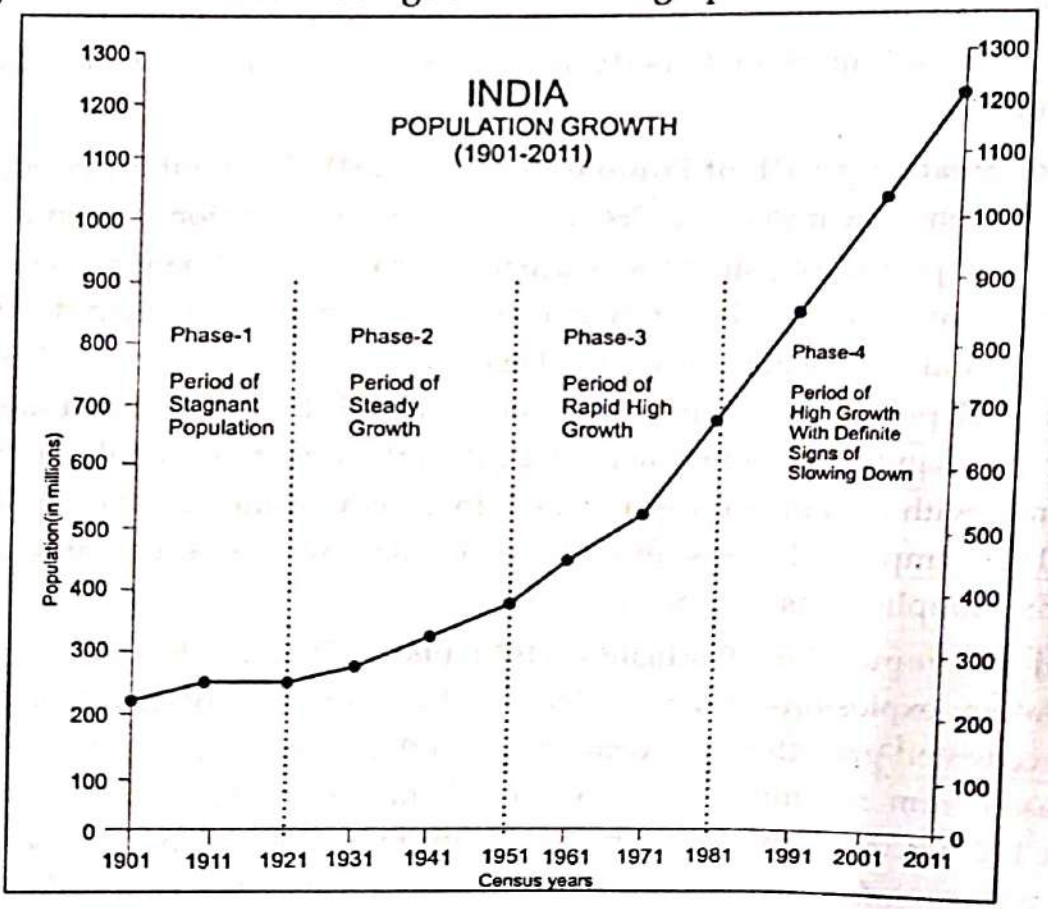

Fig. 3.5 India: Growth of Population (1901-2011)

Towards 'Young' Revolution:

It should be noted that decline in death rate is the chief contributing factor for the rapid rise of India's population. The percentage of young population in India's total population has increased. About 36 percent of the country's population that was below 15 years of age in 2004 is expected to enter into the age group of 15-30 years by the end of 2020. India is standing at a demographic crossroad, bubbling with a 'young revolution'. Whether we can reap this demographic dividend of being the young nation by providing them education, employment and other needed socio-economic infrastructure, will decide the demographic future of India.

Patterns of Population Growth in India:

Introduction:

The recent inter-census period of 2001-2011 has emerged as the most significant turning point in India's census history. It is found that the decline in death rates has sharply decelerated and has been almost stabilized at a low level. The decline in birth rate has slowly accelerated and has well established. It has resulted in slowing down of the population growth rate. It is observed that in the period of 2001-2011 the low birth rates levels are regionally more widespread, covering most of the states and union territories. Similarly, in most of the states and union territories, the death rates are either close to or below the replacement level.

Patterns of Population Growth in India:

The census data on population growth rate during inter-census period of 2001-2011 brings out the following patterns of population growth in India (Fig. 3.6):

(a) **States and Union Territories with High Growth Rates (More than 20 percent):** Meghalaya, Arunachal Pradesh, Bihar, Jammu and Kashmir, Mizoram, Chhattisgarh, Jharkhand, Rajasthan, Dadra and Nagar Haveli, Daman and Diu, Pondicherry, Delhi.

(b) **States and Union Territories with Moderate (near-average) Growth Rates (12-20 percent):** Madhya Pradesh, Uttar Pradesh, Haryana, Gujarat, Uttarakhand, Manipur, Assam, Maharashtra, Karnataka, Tamil Nadu, Tripura, Odisha, West Bengal, Punjab, Himachal Pradesh, Sikkim, Chandigarh.

(c) **States and Union Territories with Low Growth Rates (Less than 12 percent):** Andhra Pradesh, Goa, Kerala, Nagaland, Andaman and Nicobar Islands, Lakshadweep.

National average for India's population growth is 17.6 percent. The inter-state variations in the growth rate of population are wide ranging between -0.47 percent in Nagaland to 27.82 percent in Meghalaya. Similar variations are observed in union territories, ranging between 6.23 percent in Lakshadweep and 55.5 percent in Dadra and Nagar Haveli.

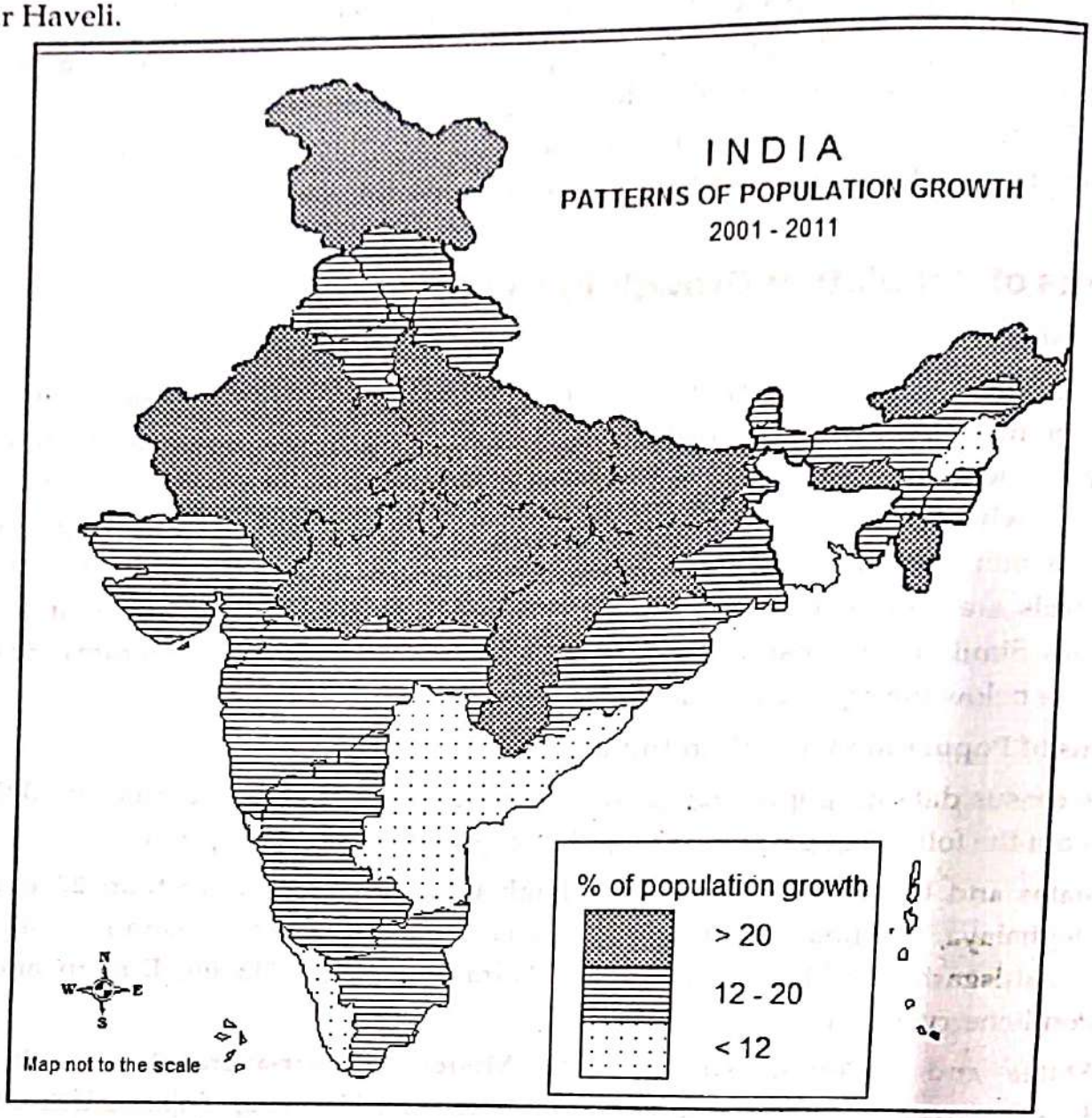

Fig. 3.6 India: Patterns of Decadal Growth Rate (2001-2011)

The top six most populous states of Uttar Pradesh, Maharashtra, Bihar, West Bengal, Andhra Pradesh and Madhya Pradesh recorded a decline in their population growth. The north-south divide existing in the pattern of growth until 2001 is narrowing down because the states in north India too have recorded a steep fall in their growth rate. The birth rates are stabilised in the contagious southern states, and this pattern is now

stretching to Maharashtra, Gujarat, Odisha and West Bengal. The rural-urban divide in the natural rate of increase is also narrowing down.

The Empowered Action Group (EAG):

The Census of India, 2011 has introduced the concept of Empowered Action Group (EAG) comprising of eighth states – Rajasthan, Uttar Pradesh, Uttarakhand, Bihar, Jharkhand, Madhya Pradesh, Chhattisgarh and Odisha – to take prompt measures to arrest their natural rate of increase. Bihar, Rajasthan, Uttar Pradesh, Madhya Pradesh, Jharkhand, Chhattisgarh among EAG states are still highly ranked for the birth rates, while Uttarakhand and Odisha are successful in controlling their birth rates. Overall, the growth rate in EAG states is much higher than the non-EAG states. It is mainly due to a sharp decline in their death rates and high birth rates.

Problems of Population Growth or Explosion in India:

Introduction:

India's population accounts for about 17 percent of the total world population, while the country occupies less than 3 percent of the land area worldwide. Almost every measure of progress that India has made since independence has been checked by its growing population. Food production has increased, but many people still remain hungry. Literacy has increased, but still the total number of illiterate people remains high.

Concerns and Problems of (Explosive) Population Growth in India:

Following are various problems and concerns (Fig. 3.7) that arise due to explosive growth of population in India:

(a) **Stress on natural resources:** Large numbers of population puts huge pressure on environmental factors leading to their quantitative loss and qualitative degradation. The expansion of economic activities has taken place at the expense of forest and grazing lands. It has led to loss of productivity, water logging, Stalinisation, and alkalinisation of croplands and eutrophication of water bodies, and thus, reductions in biodiversity across the country. The increasing population numbers and growing affluence have resulted in rapid growth of energy production and consumption. The environmental effects like ground water and surface water contamination; air pollution and global warming are of growing concern owing to increasing consumption levels.

(b) **Poverty:** Excessive growth of population with scarce resources leads to deprivation. Deprivation results in poverty. According to the data released by the World Bank in

2015, the percentage of persons living below the poverty line in India is 12.4 percent. These poor people are deprived of necessities, live in the most unhygienic, and degraded conditions.

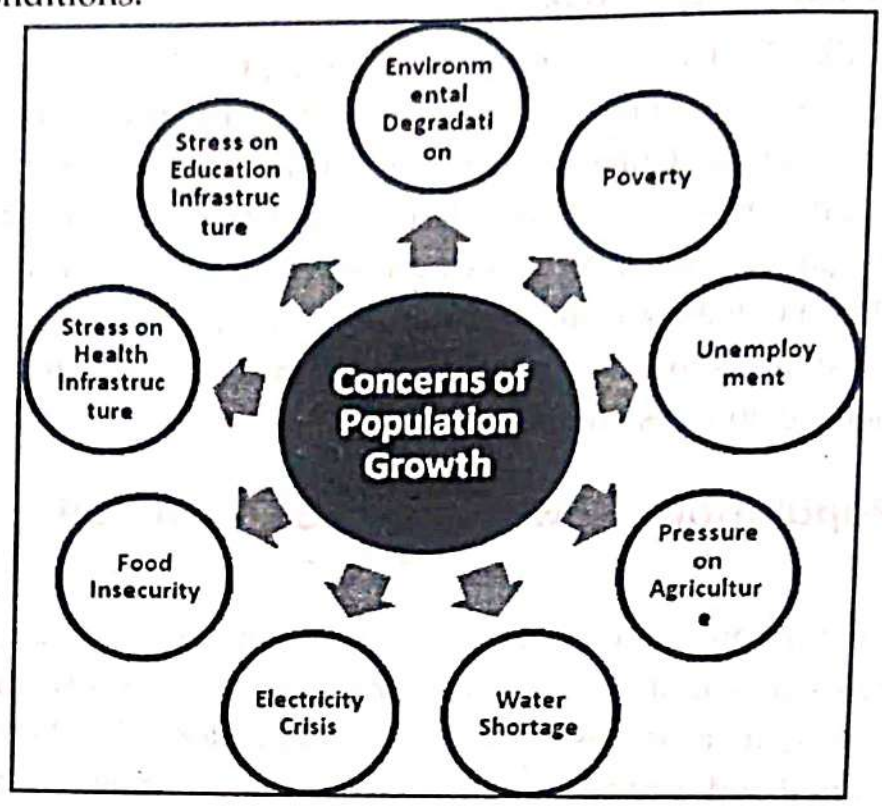

Fig. 3.7 Concerns of Population Growth

(c) **Unemployment:** With high fertility, the demand for jobs will be more than double in the next fifty years. The unemployment rate in India has shot up to a five-year high of 5% in 2015-16, with the figure significantly higher at 8.7% for women as compared to 4.3% for men. By 2061, the number of people requiring jobs could reach 1218 million. Moreover, nearly one-third of India's population is under age 15 and will be entering the labour force soon. Slower population growth would buy more time to create jobs for youth entering the labour force, ease high unemployment, and thus contribute to economic development.

(d) **Pressure on agricultural land:** Among all the countries worldwide, India faces the most acute pressure on agricultural land. Today, every million hectare of land supports 7.27 million people. The per capita availability of agricultural land in rural areas has declined consistently, and is expected to decline further due to population growth.

(e) **Food insecurity:** Such a situation leads to the problem of food insecurity. In 2010, the Targeted Public Distribution System provided 134 million people with a food subsidy. If population growth continues according to the high fertility scenario, the demand for food would rise so that the number of people who require a food

subsidy would double in fifty years; and greater pressure would be placed on the government to provide food subsidies.

Water shortages: Approximately, 130 million people in India do not have access to safe drinking water. If high fertility levels continue, greater demand will be placed on India's already limited water resources, and the number of people without access to safe drinking water will double, from 134 to 267 million people.

) **Electricity shortage:** Electricity shortage is an issue in India, particularly in urban areas where load shedding is common. Currently, India produces 7 billion kilowatt hours, with a per capita electric consumption of 631 kilowatt hours. At this rate, India will need to produce more than 1.5 trillion kilowatt hours of electricity to meet expected demand if fertility remains high.

h) **Stress on health infrastructure:** With rapidly growing demand, the health sector is already facing human resource and infrastructure shortages. If high fertility continues, the escalating demand for health services will place even greater pressure on an already overburdened health system. For example, in 2001, there was one nurse to 676 people. India would need to more than double the number of nurses by 2061 if high fertility continues.

(i) **Stress on education infrastructure:** Higher birth rate is putting excessive pressure on India's education infrastructure. The teacher-student ratios are very high. There is shortage of classrooms, blackboards, laboratories, playing grounds, etc. Fewer students require fewer teachers. In 2001, there were 43 primary students to one teacher. The government aims to reduce this ratio to 35 students per teacher.

The above issues show that unprecedented population growth in India is acting as an obstruction to economic development. Moreover, the problem also lies in the way we manage our available resources. Thus, though, India is experiencing slight fall in its birth rate, much is still to be done to control population.

Measures Taken to Control Population Growth in India:

Introduction:

Human population control is the practice of artificially altering the rate of growth of population. Population control involves measures that improve people's lives by giving them greater control on their reproduction.

Family Planning Programmes (1952 onwards):

In India, population control measures are executed through government policy mechanisms. Though full-fledged population policy was framed very late, various

population control programmes have been implemented since 1951 through five-year plans. These programmes and policies are targeted to influence fertility, mortality and migration-induced growths. The family planning programme, being implemented since 1952, has four broad approaches:

(a) **The Clinic Approach:** As per this approach, family planning clinics were set up in the country and those who needed family planning were expected to take fullest advantage of these facilities.

(b) **The Extension Approach:** It involves the adoption of an educational approach to bring about changes in the knowledge, attitudes and behaviour of the people.

(c) **The Integrated Approach:** According to this popular and more successful approach, family planning initiatives were integrated with maternal and child health facilities.

(d) **The Camp Approach:** It involves holding public camps for carrying out family planning related procedures like sterilizations.

The family planning programme, in association with other programmes and policies like National Family Welfare Programmes, the National Health Policy, etc., became successful in bringing down the fertility rates.

National Population Policy (2000):

The National Population Policy (NPP), introduced in the year 2000, thus, had an aim of stabilizing the population by achieving net replacement of the fertility rate by the year 2045. To achieve these aims and objectives, following steps were undertaken:

(a) The National Commission on Population (NCP) was formed in the year 2000. The Commission, chaired by the Prime Minister, has the mandate to review, monitor and give directions for implementation of the NPP.

(b) The National Population Stabilisation Fund (NPSF) was setup as an autonomous society of the Ministry of Health and Family Welfare in 2005. Its broad mandate is to undertake activities aimed at achieving population stabilisation. The NPSF has adopted following strategies:

- **Santushti Strategy:** For inviting doctors to conduct sterilisation operations in Public-Private Partnership mode.
- **National Helpline:** For running call centres for providing free advice on reproductive health, family planning, maternal health, child health, etc.
- **Advocacy Activities:** For executing awareness and advocacy efforts on population stabilisation, establishing networks and partnerships for spreading

its activities through various media at the national, state, district and block level.

- **Prerana Strategy:** For helping to push up the age of marriage of girls and delay in first child and spacing in second child and to award the couple who adopt this strategy.

(c) Programmes like the National Rural Health Mission, Janani Suraksha Yojana, Integrated Child Development Services, etc. have also been launched by the government to tackle the healthcare needs of people. It is also expected to contribute to population stabilisation.

(d) Free contraceptives are also being provided. In addition, monetary incentives are given to couples undertaking permanent family planning methods. Rewards were given to Panchayats and Zilla Parishads for their exemplary performance in universalising the small family norm. Cash incentive is given to parents at the birth of the girl child of birth order 1 or 2, under the Balika Sammridhi Yojana.

(e) Nutritional and educational problems are being targeted through programs like the mid-day meal scheme, and the recently enacted Right to Education. Facilities like Crèches and child care centres, and increased vocational training schemes for girls were given by the government.

(f) The policy also called for strict enforcement of laws that are directly or indirectly related to population control, such as, Child Marriage Restraint Act, 1976 and Pre-Natal Diagnostic Techniques Act, 1994.

Appreciation of Measures:

The policy has been successful in bringing down the population growth rates in the BIMARU states (Bihar, Madhya Pradesh, Rajasthan and Uttar Pradesh) and Odisha together with Chhattisgarh, Jharkhand and Assam as well as in the EAG states. However, the NPP did not work successfully in other demographic parameters. It failed to achieve the basic demographic goals set out for 2010. The infant mortality rate was to have been reduced to 30 per thousand live births, but India ended up with 40 per thousand live births. The policy aimed at the maternal mortality ratio to less than 100 per 1 lakh live births, while the country's maternal mortality ratio is 167 per 1 lakh live births. Similar failures in meeting goals are observed in case of sex ratios, ageing, and migration-induced population growth.

India has reached such a stage where she has the youthful population. Most of her population falls into the young age group. We need population policy that will use this strength to build a developed nation. However, several factors are pulling back great

achievements. A new population policy that protects our demographic assets while preparing for difficult challenges is a need of the hour.

Human Population and Environment:

Introduction:

The world population has grown from 3 billion in 1960 to 7 billion in 2011. 4 billion populations added in last fifty years. In this period, we have achieved better control over diseases and death and brought down mortality rates. Life expectancy has increased. Poverty ratios are declining. We have discovered new resource areas, invented sophisticated technologies, and increased food productivity. However, in the same period, we had an encounter with worsened cases of air and water pollution, land degradation, instances of acid rain, ozone layer depletion, global climate change, fear of sea level rise, etc.; all of these threatening very human survival. Thus, the data during the period 1960 to 2011 has shown that more the people, more is the environmental degradation.

Environmental Implications of Human Population:

L. Hunter (2000) in his essay 'Population and Environment: A Complex Relationship', examines how specific population factor influences environment.

(a) **Population size and environment:** As population size continues to increase, stress on global resources like arable land, forests, water, fisheries, etc. also increases tremendously. In the latter half of the 20th century, shrinking agricultural lands resulted in limits to global food production. In the same way, population growth affects accelerating demand for water. Global water consumption raised six fold between 1900 and 1995, more than double the rate of population growth. Thus, increased population pushes resources to their maximum limit creating threats of their extinction.

(b) **Population distribution and environment:** The distribution of population in the world is uneven. As per estimates for the year 2014, about 83 percent of the total world population lives in less developed countries. Further, human migrations are at all-time high, and the trend is to move from rural to urban areas, showing concentration of population in urban areas. Such an uneven distribution leads to more concentrated regional impacts on the environment. As less developed countries cope with a growing population, pressures intensify on already dwindling resources within these countries. Migration swings relative pressures exerted on local environments, easing the strain in source areas and increasing it in the

destination areas. Further, urbanisation in less developed countries outpaces the development of infrastructure and environmental regulations, resulting into high levels of pollution.

(c) **Population composition and environment:** Different behaviour by different segments of populations affect environment. For instance, age-sex composition of the world population shows large number of the young and elderly population. As younger people are more likely to migrate, we might anticipate increasing levels of migration and urbanisation, and subsequent intensification of urban environmental concerns. Income levels are also related to environmental conditions. It is seen that middle-income countries are most likely to exert powerful pressures on the natural environment, mostly in the form of intensified resource consumption and the production of wastes. On the other hand, low income countries exert relatively less powerful pressure due to low levels of industrial engagement. At highly advanced development stages, environmental pressures may subside because of improved technologies and energy efficiency.

(d) **Technology and environment:** The technological changes that have most affected environmental conditions relate to energy use. The consumption of oil, natural gas, and coal increased dramatically during the 20th century. Until about 1960, developed nations were responsible for most of this consumption. Since then, however, industrialization in the newly developing nations has resulted in greater reliance on resource- intensive and highly polluting production processes.

(e) **Cultural factors and environment:** Cultural factors of the population also affect the environment. For example, cultural variations in attitudes toward wildlife and conservation influence environmental conservation strategies, because public support for various policy interventions will reflect societal values. Religious factors are one of the major factors that are responsible for extreme pollution of the Ganges in India.

(f) **Population and global climate change:** Among many environmental problems faced by the humanity today, global climate change is the most serious one. It has been seen in recent years that temperatures are rising and rainfall patterns are becoming erratic. These changes are influenced by growing concentrations of greenhouse gases, which absorb solar radiation and warm the atmosphere. Many changes in atmospheric systems are the result of human beings, esp. due to demographic factors. Increasing industrial production and consumption of fossil fuels leads to carbon dioxide emissions. Landuse changes, such as deforestation, affect the exchange of carbon dioxide between the Earth and the atmosphere.

Agricultural processes like, paddy-rice cultivation and livestock production, are responsible for greenhouse gas (esp. Methane) releases into the atmosphere. Population growth will account for 35 percent of the global increase in carbon monoxide emissions between 1985 and 2100 and 48 percent of the increase in developing nations during that period. As such, both attention to demographic issues and the development of sustainable production and consumption processes are central responses to the processes involved in global warming.

Environment and Human Health:

Ecosystem Services and Human Health:

Ecosystem services are the benefits that people obtain from ecosystems. These services, often not acknowledged and taken-for-granted, are indispensable to the wellbeing of all people. They include provisioning (food, freshwater, wood, fibre, fuel, etc.), regulating (climate, floods, diseases, water, etc.) and cultural services (aesthetic, spiritual, educational, recreational, etc.) that directly affect people, and supporting services (nutrient cycle, soil formation, primary production, etc.) needed to maintain the other services.

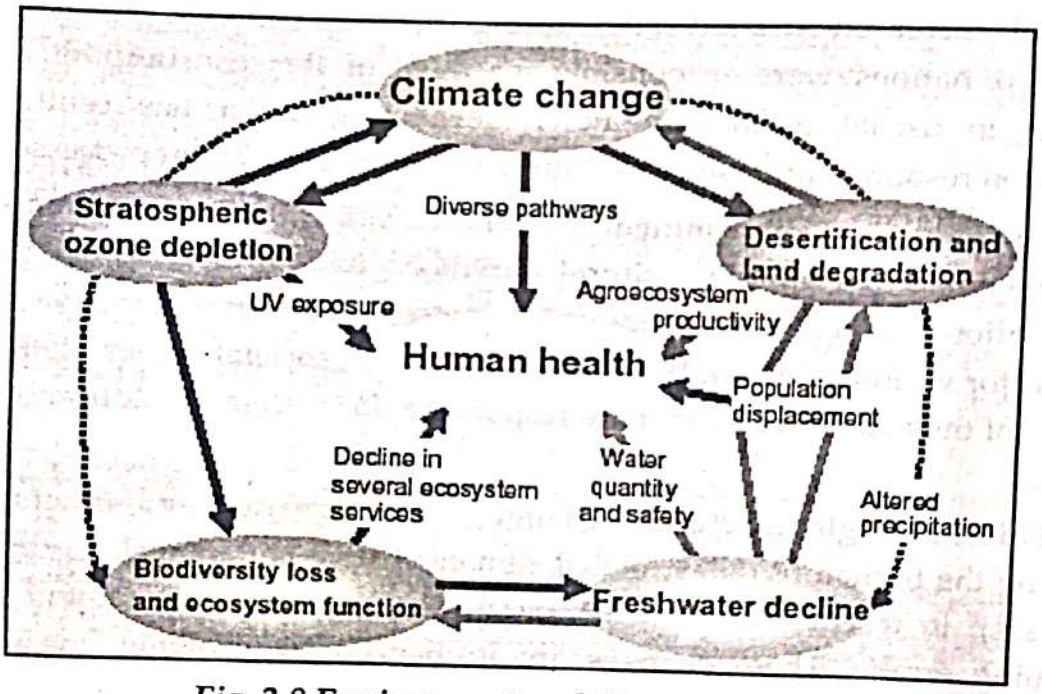

Fig. 3.8 Environment and Human Health

The WHO defines health as 'a state of complete physical, mental, and social wellbeing, not merely the absence of disease'. Human health ultimately depends upon ecosystem products and services (such as availability of fresh water, food and fuel sources) which are necessities for sound human health. Significant direct human health

impacts can occur if ecosystem services are no longer adequate to meet the needs. Such impacts occur if there is quantitative loss and qualitative degradation of these ecosystem services (Fig. 3.8).

Issues related to Environment and Human Health:

The complex relationship between the damaged ecosystem services and its impact on human health can be understood with the help of following issues:

(a) **Air pollutants and health:** Air pollution spoils the quality of air that we breathe. Air pollutants like sulphur dioxide, nitrogen dioxide, carbon monoxide, hydrocarbons, and particulate matter, enter into our lungs and create acute to chronic health disorders. For instance, sulphur dioxide causes acute allergic asthma, bronchial spasms, and if aggravated, it causes chronic bronchitis and pulmonary fibrosis that leads to increased stress on the heart. Exposure to carbon monoxide leads to serious disorders like polycythemia (increased red blood cells), weakness, fatigue and headaches. Depending upon nature and size, suspended particulate matter causes irritation and systemic toxicity. Long exposure to asbestos dust and silica causes asbestosis and silicosis respectively.

(b) **Water pollutants and health:** The growing pollution of rivers and other water bodies constitutes a very big threat to public health. Water borne diseases are spread by drinking water contaminated by faeces, by water used for personal hygiene, for washing food and other items. Pathogens (diseases causing) present in domestic water supply cause diarrhoea, cholera, typhoid and hepatitis. Polluted waters lead to various gastrointestinal problems, liver infection, cancer, etc. Diseases are spread by poor quality water used for washing, and causes skin diseases like scabies and eye disease such as trachoma and conjunctivitis. Diseases transmitted by vectors (carrier of pathogens) like mosquitoes, which live in the water, are responsible for about one third of all deaths in the world. Mosquito is responsible for transmitting malaria, yellow fever, encephalitis, filarial and dengue.

(c) **Heavy metal toxicity:** The heavy metals often encountered in the environment include lead, mercury, arsenic, and chromium. These are known to cause toxic effects in living organisms. It can cause irreversible behavioural disturbances, neurological damage and other developmental problems in young children and babies. Typical symptoms of mercury poisoning are irritability, excitability, loss of memory, insomnia, and tremor. Arsenic is associated with copper, iron and silver ores. Chronic arsenic poisoning leads to loss of appetite and weight, diarrhoea, gastrointestinal disturbances, and skin cancer.

(d) **Sanitation, habitation and health:** Unregulated growth of habitations, inadequate infrastructure facilities and lack of proper facilities for collection, transportation, treatment and disposal of wastes have all contributed to increased pollution causing health hazards. Lack of proper toilets, especially in villages, towns and slum areas of cities does not permit proper disposal of human waste, which in turn, leads to improper sanitary conditions and health problems. Poor drainage or improper drainage results in the accumulation of wastewater in public places in villages, towns and cities. Animal excreta and movement of cattle in and out of water pools and puddles spreads this filth over larger areas further causing sanitary problems. Contamination of food, often due to lack of understanding of the reasons and consequences is another health hazard faced by humans. Poor personal hygiene and eating without washing of hands lead to many types of health problems.

(e) **Cancer and environment:** It is now understood that cancer is largely an environmental disease. The WHO sources estimate that up to 95 percent of all cancer is caused by environmental factors. It means that pollutants such as agricultural and industrial chemicals are the culprits. However, other factors like radiation, diet, tobacco smoking and sunlight are also significant cancer-causing factors. A number of chemicals released as pollutants like arsenic, benzene, chromium, cadmium, diethylstilboestrol, hematite, phenacetin, vinyl chloride, etc. are carcinogenic (cancer-causing) and causes cancers of skin, lung, liver, bladder, uterus, nasal cavities, kidneys, and brain.

(f) **Occupational health hazards:** The work environment exposes workers to health hazards that contribute to injuries, respiratory diseases, cancer, musculoskeletal disorders, reproductive disorders, cardiovascular diseases, mental and neurological illnesses, hearing loss, etc. Such health hazards are termed occupational health hazards, being associated with occupation. Workers who are exposed to heavy physical work carry out repetitive tasks, and static muscular load that leads to injuries and musculoskeletal disorders. Workers in mining, manufacturing and construction industries are exposed to high levels of noise that lead to auditory fatigue, deafness and impaired hearing. Workers exposed to suspended particles suffer from respiratory disorders. Teachers, for example, suffer from throat irritation and infections due to chalk-dust.

(g) **Environment and COVID-19 pandemic:** The outbreak of COVID-19 pandemic in the later months of 2019 and its aftermath has compelled the humanity to look at the way we are treating our environment. It is well-known how the COVID-19 lockdowns impacted environment in terms of reduction in pollution. However, it

also must be understood how human-induced environmental degradation has caused the pandemic like the COVID-19. Various recent studies shows that the same human activities that drive climate change and biodiversity loss also drive pandemic risk through their impacts on the environment. Unsustainable ways of land utilisation, agricultural expansion and intensification, and finally the unsustainable trade, production and consumption disrupts nature and increases the contact between wildlife, livestock, pathogens and people. This subsequently makes us more vulnerable to the outbreaks of such pandemic. The 2021 Global Risk Report (2021), published by the World Economic Forum, reveals those environmental concerns including climate change and biodiversity loss - linked to the rise in global pandemics - are among the top long-term risks the world is likely face in the next decade. It is clear that the destruction of nature is increasing human vulnerability to pandemics, accelerating climate change and placing livelihoods at risk.

Human Development Index (HDI):

Concept:

Over the past decades, there have been unprecedented increases in material wealth and prosperity across the world. At the same time, these increases have been very uneven, with vast numbers of people not participating in the progress. Mass poverty, deeply entrenched inequality, and lack of political empowerment contribute to deny a large share of the world's population the freedom to make real choices. These issues led to the endorsement of Human Development Index (HDI), as a measure of human development, by the United Nations.

The Human Development Index (HDI) was developed in 1990 by Indian Nobel Prize winner Dr. Amartya Sen, Pakistani economist Mahbub-ul-Haq, Gustav Ranis of Yale University and Lord Meghnad Desai of the London School of Economics, UK. The basic objective of development is to create an enabling environment in which people can enjoy long, healthy and creative lives. Since then, the United Nations Development Programme (UNDP) has urged the use of HDI as a measure of development. The UNDP believes that the HDI is a more reliable and accurate measure of development as it sees human development as a process of expanding the real freedoms that people enjoy.

Measuring HDI:

HDI is a summary measure of average achievement in key dimensions of human development: a long and healthy life, being knowledgeable and have a decent standard of living. The HDI is the geometric mean of normalized indices for each of the three dimensions:

(a) **Health:** The health dimension is assessed by life expectancy at birth. It indicates at the health status of the people as well as access to and quality of healthcare services in a country.

(b) **Education:** The education dimension is measured by mean of years of schooling for adults aged 25 years and more and expected years of schooling for children of school entering age. It indicates the access to and quality of education infrastructure and helps to infer the quality and skills of citizens.

(c) **Standard of living:** The standard of living dimension is measured by gross national income per capita. It is helpful to judge the country's comparative position with reference to its economic development.

The scores for the three HDI dimension indices are then aggregated into a composite index using geometric mean. The score of HDI varies between 0.0 to 1.0, where a country with 0.0 represents lowest human development and a country with 1.0 represents the highest human development.

Appreciation of HDI:

The HDI was created to emphasize that people and their capabilities should be the ultimate criteria for assessing the development of a country, not economic growth alone. The HDI can also be used to question national policy choices, asking how two countries with the same level of gross national income per capita can end up with different human development outcomes. However, many social scientists have criticised the HDI measure on the ground that it simplifies and captures only a part of what human development entails. It ignores a number of dimensions of human development that are non-monetary in nature. It does not reflect on inequalities, poverty, human security, empowerment, etc.

Patterns of Human Development in the World:

Table 3.4 reveals the patterns of human development in the world as reported in the Human Development Report, 2020. Norway, with a score of 0.957, and Niger, with a score of 0.394 continues to hold the positions as the countries with highest and lowest human development index respectively. India is at 131st position on human development scale with a score of 0.645.

Table 3.4

Patterns of Human Development in the World (2020)

Human Development	HDI Value	Examples of Selected Countries (Ranks in the Bracket)
Very High	> 0.799	Norway (1), Ireland (2), Switzerland (2), Hong Kong (4), Iceland (4), Germany (6), Sweden (7), Australia (8), Singapore (11), Israel (19), Chile (43)
High	0.700 – 0.799	Seychelles (67), Cuba (70), Islamic Republic of Iran (70), Sri Lanka (72), Thailand (79), Brazil (84), China (85), South Africa (114), Egypt (116)
Medium	0.549 – 0.699	Iraq (123), Bhutan (129), India (131), Bangladesh (133), Pakistan (154)
Low	< 0.549	Nigeria (161), Afghanistan (169), Sudan (170), Ethiopia (173), Central African Republic (188), Niger (189)

Source: UNDP Human Development Report (2020)

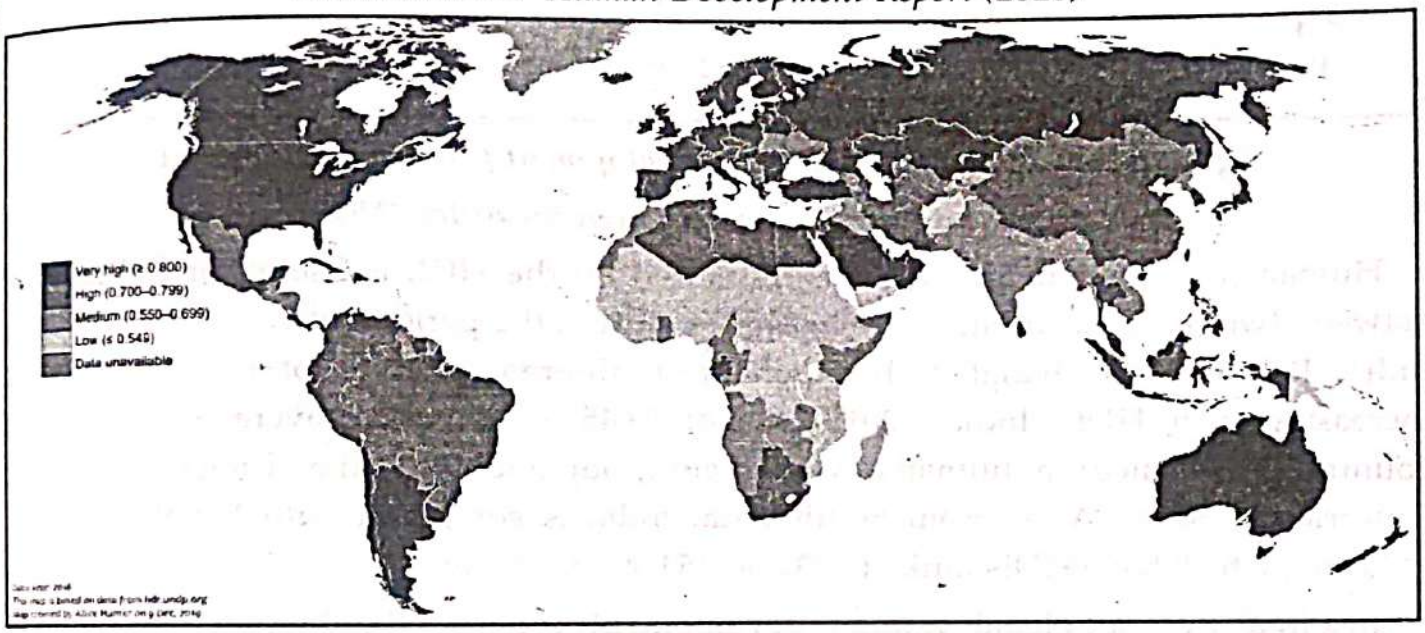

Fig. 3.9 Patterns of Human Development in the World (2020)

(https://commons.wikimedia.org/wiki/File:2019_UN_Human_Development_Report.svg)

Patterns of Human Development in India:

The Human Development Report, 2022 calculates India's HDI value as 0.645, which put the country in the medium human development category. It is positioned at 131st rank out of 189 countries and territories. Between 1990 and 2019, India's HDI value increased from 0.429 to 0.645 (Fig. 3.10), an increase of 50.3 percent. India's progress in each of the HDI indicators between 1990 and 2019 reveals that India's life expectancy at birth increased by 11.8 years, mean years of schooling increased by 3.5 years and

expected years of schooling increased by 4.5 years. India's GNI per capita increased by about 273.9 percent between 1990 and 2019.

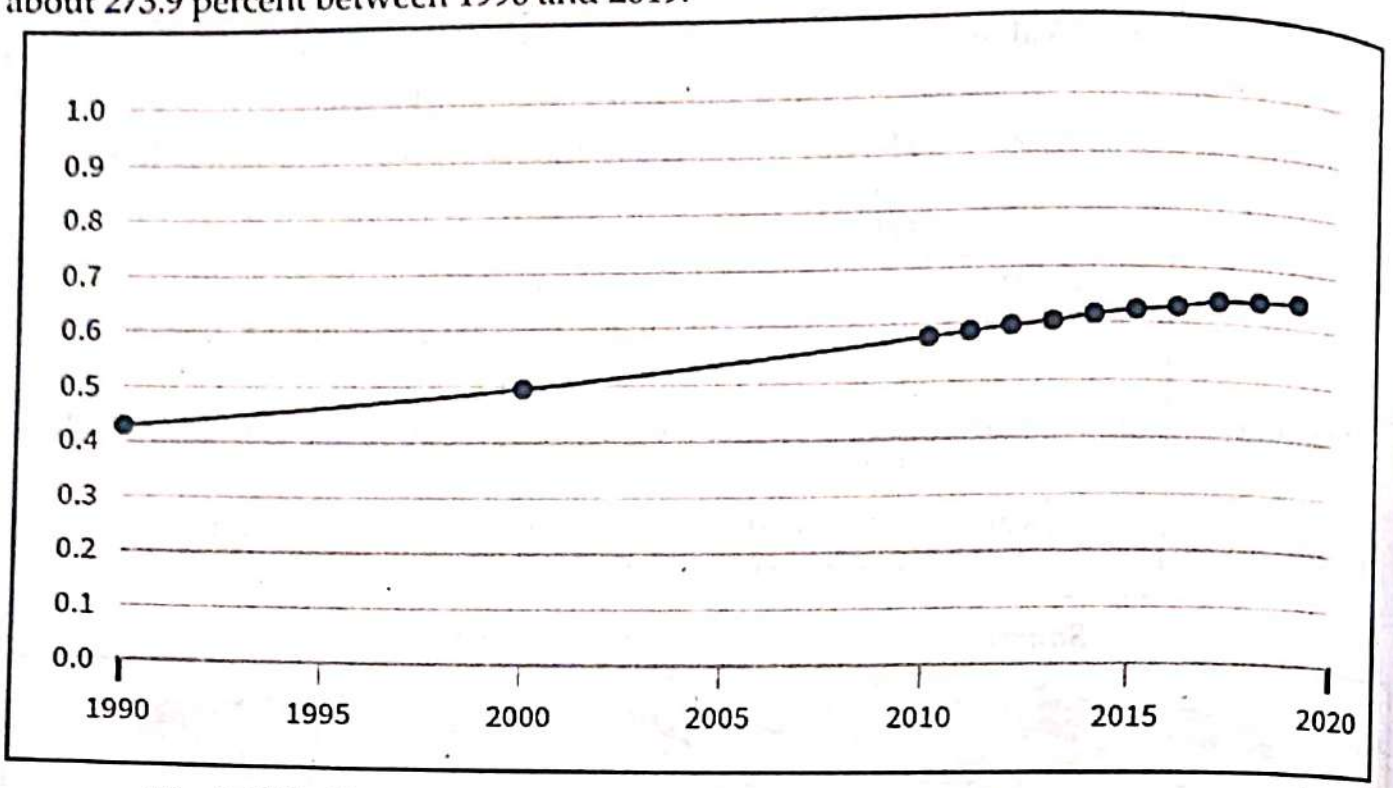

Fig. 3.10 India: Trends of Human Development from 1990 to Present)
(https://hdr.undp.org/en/countries/profiles/IND#)

Human development progress, as measured by the HDI, is useful for comparison between two or more countries. For instance, during the period between 1990 and 2019 India, Pakistan and Bangladesh experienced different degrees of progress toward increasing their HDIs. India's 2019 HDI of 0.645 is above the average of 0.631 for countries in the medium human development group and above the average of 0.641 for countries in South Asia. From South Asia, India is compared with Bangladesh and Pakistan, which have HDIs ranked 133 and 154, respectively.

Inspired by the global human development reports, the human development paradigm was introduced in the 8th Five-Year Plan. Some states in India started preparing sub-national human development reports. As themes like education and health falls into the state list of the Indian Constitution, it is quite natural that some of the state governments independently started preparing Human Development Reports. These reports largely followed the UNDP methodology. The world's first state human development report was published in Madhya Pradesh in 1995. Madhya Pradesh was then followed by several other states. In 2001, the Planning Commission released the first National Human Development Report. It compares the human development situation in the states in India with the help of about 70 development indicators for each

state. The recent National Human Development Report for India was published in 2010. Table 3.5 provides patterns of human development in India for the year 2011-2012, as calculated by the researchers of the National Institute of Public Finance and Policy, New Delhi.

Table 3.5

Patterns of Human Development in India (2011-12)

Human Development	HDI Value	States (Ranks in the Bracket)
High	> 0.600	Kerala (1), Goa (2), Himachal Pradesh (3), Tami Nadu (4), Maharashtra (5)
Medium	0.300 – 0.600	Punjab (6), Haryana (7), West Bengal (8), Jammu and Kashmir (9), Gujarat (10), Uttarakhand (11), Karnataka (12), Mizoram (13), Tripura (14), Sikkim (15), Rajasthan (16), Andhra Pradesh (17)
Low	< 0.300	Odisha (18), Nagaland (19), Meghalaya (20), Jharkhand (21), Manipur (22), Madhya Pradesh (23), Chhattisgarh (24), Bihar (25), Assam (26), Arunachal Pradesh (27), Uttar Pradesh (28)

Source: *Mukherjee, S. et al (2014)*

Calculations released by the Mint (2015) show that states like Tamil Nadu, Karnataka, Andhra Pradesh, Rajasthan, Odisha, and Madhya Pradesh have improved the human development standards, while Punjab, Gujarat, West Bengal, Assam, Uttar Pradesh, and Bihar show deterioration in their human development levels. Following are the salient characteristics of human development in India:

(a) **General Observations:** Overall human development level has been consistently high for states like Kerala, Goa, Himachal Pradesh etc., but Chhattisgarh, Uttar Pradesh, and Bihar remain among the bottom liners. Jammu and Kashmir, West Bengal and Tamil Nadu have enhanced their human development level due to consistent efforts of the successive governments. Jharkhand has shown a marginal improvement in human development scores in urban areas after separation from Bihar in 2004-05. Uttarakhand has witnessed a similar scenario after separation from Uttar Pradesh.

(b) **Education:** On the education front, Himachal Pradesh, Mizoram, Meghalaya, and Nagaland are among the toppers in the terms of achievements in urban areas, while Jammu and Kashmir, Uttar Pradesh, Bihar, and Rajasthan are at the other end of the spectrum. On the rural front, Kerala, Tripura and Himachal Pradesh remain at the top, while Bihar, Andhra Pradesh, and Arunachal Pradesh are at the other extreme. The rural-urban disparity for a number of states turns out to be major concern.

(c) **Health:** On the whole, in 2011-12, Jammu and Kashmir, Himachal Pradesh, Kerala, and Punjab are among the toppers, while Uttarakhand, Uttar Pradesh, Odisha, and Bihar are located at the bottom on the urban scale. On the rural front, Kerala, Jammu and Kashmir, Himachal Pradesh, Punjab and Haryana are at the top, while Assam, Meghalaya, Mizoram, and Arunachal Pradesh are at the other extreme.

(d) **Rural and Urban Consumption:** Goa, Kerala, Tamil Nadu, Himachal Pradesh, and Maharashtra are among the topper states in terms of urban consumption in 2011-12, while Manipur, Bihar, Uttar Pradesh Arunachal Pradesh and Nagaland are placed at the bottom. On the rural front, Goa, Kerala, and Punjab are at the top, while Uttar Pradesh, Chhattisgarh, and Madhya Pradesh are at the other extreme.

The World Happiness Index:

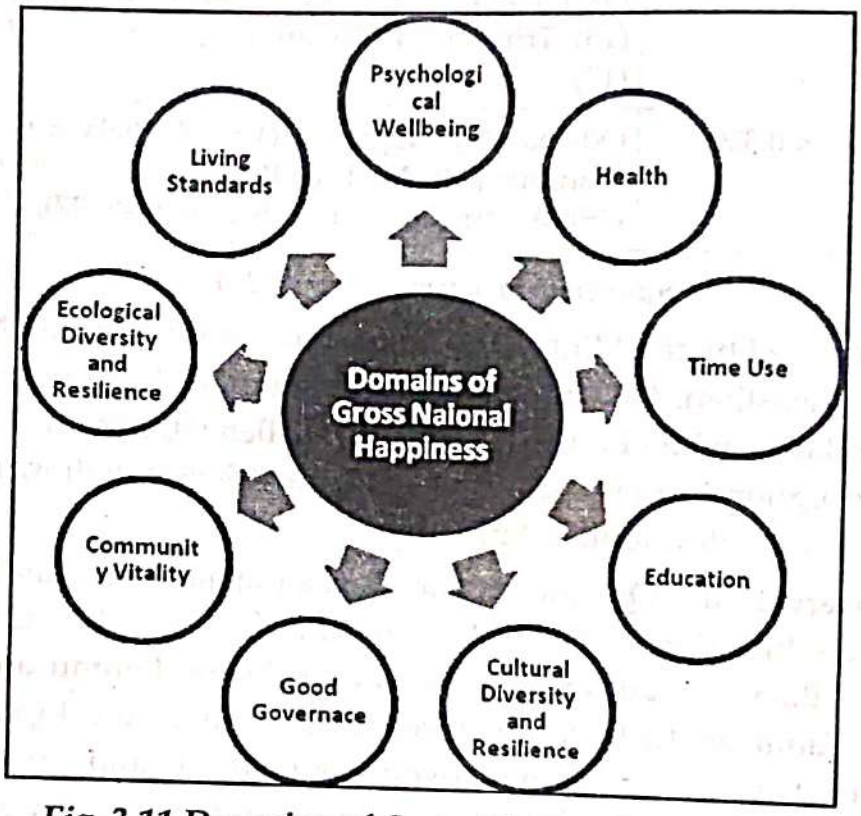

Fig. 3.11 Domains of Gross National Happiness

Concept of Gross National Happiness (GNH):

The phrase 'gross national happiness' (GNH) was first coined by the 4th King of Bhutan, King Jigme Singye Wangchuck, in 1972. It emphasized the need for taking holistic approach towards the notion of progress, and give equal importance to non-monetary aspects of wellbeing as well. GNH has often been explained by its four pillars; good governance, sustainable socio-economic development, cultural preservation, and environmental conservation. The four pillars have been further classified into nine domains. Fig. 3.11 shows nine domains that are considered in GNH.

Concept of Gross Happiness Index (GHI):

The Gross Happiness Index (GHI) is a statistical measurement of GNH. It includes both traditional areas of socio-economic concerns, such as living standards, health and education, and less traditional aspects related to culture and psychological wellbeing. It is a holistic reflection of the general wellbeing of the Bhutanese population rather than a subjective psychological ranking of 'happiness' alone.

Measuring Happiness:

There are 33 indicators in the nine domains of GNH. GHI seeks to measure the nation's wellbeing directly by starting with each person's achievements in each of these indicators. GHI identifies four groups of people - unhappy, narrowly happy, extensively happy, and deeply happy. The analysis explores the happiness people enjoy already, and then focuses on how policies can increase happiness among the unhappy and narrowly happy population groups.

The rankings in the World Happiness Report are based on answers to the life-evaluation questions asked in the poll. This is called the Cantril Ladder. It asks respondents to think of a ladder, with the best possible life for them being a 10, and the worst possible life being a 0. They are then asked to rate their own current lives on that 0 to 10 scale, on the basis of certain criteria.

Patterns of GNH:

In 2011, the United Nations supported Bhutan's GHI, calling for a holistic approach to development aimed at promoting sustainable happiness and wellbeing. The first World Happiness Report was published in 2012. The World Happiness Report, 2020 was published recently, based on the data from 2017 to 2019. The report ranks 153 countries by their happiness levels. The report measures the level of happiness with reference to six criteria – GDP Per Capita, Social Support, Healthy Life Expectancy, Freedom to Make Life Choices, Generosity, and Perceptions of Corruption. Following are the patterns of happiness as reported by the World Happiness Report, 2022:

(a) **The 'happiest' countries:** It includes economically developed countries – Finland (Rank 1), Denmark (2), Iceland (3), Switzerland (4), The Netherlands (5), Luxembourg (6), Sweden (7), Norway (8), Israel (9) and New Zealand (10). The United States ranked 19th, China ranked at 82 and India secured a rank of 136.

(b) **The ten most 'unhappy' countries:** It includes crisis states, wracked by disease or war – Haiti (140), Malawi (141), Lesotho (142), Botswana (143), Rwanda (144), Zimbabwe (145) and Afghanistan (146).

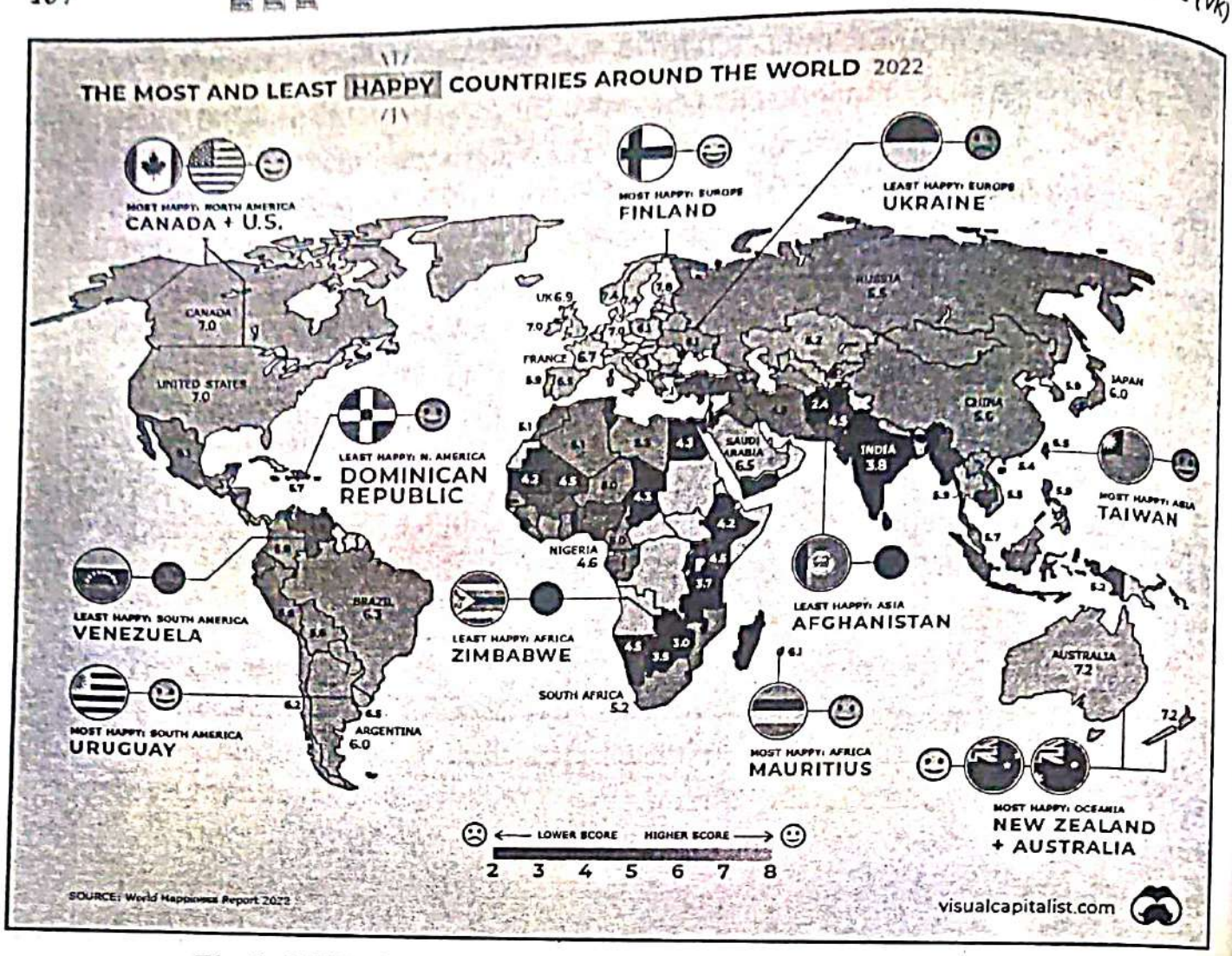

Fig. 3.12 World: Patterns of Gross National Happiness (2022)

(https://www.visualcapitalist.com/mapped-global-happiness-levels-in-2022/)

The levels of happiness in South Asia have largely fluctuated. India has shown change in her happiness index. India secured 136th rank in 2022. On one side, Indians expressed satisfaction on the basis of GDP Per Capita and Social Support, they have expressed deep unhappiness as far as corruption and generosity is concerned. China's rank has a slight change from 83 in 2015, to 82 in 2022. Pakistan (103), Nepal (85), Bangladesh (99), Sri Lanka (126) have done better than India. Fig. 3.12 is an interesting infographic by the visualcapitralist.com depicting the patterns of happiness as revealed by the World Happiness Report, 2022.

Criticism of GHI:

In spite of the huge international attention received by the concept of GHI, it has attracted strong criticism. GHI has been criticised because it is a government's perspective to define 'happiness' for its people. It defines and imposes a unitary set of values that does not protect diversity or individual rights, or at least addresses them

only in ways that can be defined and controlled by the government. Similarly, the overlap between the rich countries and the happy countries questions the very need of such a measurement.

Conclusion:

As a result of such a critical discussion, better measurements of happiness, with a broader spectrum are evolving. One of such measurements is the Happy Planet Index (HPI). HPI measures sustainable wellbeing for all. It tells us how well nations are doing at achieving long, happy, and sustainable lives. Unlike GHI, rich Western countries, often seen as the standard of success, do not rank highly on the HPI. Instead, several countries in South America and the Asia-Pacific region lead the way by achieving high life expectancy and well-being with much smaller ecological footprint. The HPI shows a new ray of hope for this exploding world by stating that it is possible to live good lives without costing the Earth.

Relevant Terms:

Population Explosion: Population explosion is a negative condition in which number of human population rises rapidly in a short span of time.

Fertility: Fertility refers to the occurrence of births or an ability to reproduce.

Crude Birth Rate: Crude Birth Rate (CBR) is a measure of fertility, which is expressed as number of live births in a year per thousand of population.

Mortality: Mortality is defined as permanent disappearance of all evidence of life at any time after birth has taken place.

Crude Death Rate: Crude Death Rate (CDR) is a measure of mortality, which is expressed as number of deaths in a year per thousand of population.

Migration: Migration refers to the permanent change of residence of people from one place to another.

Demographic Transition: Demographic transition refers to a sequence of change over a period of time occurring as a result of complex relationship among birth rate, death rate and overall population change.

Population Doubling Time: Population doubling time is the time that a country takes to double its population.

Population Control: Population control is the practice of artificially altering the rate of growth of population.

Ecosystem Services: Ecosystem services are the benefits that people obtain from ecosystems.

Health: Health as 'a state of complete physical, mental, and social wellbeing, no merely the absence of disease'.

Human Development Index: Human Development Index (HDI) is a summary measure of average achievement in key dimensions of human development: a long and healthy life, being knowledgeable and have a decent standard of living.

Gross Happiness Index: Gross Happiness Index (GHI) is a statistical measurement of GNH that includes both traditional areas of socio-economic concerns, such as living standards, health and education, and less traditional aspects related to culture and psychological wellbeing.

Review Questions:

(1) Discuss the concept of 'population explosion'. Explain the factors responsible for population explosion. Give examples from the world and India.

(2) Describe stages of demographic transition envisaged by the Theory of Demographic Transition. Give criticism.

(3) Discuss the different stages of population changes mentioned in 'Demographic Transition Theory'. ***(Nov. 17)***

(4) Discuss the "Demographic transitional theory". ***(March 17)***

(5) Describe the Demographic Transition Theory with diagram. ***(Dec. 18)***

(6) Describe the patterns of population growth in the world.

(7) Comment on the factors influencing the growth of population. ***(Nov. 17)***

(8) Discuss the various factors affecting growth of world population. ***(March 18)***

(9) Examine various problems associated with population explosion in the world. ***(May 19)***

(10) Explain the factors responsible for population explosion.

(11) Explain in detail pattern of population growth and associated problems in India. ***(Nov. 16)***

(12) Describe the trends of population growth in India with reference to population explosion.

(13) Discuss various problems associated with population explosion in India.

(14) Write a note on over population and associated environmental problems. ***(Nov. 17)***

(15) Give in details population explosion in India. ***(Nov. 16)***

(16) Which are the causes of population explosion in India? ***(Dec. 18)***

(17) Write a detailed note on population explosion in India. ***(March 17; May 19)***

(18) Describe the measures taken to control population growth in India. ***(Nov. 16)***

(19) Suggest various measures to control population growth with reference to India. ***(March 18)***

(20) Explain the National Population Policy of India in detail. ***(Dec. 18)***

(21) Discuss the environmental implications of human population.

(22) Explain the relationship between environment and human health with reference to the issues related to it.

(23) What is Human Development Index? Discuss the concept and patterns of Human Development Index in the world.

(24) What are the different criteria to measure Human Development Index (HDI)? ***(Nov. 17)***

(25) Discuss on Human Development Index. ***(Nov. 16)***

(26) Give an account of human development index. ***(March 17)***

(27) What is Human Development Index? Discuss its indicators. ***(March 18)***

(28) Explain the concept of HDI (Human Development Index) in detail. ***(May 19)***

(29) Discuss the concept of 'Human Development Index'. Discuss the patterns of human development in India.

(30) Elaborate the concept of 'Gross Happiness Index'. Discuss the patterns of gross national happiness in the world.

(31) **Write notes on:**

(a) Measures taken to control population growth in India. ***(March 17)***

(b) Environment and Human Health. ***(March 17, 18)***

(c) World Happiness Index. ***(March 18)***

(32) **Mark and label the following in the outline map of the world:**

(Answers given in bracket) **(a)** The country with highest population in the world (China) *[March 18]*, **(b)** A country at stage 1 of demographic transition (Bangladesh), **(c)** A country at stage 2 of demographic transition (Peru), **(d)** A country at stage 3 of demographic transition (Australia), **(e)** A country at stage 4 of demographic transition (USA), **(f)** A country with negative or very low population growth rate (Germany), **(g)** A region with negative or very low population growth rate (East Europe), **(h)** A country with moderate population growth rate (India), **(i)** A region with moderate population growth rate (Southeast Asia), (j) A country with very high population growth rate (Zimbabwe), **(k)** A region with very high population growth rate (Northeast Africa), **(l)** A country with low population growth rate (France), **(m)** A region with low population growth rate (West Europe), **(n)** A densely populated region (Indo-Gangetic Plains in India) ***[Nov. 16]***, **(o)** A sparsely populated region (Sahara Desert in Africa) ***[Nov. 16; March 17]***, **(p)** A country suffering from hunger and malnutrition (Rwanda), **(q)** A country with highest HDI or A country ranked first in HDI (Norway), **(r)** A country with lowest HDI (Niger), **(s)** A country with highest GHI or A country ranked first in GHI (Finland), **(t)** A country with lowest GHI (Afghanistan), **(u)** Any one country having low population growth rate from Africa (South Africa) ***[Nov. 17]***, **(v)** Any one country having low human development index from Asia (Afghanistan) ***[Nov. 17]***, **(w)** Any one country from Europe with high Human Development Index (Norway) ***[March 18]***, **(x)** Most populous country in the world (China) ***[May 19]***, **(y)** An Asian country having high Human Development Index (Japan) ***[May 19]***

Chapter 4

Urbanisation and Environment

"Cities have the capability of providing something for everybody, only because, and only when, they are created by everybody."

— Jane Jacobs,
The Death and Life of Great American Cities

Concept of Urbanisation – Problems of Migration and Urban Environment – Changing Land Use – Crowding and Stress on Urban Resources – Degradation of Air and Water – Loss of Soil Cover – Impact on Biodiversity – Urban Heat Islands – Emerging Smart Cities and Safe Cities in India – Sustainable Cities – Review Questions

Concept of Urbanisation:

Introduction:

The location, growth and relationship of the cities with the peripheral areas have been vibrant topics of study and research for urban planners, demographers, geographers, economists and social scientists. This is because cities or urban centres have a definite identity with reference to land use, function and the socio-cultural attributes of the people dwelling in the cities. The ecological approach of studying the urban centres therefore focuses on studying the relationships between the patterns and structure of urban society and the anthropogenic environment created in the city with both its immediate and distant neighbourhoods.

The urban population of the world has grown rapidly from 746 million in 1950 to 5 billion in 2018. Projections show that urbanisation combined with the overall growth

of the world's population could add another 2.5 billion people to urban populations by 2050, with close to 90 percent of the increase concentrated in Asia and Africa.

The world's urban population is expected to surpass six billion by 2045. Much of the expected urban growth will take place in countries of the developing regions, particularly Africa. As a result, these countries will face numerous challenges in meeting the needs of their growing urban populations, including for housing, infrastructure, transportation, energy and employment, as well as for basic services such as education and health care.

In 1990, there were ten "mega-cities" with 10 million inhabitants or more, which were home to 153 million people or slightly less than seven per cent of the global urban population at that time. According to the United Nations World's Cities Report 2018, there were 548 cities with at least 1 million inhabitants globally. By 2030, a projected 706 cities will have at least 1 million residents. While rural areas were home to more than 45 per cent of the world's population in 2018, that proportion is expected to fall to 40 per cent by 2030. As these cities increase in both size and number, they will become home to a growing share of the population. Of the world's 33 megacities (that is, cities with 10 million inhabitants or more) in 2018, 27 are located in the less developed regions or the "global South" most of which are located in Asia and Africa. China alone was home to six megacities in 2018, while India had five.

History of Urbanisation:

City formation and morphology of the cities has always caught the attention of researchers and scholars across social sciences. The history of city formation dates between 5,000 and 2,000 B.C. There are records of town and cities in the civilisations that flourished in Mesopotamia, Egypt, Greece, the Indus and the Ganges valley in India, the Roman Empire, China and South-East Asia.

Social scientists have studied that the necessary conditions required for the formation of cities would have included a prosperous agricultural economy that facilitated the production of surplus food to support a non-agricultural urban population. This would have allowed a section of the population to engage in non-agricultural activities. Advancement in technology like invention of the wheel, domestication and use of animals in agricultural operations, methods of irrigation, development of pottery, metallurgy and other related activities helped in various changes in the socio-economic organisation of these newly formed urban centres.

Increase in agricultural output, connectivity with improved transport also helped in the development of trade and further specialization of occupations. London, Paris, Delhi, Cologne, Berlin, Moscow and Rome are some of the examples of the historical cities in the world.

After the occurrence of the Industrial Revolution in Europe the course of the entire history of urbanisation changed. Use of machines running on steam power led to large scale extraction of coal from the coalfields and also resulted in creation of industrial towns. Improvements in transport played a triple role of increasing the mobility of people, helping in the movement of food and industrial raw material to the urban centres and distribution of the factory made finished products to distant markets. Thus it led to the hand in hand journey of industrialisation with urbanisation in the nineteenth century.

The period of colonisation also had a noticeable impact on the ancient cities and the newly formed urban centres especially in the colony countries. For example, 'Mumbai' the capital city of Maharashtra and the financial capital of India originally was divided into seven islands where the primary occupation was fishing. These seven islands initially were under the Portuguese possession and then were handed over as a part of the royal dowry in 1661 to *King Charles II* of England on his marriage to the Portuguese princess, *Infanta Catherine de Braganza*. During the period between the rise and fall of the British Empire, Bombay gradually developed into a harbour town, a city known for cotton textile mills, a metropolis of world renown with multiple industrial and commercial functions and now a global city in making experiencing the change in land-use due to gentrification. The name "Bombay" was changed to "Mumbai" in the year 1996. In spite of these changes in formation of Mumbai city, the architectural structures in Mumbai depict a history of colonisation and in the post globalisation phase it also portrays the process of gentrification. This transition from colonial towns to post-colonial cities and in the present times to global cities has been experienced by many cities in the developing world.

Table 4.1

Total Population of selected cities in the world

Cities	Population (2022)
Tokyo	37.5 million
Delhi	30.5 million
Seoul	25.71 million
Shanghai	24.3 million
Greater New York	22.8 million
São Paulo	22 million
Mexico City	21.7 million

Cairo	21.3 million
Mumbai	20.6 million
Beijing	20.8 million
Dhaka	20.7 million

Source: https://www.populationu.com/world-cities

From table 4.1 it can be observed that most of the cities with very high population are from the global 'south' while two cities from India i.e. Delhi and Mumbai record a very high population.

Meaning of 'Urban':

In the post-globalisation era, the boundary line between what is 'rural' and what is 'urban' is noticeably diminishing. From country to country definitions of 'urban' places differ. For example, in USA places having a population of 2500 or more are considered as urban areas. While in Iceland, all localities having a population of 200 or more people are considered as urban. Census of India gives a very comprehensive definition of both 'rural' and 'urban' areas because it has taken into consideration not just the size of population but also the economic function of the settlements. According to the Census of India, the bench mark to identify rural and urban areas is as described below:

A 'village' or a 'town' is recognised as the basic area of habitation. In the rural areas the smallest area of habitation, viz., the village generally follows the limits of a revenue village that is recognised by the normal district administration. The revenue village need not necessarily be a single agglomeration of the habitations. But the revenue village has a definite surveyed boundary and each village is a separate administrative unit with separate village accounts. It may have one or more hamlets. The entire revenue village is one unit. There may be unsurveyed villages within forests etc., where the locally recognised boundary of each habitation area is followed within the larger unit of say the forest range officers' jurisdiction.

For the Census of India 2011, the definition of urban area used is as follows:

- All places with a municipality, corporation, cantonment board or notified town area committee, etc.
- All other places which satisfied the following criteria of:
  - A minimum population of 5,000;
  - At least 75 per cent of the male main working population is engaged in non-agricultural pursuits; and
  - A density of population of at least 400 persons per sq. km.

Meaning of 'urbanisation':

Urbanisation means an increase in the proportion of people living in urban areas compared to rural areas. It is a process in which population gets concentrated in specific place because of its attractive factors. As per the definition given in the Encyclopedia of Social Sciences, 'urbanisation is characterised by movement of people from small communities concerned chiefly or solely with agriculture to other communities generally larger, whose activities are primarily centered in government, trade, manufacture or allied interests. Thus, urbanisation has certain characteristics – (a) mobility of population from agricultural to non-agricultural areas, (b) concentration of people in a new place characterised by a new way of life, (c) variety of professions other than agriculture and continued vertical and horizontal mobility in these occupations, (d) a particular mode of habitation and non-agricultural (i.e., industrial, commercial etc.) pattern of economy.

Although cities all over the world have different historical growth and development there lays a difference between the process of urbanisation of cities in the developed and the developing worlds. The cities of the developed world experienced urbanisation because of industrialisation. However, cities from the developing world as discussed earlier have been victims of colonisation and globalisation. Following are the causes of urban growth in the developing countries:

Population in the urban areas grows due to two processes: natural increase and due to migration. Both these processes put stress on existing amenities like housing, water supply, energy, education and health care facilities.

Problems of Migration and Urban Environment:

Migration is defined as movement of an individual or a group of individuals from one place to another either for a temporary time or on a permanent basis. Migration can be classified into different types based on place of birth, place of last residence and duration of residence. In the present times, urbanisation and migration go hand in hand. Advanced and well-connected transportation and communication facilities, poverty, inequality, lack of adequate and proper employment opportunities are some of the major reasons that force people to leave their hometowns or native places in search of better opportunities. Push and pull factors of migration are responsible for the increased pace of urbanisation in the developing world. It has been observed that in India across the country many rural areas are lacking in economic development especially industrialisation, failure of agriculture, indebtedness of poor and marginal farmers forcing them to commit suicides, poor availability of even basic services like transport,

education and health care facilities due to which people are forced to migrate to already over-crowded and over-burdened cities in search of employment. This with reference to availability of funds for economic development lopsided government policies are also responsible for favouring the urban areas than the rural areas. Most of the budgetary allocation in planning is biased in providing amenities to urban centres (especially around the capital city where the leaders and the rich-powerful class are located). Thus, more employment opportunities are created in the urban centres and this uncontrolled and unplanned growth of cities in the developing world leads to haphazard growth of cities.

Problems arising due to migration in urban areas:

For the migrant population urban areas seem to be better destinations that offer employment opportunities, better incomes, good health and educational facilities, etc. However due to overcrowding and haphazard urbanisation these areas also face a number of problems. Following are some of the problems that arise due to migration in urban areas:

(i) **Pressure on social and physical infrastructure:** Overcrowding puts pressure on the existing social and physical infrastructure in the urban areas. Due to over-exploitation of natural resources, cities are facing the acute problem of depletion of ground water, air pollution, and disposal of sewage and management of solid wastes. This ultimately leads to unplanned growth of urban settlement.

(ii) **Growth of slums:** Unregulated migration to the metropolitan cities leads to overcrowding and development of slums. Development of slums in industrially and commercially developed regions is the result of unregulated migration. It further leads to stress and shortages of resources.

(iii) **Competition in the labour market:** Greater labour market competition can be experienced in certain sectors of the urban economy.

(iv) **Imbalance in gender composition:** Migration results in imbalances in gender composition due to selective male or female migration. Large cities have unfavourable sex ratio as compared to rural areas due to high male immigration. Migration affects the women more. In the rural areas, male selective out migration leaving their wives behind puts extra physical as well mental pressure on the women that increases their vulnerability.

(v) **Spread of diseases:** Migration may lead to spread of diseases.

(vi) **Creation of social vacuum:** It leads to a rift in the society as locals vs. migrants. Further, political implications of it also lead to various political issues.

(vii) **Creation of psychological vacuum:** It also causes anonymity, which creates social vacuum and sense of dejection among individuals. Continued feeling of dejection may motivate people to fall in the trap of antisocial activities like crime and drug abuse.

(viii) **Cultural disharmony:** Heavy in-migration can result into racism, segregation and cultural disharmony.

Following are some interesting statistics about migration and urban growth based on the 2001 and 2011 Census data of India:

- According to 2011 Census, there were 454 million migrants in India which has increased by 139 million from 315 million as per the 2001 Census.
- The National Capital Region area of Delhi possesses the highest of the population density 2011 among the states of India having a statistics of 11,297 per square kilometre. According to the 64th round of NSS 43% of population in Delhi and Mumbai are migrants. Majority of these migrants are from Uttar Pradesh and Bihar who migrate to Delhi and Mumbai for employment.
- Among males the most important reason for migration was 'Work/ Employment', 12.3 million out of 32.8 million total male migrants reported this reason for migration.
- In 2011 Census, about 4.7 million persons reported as migrant by last residence from across the International border. About 88% of these migrants were from the eight neighbouring countries (including Afghanistan). Of these migrants 2.7 million were from Bangladesh, 0.9 million from Pakistan, 0.8 million from Nepal and 0.1 million from Sri Lanka. About 65.2% of these migrants from the neighbouring countries had migrated to India at least 20 years back perhaps at the time of partition and later during the Bangladesh war in 1971.
- Maharashtra stands at the top of the list with 2.3 million net migrants, followed by Delhi (1.7 million), Gujarat (0.68 million) and Haryana (0.67 million) as per 2001 Census.
- Uttar Pradesh (-2.6 million) and Bihar (-1.7 million) were the two states with largest number of net migrants migrating out of the state.
- The migration data of 2001 Census indicates that 20.5 million people enumerated in urban areas are migrants from rural areas who moved in within the last 10 years.

Table 4.2

Number of in-migrants by last residence (duration 0-9 years) into important Urban Agglomerations: 2001 Census

Name of the UA	2001 Population	In-migrants			Total In migrants	% of immigrants to total population
		From within the state	From other states	From other countries		
Greater Mumbai UA	16,434,386	892,706	1,571,181	25,665	2,489,552	15.1
Delhi UA	12,877,470	77,663	1,988,314	46,386	2,112,363	16.4
Chennai UA	6,560,242	334,972	94,964	5,684	435,620	6.6
Kolkata UA	13,205,697	470,601	297,279	54,509	822,389	6.2
Hyderabad UA	5,742,036	407,861	88,216	2,406	498,483	8.7
Bangalore UA	5,701,446	401,932	353,156	6,397	761,485	13.4

Source: Table D3 UA City, Census of India 2001

From the above table it can be observed that Greater Mumbai recorded the largest number of in-migrants (2.4 million) making it top on the ladder followed by Delhi and Kolkata. Kolkata received largest number of in-migrants from other countries that is mostly from Bangladesh.

According to the 2011 Census of India, Greater Mumbai is the most populated city in India with a population of 1.25 crores. From 1950 to 1991, Mumbai experienced a considerable increase in its population due to industrial development and expansion of the suburban areas. Navi Mumbai was created in the decade of 1990s in order to minimise the pressure on Mumbai city. Today approximately 70% of its population resides in suburban areas. Most of the current residents of Mumbai have migrated about 10 to 20 years ago to this city mostly for employment.

Changing Land Use:

In the post-globalisation phase, cities all over the world have been experiencing the process of gentrification. The size of the cities in the past was restricted because of less population as compared to the present times. However, the past few decades especially the post globalisation phase has seen rampant changes in the land use of urban, suburban as well as the neighbouring rural areas.

Some of the noticeable changes in land use are discussed below:

(1) **Impact on urban periphery:** In the past, activities that require a huge open space like airports, warehouses, garbage landfill sites, etc. used to be located in the periphery of the city. This is because they would not only require open spaces but also are responsible for air and noise pollution. However, today with the sprawling urban areas these activities have been engulfed by the cities. Mumbai's example in this context is very relevant. In case of Mumbai the dumping grounds at Mulund and Deonar also have a negative impact on the air quality in the suburbs which in turn has an effect on the health of the people.

(2) **Absence of segregation between different land uses:** There used to be a distinctive segregation between residential, industrial and commercial areas in many cities of the world. However, this segregation today no more exists because of change in the nature of urbanisation.

(3) **Impact on suburbs and peripheral rural areas:** The land use in the peripheral suburban and rural areas is also drastically changing. For example, Mumbai's peripheral suburban and rural areas like Vasai-Virar, Karjat and Kasara regions which were known for farming, horticulture and floriculture activities now are converted into non-agricultural areas and the land is heavily used for real estate development either for suburban homes or as 'second/weekend' homes or for construction of 'farm houses'. These houses are owned by the rich and the neo-rich class from the urban areas.

(4) **Impact on the natural ecosystem:** Reclamation of land in Mumbai especially the creek and marshy areas which were rich in mangrove vegetation are also used for real estate development. Removal of mangroves has a negative impact on the wetland ecosystem in the form of water logging, decline in fish catch and so on.

(5) **Impact of Gentrification:** As the world accepted 'LPG' policies since 1990s, cities all over the world experienced 'gentrification' or 'urban renewal' where the old industrial land use was replaced by the service sector. Mumbai's example in this case is also evident because one can see how the 'mill land' is getting replaced with high rised residential and commercial buildings and/or with shopping malls and multiplex theatres.

Crowding and Stress on Urban Resources:

Rise in the population of urban centres either due to natural increase or due to in-migration of people results into over-crowding and exerts stress on the civic amenities like housing, water supply, transport services and so on.

Every citizen has a right to adequate shelter. However, most of the cities all over the world have been experiencing unprecedented growth of population in the last few years. The plight of the urban poor therefore is dismal. Adequate shelter includes a roof over one's head, proper lighting, ventilation and secure neighbourhood. In many countries especially in Mumbai, India, affordability of housing also matters for the urban poor. Low cost housing options with better civic amenities are not available in Mumbai and therefore these poor in-migrants have to take shelter in slum areas. Slums account for about three in five people in urban areas of sub-Saharan Africa, one in three people in urban Asia and one in five people in urban Latin America and the Caribbean.

Studies have shown that 50% of Mumbai's population lives in slum areas. According to the Municipal Corporation of Greater Mumbai (MCGM) report on slums, due to huge gap in housing facilities there are approximately 2000 slum settlements in Mumbai city and suburban areas. These slums have proliferated on land owned by the private, public and railways. Many of these slums are located in environmentally vulnerable areas like hills (examples include Ghatkopar and Vikhroli hills, Mumbra-Parsik hills, etc.) which are highly prone to landslides during heavy monsoon rains. Slums are also located along the creeks for example, the Mahim creek, which are built after removal of mangrove vegetation and by landfilling activities. These slums are prone to marine erosion and to the sea level changes that are taking place because of global warming. Mumbai being an island city, some of the areas in the city are also susceptible to sinking of lands. Slums experiencing such problems can be seen in Wadala and Santacruz areas of Mumbai. While moving in the slums one observes that most of the slums have temporary housing structures as the slum dwellers cannot afford a permanent house but can afford a 'dish antennae'.

Studies done by YUVA and Montgomery-Watson in the year 2000-2001 throws light on the following issues:

- The average household size of a slum dwelling is 4.5 Sq. metres.
- 50% of the slum population does not have access to adequate sanitation facilities. 73% depend on community toilets, 28% defecate in the open and less than 1% have access to pay to use toilets. Poor maintenance and over use of toilets makes them unhygienic. Shortage of water and electricity supply further adds to the problem of usage of toilet facilities. Women and children still find it worse to use these toilets.
- With respect to water supply 50% slums are covered through stand post based supplies, 40% have supply from more than one source and only 5% have individual tap connections.

- Only 36% slums have an organised system of garbage collection. MCGM's innovative 'Slum Adoption Scheme' is creating awareness and improving the collection of garbage.
- The condition of the pavement dwellers (mostly poor migrant labourers from other regions of the country) is still pathetic as they pay rent to the local *gundas* who control the pavements.
- The rent in slums differs based on the location, availability of services and condition of the hutment. It can be as high as 4000 in South Mumbai to 1000 in other areas.
- Lack of sanitation, inaccessibility to safe drinking water, etc. has led to incidences of typhoid, malaria, dengue, hepatitis and so on. Incidences of these health problems become severe during monsoon.

Another issue along with housing in urban areas today is transportation and traffic jams. With a sudden increase in the standard of living of the population in the post-globalisation era a 'neo-rich' class of people emerged. The demand for and use of private vehicles suddenly experienced an increase in the developing world. The cities already experiencing space crunch with inadequate housing also experienced an increase in the demand of open land for maintaining parking lots and for constructing highways and express ways to improve connectivity with the neighbouring urban centres. Mumbai's example again is apt in this situation because the politics behind construction of flyovers and sky walk projects for pedestrians throws light on the mismanagement of urban planning in the city.

Degradation of Air and Water:

Urban areas are centres of industries and commercial activities and therefore it is important to study and discuss the quality of natural resources in these areas. Due to continuous influx of migrant population, there is a heavy stress on natural resources in the urban areas. Lack of proper planning and management and adequate finance leads to deterioration of the quality of environment and which in turn has a negative effect on the quality of life of the city dwellers. As mentioned in Cunningham and Cunningham's Principles of Environmental Science, 60% of Kolkata's residents are believed to suffer from respiratory diseases related to air pollution. Mexico located in a valley with abundant sunlight, less rain, heavy traffic levels and frequent air stagnation has one of the highest levels of photochemical smog in the world. The sources of air pollution in cities are overcrowding, traffic jams, polluting factories, use of wood and charcoal for cooking especially in the slum areas, use of faulty architectural designs of high rised

buildings, etc. Following are some of the problems associated with degradation of air resources in urban areas:

(1) **Air quality:** In February 2016, the Deonar dumping ground in Mumbai experienced a major outbreak of fire, which resulted in increase in the air pollutants such as particulate matter, which created haze. In addition to these woes, Mumbai also experienced high humidity and low temperature conditions, which further aggravated the problem especially for the residents staying near the dumping ground, resulting in people suffering from coughing, sneezing and irritation of the eyes.

(2) **International travel and migration:** Increased international travel and migration have resulted in cities becoming important hubs for the transmission of infectious diseases, as shown by recent pandemics such as H1N1 and Ebola virus.

(3) **Indoor air quality:** The air quality inside houses, buildings or in slums also needs to be monitored for levels of air pollutants like carbon monoxide, methane, nitrogen dioxide and others. Indoor air quality can be severely affected due to use of wood and charcoal as a fuel for cooking and heating, tobacco smoke, air conditioning, space heaters, fireplaces, damp environments, paints-varnishes and certain cleaning products. Indoor air quality in air-conditioned rooms also needs to be monitored especially for availability of proper oxygen for respiration.

(4) **Faulty architecture:** In tropical countries, there is no dearth of sunlight. However, for the past few years most of the newly constructed high rised buildings cover the exterior of the building's with glass which absorbs solar radiation and unnecessarily heats up the interior of the buildings. In order to control the inside temperature centralised air conditioning systems have to be fitted which further adds to the problems of environmental degradation.

(5) People working in centralised air-conditioned offices may also suffer from a number of health ailments. For example, many people today are found to be suffering from Vitamin D deficiency, which is directly available from sunlight, as they are not exposed to natural sunlight during the daytime. Similarly the body also takes time to adjust to the temperature fluctuation caused due to use of air-conditioners in the office and non-use of air-conditioners while travelling or at home.

(6) As per the World Air Quality Report (2020), air pollution is one of the biggest health hazards, which accounts for about 7 million premature deaths per annum. Bangladesh, China, India and Pakistan record 49 out of the 50 most polluted cities worldwide.

(7) According to System of Air Quality and Weather Forecasting and Research (SAFAR), after the Holi celebrations in March 2017, Mumbai witnessed a rise in air pollution levels. The air in the city Monday was categorised as 'very poor'. AQI levels between 201-300 fall under the 'poor' category and 301-400 is 'very poor', indicating a health risk for people who are sensitive to air pollution. The lead pollutant was particulate matter (PM) 2.5 — small pollutant particles that can enter the lungs — found twice more than safe limits.

Degradation of Water Resources:

Due to rise in population and changing land use in the urban areas demand for water and quality of water resources also gets affected. Following are some of the problems associated with degradation of water resources in urban areas:

(1) **Lack of water treatment system:** Very few cities from the developing world can afford to invest in water treatment systems. The World Bank estimates that only 35% of urban residents in the developing world have access to satisfactory sanitation facilities. Mumbai again is a good example with reference to access to drinking water and water pollution. The rivers of Mumbai, viz., Mithi, Dahisar, Poisar and Oshiwara Rivers originate in the hilly area of the Sanjay Gandhi National Park. Today they practically have been converted into sewerage channels carrying polluted water from residential complexes, industries and slum settlements.

(2) **Availability of drinking water:** Access to drinking water is better in many urban areas of the developing world as compared to the rural areas. However many of these cities have to fetch water from a distance of 50 to 100 kilometres from the distant neighbourhood rural areas. These cities lack in water harvesting techniques. For example, Mumbai gets major part of its water supply from Tansa, Vaitarna, Bhatsa and Modak Sagar lakes, which are located in the neighbouring Thane district.

(3) **Affluent society and demand for water:** Improvement in the standard of living of the population has also resulted in more demand for water. Today apart from bathing, cooking, cleaning etc. water is also required for car washing, maintenance of lawns and golf courses, etc.

(4) **Recharge of ground water:** The ground water table in urban areas is not recharged properly due to lack of soil cover in urban areas. This is caused due the fact that in most of the cities soil is covered by impervious material like concrete, tar, cement and/or tiles.

(5) **Degradation of vegetation:** Degradation of forests and wetlands in and around the urban areas in many parts of the world has resulted in reduction in the ability of soil

to retain water, which makes the cities more vulnerable to flooding. Building dams, diverting the natural course of the drainage channels have become common problems in many cities in the world. For example, the disaster that Mumbai city experienced on 26th July, 2005 best fits the issue discussed.

(6) **Quality of water:** The quality of ground water which has increasingly becoming a source of water in many urban areas in the last few years is also deteriorating due to sewage and industrial effluents which are being disposed indiscriminately into the surface water bodies. In coastal cities like Mumbai, over pumping of ground water may also lead to sea water ingress.

Loss of Soil Cover:

Soil profile in the urban areas is prone to a number of environmental problems. Few of these are discussed below:

(1) **Deforestation:** Heavy deforestation is caused due to the expansion of cities into the neighbouring rural areas. This alters the pattern of water cycle and also enhances the problem of soil erosion. This eroded soil then results into siltation of rivers, dams are filled with silt, hydro-electric schemes are damaged, navigable waterways are blocked and quality of water deteriorates. In several parts of India, the potential life of reservoirs has reduced by 50 percent due to siltation.

(2) **Loss of prime agricultural land:** Prime agricultural land is also lost due to expansion of urban areas. Many farmers from the rural areas are being forced to farm on marginal and unsuitable land.

(3) **Dumping grounds:** Due to rising population in the urban areas, prime land is also required for disposal of solid waste and landfill sites.

(4) **Soil compaction:** Soil compaction can be caused due to movement of heavy traffic and regular movement of pedestrians. Removal of vegetation for developmental activities also is responsible for degrading the soil in urban areas. Compacted soils have limited capacity to absorb and store water, filter pollutants, restricted air movement which results in less biological activity and stunted or no plant growth.

(5) **Expanding deserts:** Arid areas in the world approximately cover about 50 million Sq. Km. of area. Asia and Africa account for about 50% of the world's dry areas. However due to heavy deforestation, loss of soil fertility and changing rainfall patterns has resulted in increasing the problem of desertification. Cities in north-western China (bordering the Gobi desert), Africa, U.S.A. and Australia are experiencing sandstorms due to desertification. Dust storms originating in the Gobi desert also have an effect on the Korean peninsula and Japan. These dust storms

result in incidences of cough, fever and sore eyes during the dry season. Poor visibility can severely affect the transport systems.

Impact on Biodiversity:

Biodiversity can be defined as the variety found in the living organisms present on the planet. Due to increasing industrialisation and urbanisation, natural habitats are destroyed and the biodiversity is severely affected in a number of ways. Various studies have proven that both the richness and abundance of native species including plants, mammals, insects and amphibians decline in response to urbanisation. Following examples throw light on the issue of urbanisation and its impact on loss of biodiversity:

(1) **Introduction of non-native species:** Urban growth that is often responsible for the introduction of non-native species, either accidentally for e.g. the brown rat, or deliberately, for food, pets or for aesthetic reasons. Non-native plants for example, are often planted in urban and suburban gardens, which then have an impact on the local plant species.

(2) **Fragmentation of natural habitats:** Urbanisation also leads to fragmentation of natural habitats and ultimately only small patches of original habitats remain.

(3) **Extinction of sensitive species:** Some of the sensitive species may locally become extinct due to expansion of cities. The House Sparrow is a commonly found bird is on the verge of extinction. These house sparrows are sedentary in nature and prefer to dwell in thatch houses and bungalows. Studies have shown that the population of sparrows is drastically declining in cities due to use of unleaded fuel, lack of holes for nesting, use of chemically treated seeds and emission of electro-magnetic waves from cell phone towers and cable wires.

(4) **Conflict between the fauna and human habitat:** The leopards in the Sanjay Gandhi National Park and Yeoor hills of Thane are found to be entering and attacking the neighbouring human settlements. This is because of uncontrolled real estate development along the Ghodbunder road connecting Thane and Borivali. These leopards are losing their natural habitat and hence these attacks on human beings are done.

(5) **Impact on the birds:** Pune based NGO Ela Foundation and the National Institute of Virology (NIV) on their study about Indian Vultures have analysed the causes of drastic fall in the vulture population of India. The main reasons being use of *Diclofenac*, a chemical that is fatal to the birds, electrocution from electricity wires (death caused due to electric shocks), shortage of food especially the carcasses of dead animals which are buried by the villagers to keep the villages clean as per the directions of the Indian government and lack of nesting trees. Ornithologist Satish

Pande from the Ela Foundation has also said that Great Indian Bustard, Saras Crane and some species of Eagles are also threatened due to electrocution.

9) **Impact on the behaviour of animals and birds:** In the forest or natural areas the population of different species of organisms is kept under control by the natural food chain. However, this natural mechanism is being disturbed in the urban areas is drastically because human beings feed these organisms with grains and other food varieties. This has a negative impact on the natural instincts of animals and birds of finding food, water, etc. A better-known example is that of feeding the common pigeon abundantly found in India. Due to the availability of food, pigeons have started nesting throughout the year and their population is widely increasing.

Urban Heat Island:

The climate in an urban centre varies as compared to that in the neighbouring rural areas. H. E. Landsberg (1981) put forward this concept of 'urban heat island'. It refers to a situation where the built-up areas in the city along with human activities produce heat by combustion of fossil fuels used in cooking, transportation and industries because of which the heat generated in the cities is high as compared to the neighbouring suburban and rural areas. The following figure explains the concept of 'urban heat island'.

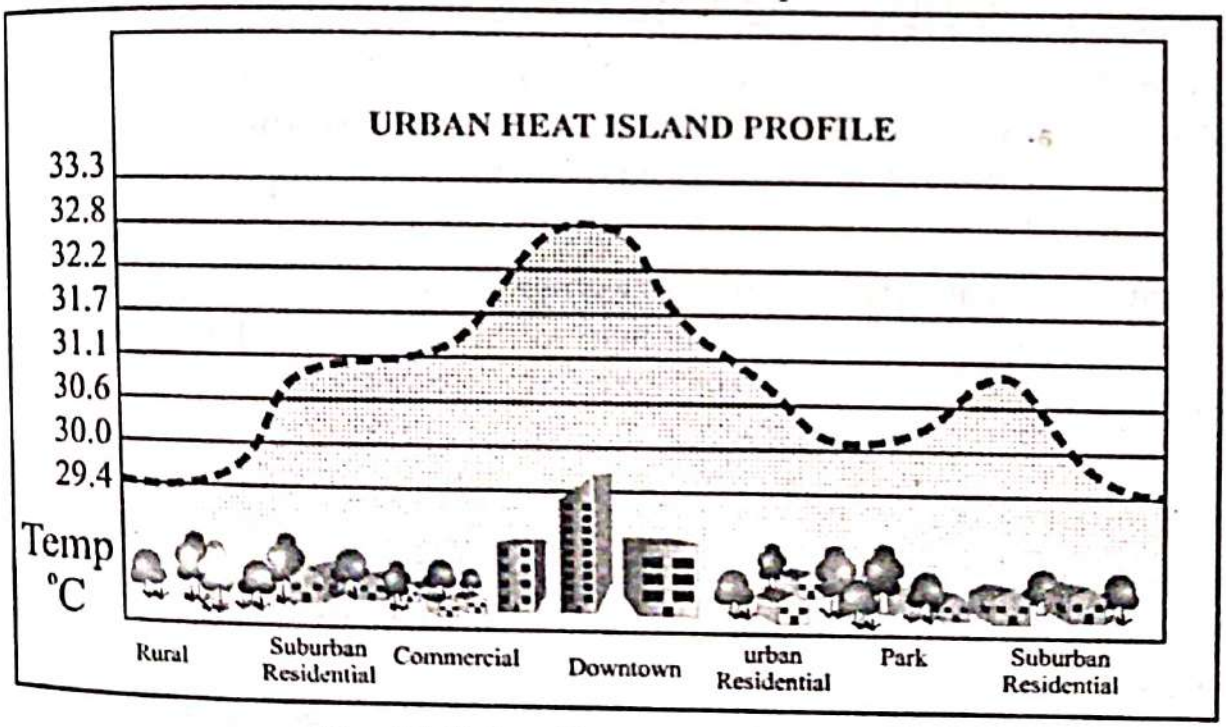

Fig. 4.1 Urban Heat Island Profile

Source: https://commons.wikimedia.org

This results in the rise of average temperature by a few degrees. If temperature data for several locations in and around the city are available, isotherms can be drawn to

explain the emerging pattern of urban heat island. The heat island effect is stronger during the daytime. This effect is created due to the following factors:

- The density of high raised buildings in the urban areas is very high which reduces the wind speed. These buildings block the surface heat from radiating back into the relatively cold night sky. It results in trapping of heat on the surface.
- Materials used for construction of roads and buildings in urban areas are made of cement, concrete and tar which are heat absorbing materials. In the recent times, many high raised buildings cover the exterior part with glass which is transparent to heat further adding to the problem of warming.
- Lack of luxuriant vegetation in the urban areas further aggravates the problem of heating.
- High amount of air pollution coming from the automobiles, air conditioning and industries also adds to the problem of increasing temperature in the urban areas.
- Due to increase in the amount of heat in the urban areas the amount of moisture/ humidity in the urban areas also increases which indirectly enhances the problem of warming.

Emerging Smart Cities and Safe Cities in India:

The present Prime Minister of India, Mr. Narendra Modi, has launched the 'Smart Cities Mission', a very ambitious project under his government. This project was inaugurated on 25th June, 2016 in Pune, Maharashtra. The proposed total investment in the cities participating in this Mission have would be of Rs. 48,000 crore in area development and Pan-city solutions. Public-Private Partnership (PPP) has been proposed as a major vehicle, which will help in the resource mobilization process. Loan assistance will also be made available from the Asian Development Bank, the World Bank and the BRICS Development Bank.

Concept of Smart Cities:

There is no universally accepted definition of a 'smart city'. How one defines, a smart city will be based on the level of aspirations of the city dwellers. However, one may summarise the definition based on the common needs and expectations of city dwellers as, A 'smart city' is a city that provides core infrastructure and gives a decent quality of life to its citizens along with a clean and sustainable environment. The picture of a smart city contains a wish list of infrastructure and services. The focus in on sustainable and inclusive development of compact areas in order to create a replicable model, which will act like a lighthouse to other aspiring cities.

The Project 'Smart Cities Mission' aims to drive economic growth and improve the quality of life of people by enabling local area development and harnessing technology, especially technology that leads to Smart outcomes.

Features of a 'Smart City':

Some typical features of comprehensive development in Smart Cities are described below:

- Promoting mixed land use in area based developments–planning for 'unplanned areas' containing a range of compatible activities and land uses close to one another in order to make land use more efficient. The States will enable some flexibility in land use and building bye-laws to adapt to change;
- Housing and inclusiveness - expand housing opportunities for all;
- Creating walkable localities –reduce congestion, air pollution and resource depletion, boost local economy, promote interactions and ensure security. The road network is created or refurbished not only for vehicles and public transport, but also for pedestrians and cyclists, and necessary administrative services are offered within walking or cycling distance;
- Preserving and developing open spaces - parks, playgrounds, and recreational spaces in order to enhance the quality of life of citizens, reduce the urban heat effects in Areas and generally promote eco-balance;
- Promoting a variety of transport options - Transit Oriented Development (TOD), public transport and last mile para-transport connectivity;
- Making governance citizen-friendly and cost effective - increasingly rely on online services to bring about accountability and transparency, especially using mobiles to reduce cost of services and providing services without having to go to municipal offices. Forming e-groups to listen to people and obtain feedback and use online monitoring of programs and activities with the aid of cyber tour of worksites;
- Giving an identity to the city - based on its main economic activity, such as local cuisine, health, education, arts and craft, culture, sports goods, furniture, hosiery, textile, dairy, etc;
- Applying Smart Solutions to infrastructure and services in area-based development in order to make them better. For example, making areas less vulnerable to disasters, using fewer resources, and providing cheaper services.

The core infrastructure elements in a smart city would include:

- Adequate water supply,

- Assured electricity supply,
- Sanitation, including solid waste management,
- Efficient urban mobility and public transport,
- Affordable housing, especially for the poor,
- Robust IT connectivity and digitalisation,
- Good governance, especially e-Governance and citizen participation,
- Sustainable environment,
- Safety and security of citizens, particularly women, children and the elderly, and
- Health and education.

The above mentioned core infrastructure elements will be made applicable in the form of Smart Solutions as summarised in the following figure:

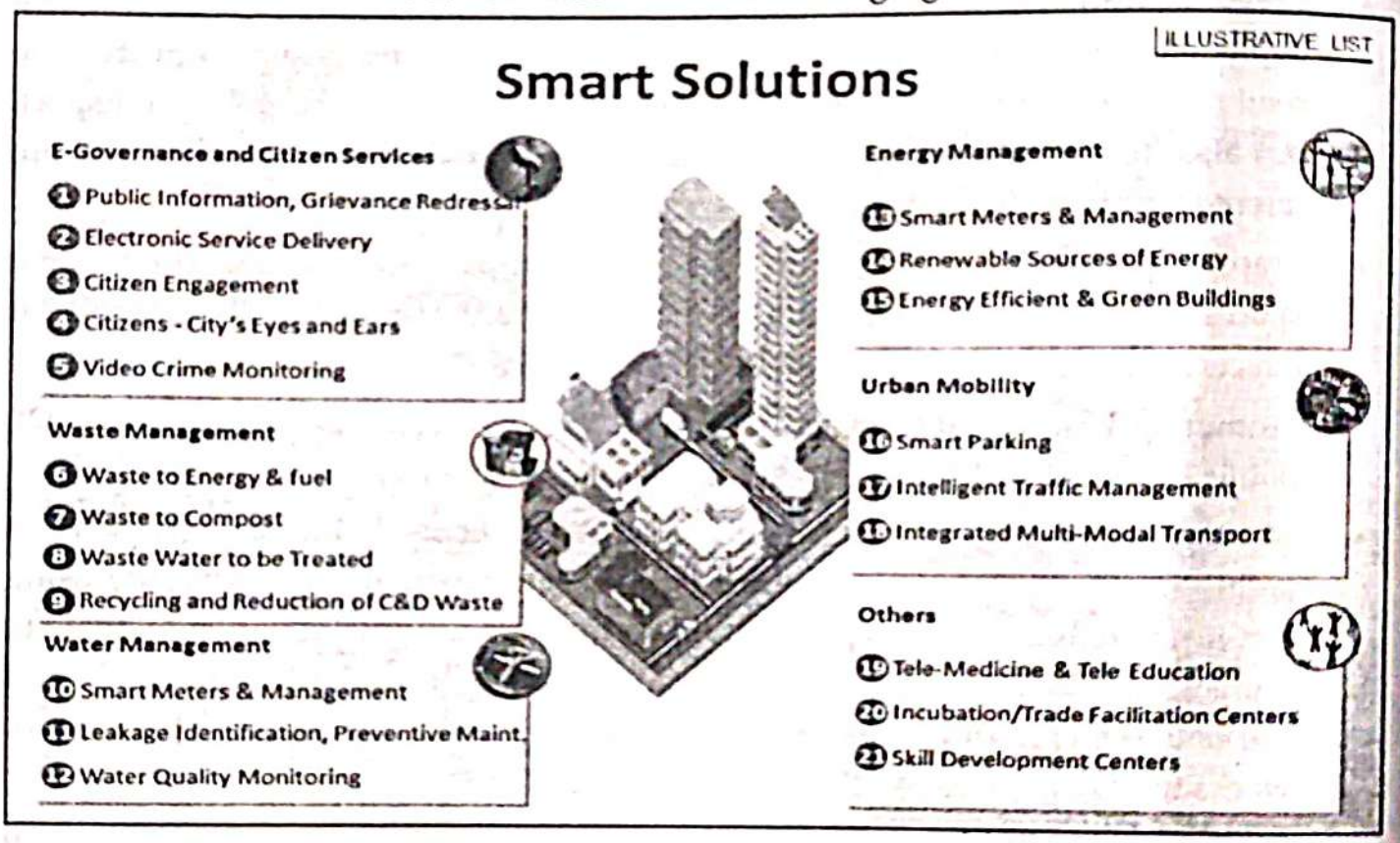

Fig. 4.2 Smart Solutions for Implementation of Smart Cities

Source: www.smartcities.gov.in

Need for Smart Cities:

Area- based development will transform existing areas (retrofit and redevelop); including slums, into better planned ones, thereby improving live ability of the whole City. New areas (Greenfield) will be developed around cities in order to accommodate the expanding population in urban areas. Application of Smart Solutions will enable

cities to use technology, information and data to improve infrastructure and services. Comprehensive development in this way will improve quality of life, create employment and enhance incomes for all, especially the poor and the disadvantaged, leading to inclusive cities.

Strategy:

The implementation of the project 'Smart Cities Mission' is based on three components viz., city improvement (retrofitting), city renewal (redevelopment) and city extension (greenfield development) plus a Pan-city initiative in which Smart Solutions are applied covering larger parts of the city.

(a) **Retrofitting:** It is nothing but to make the existing built up area more efficient and livable. In retrofitting, an area consisting of more than 500 acres will be identified by the city in consultation with citizens. Depending on the existing level of infrastructure services in the identified area and the vision of the residents, the cities will prepare a strategy to become smart.

(b) **Redevelopment:** It refers to replacement of the existing built-up environment and enables co-creation of a new layout with enhanced infrastructure using mixed land use and increased density. Redevelopment envisages an area of more than 50 acres, identified by Urban Local Bodies (ULBs) in consultation with citizens.

(c) **Greenfield development:** It will introduce most of the Smart Solutions in a previously vacant area (more than 250 acres) using innovative planning, plan financing and plan implementation tools (e.g. land pooling/ land reconstitution) with provision for affordable housing, especially for the poor. Greenfield developments are required around cities in order to address the needs of the expanding population.

For example, project Gujarat International Finance Tec-City (GIFT) which has been planned as a financial Central Business District (CBD) between Ahmedabad and Gandhinagar as a Greenfield development. GIFT shall be a part of the future urban complex of Ahmedabad and Gandhinagar. GIFT is designed as a hub for the global financial services sector. More particularly, state-of-the-art connectivity, infrastructure and transportation access have been integrated into the design of the city.

(d) **Pan-city development:** It consists of application of selected Smart Solutions to the existing city-wide infrastructure. Application of Smart Solutions will involve the use of technology, information and data to make infrastructure and services better. For example, applying Smart Solutions in the transport sector (intelligent traffic management system) and reducing average commute time or cost of citizens will

have positive effects on productivity and quality of life of citizens. Another example can be waste water recycling and smart metering which can make a huge contribution to better water management in the city.

Selection of 'Smart Cities':

The total number of 100 smart cities have been distributed among the States and UTs on the basis of an equitable criteria. The formula gives equal weightage (50:50) to urban population of the State/UT and the number of statutory towns in the State/UT. Based on this formula, each State/UT will, therefore, have a certain number of potential smart cities, with each State/UT having at least one. The following table shows the list of 20 cities selected for the first round of the Smart City Mission:

Table 4.3

Selected 20 Cities for the First Round of the Smart City Mission

State/ UT	20 Cities selected for the first round of the Smart City Mission
Andhra Pradesh	Kakinada
Assam	Guwahati
Delhi	NDMC (New Delhi Municipal Council)
Gujarat	Surat, Ahmedabad
Karnataka	Davanagere, Belagavi
Kerala	Kochi
Madhya Pradesh	Jabalpur, Indore, Bhopal
Maharashtra	Pune, Solapur
Odisha	Bhubhaneshwar
Punjab	Ludhiana
Rajasthan	Jaipur, Udaipur
Tamil Nadu	Coimbatore, Chennai

Challenges:

Following are the challenges for the 'Smart City' mission:

- States and ULBs will play a key supportive role in the development of Smart Cities. Smart leadership and vision at this level and ability to act decisively will be important factors determining the success of the Mission.

- The main requirement of the Smart Cities Mission is that it requires people who are smart and those who will actively participate in governance and reforms.
- The involvement of the citizens will be significant than a ceremonial participation in governance. Smart people will be the key players in the functioning of the Smart City, decisions on deploying Smart Solutions, implementing reforms, doing more with less and oversight during implementing and designing post-project structures in order to make the Smart City developments sustainable.

Sustainable Cities:

Urban planning has a major role to play in the making of sustainable cities. The main purpose of creating sustainable cities is to give order and aesthetic value to public spaces so that people can enjoy a peaceful and pleasant life and also can perform with vigour and zeal in efficiently carrying out various economic activities.

In the present times, cities from both developed as well as developing world are suffering from a number of problems like rising migrant population, lack of space for housing, traffic congestion, pollution, and so on.

Strategy for Developing Sustainable Cities:

Sustainable development of the cities is the need of the hour as it can help in minimising the burden of the growing population on the urban infrastructure. It can also help in improving the efficiency of the systems including that of the urban dwellers functioning in the urban areas. Following methods can be promoted in making the cities sustainable:

- Open and Green spaces within the city and at the periphery of the city can be maintained which will help in controlling the problems of urban heat island, air and water pollution. It will also increase the aesthetic value and can also be used as recreational space.
- 'Polluter pays principle' has to be effectively implemented to maintain cleanliness in the city and also to control air, water, noise and soil pollution taking place in the city. For example, in cities like Mumbai a heavy tax on spitting has to be charged on people who spit in public places.
- Separate lanes and footpaths can be maintained properly for pedestrians and bicycle riders. Walking and cycling can be encouraged in case of local-nearby trips. Cities like Singapore and California have already implemented such designs.
- 'Mass Rapid Transit' services can be provided for public transport like buses, trams, etc. This will help in minimising the pressure of private vehicles on congested

roads. In Ahmedabad city in Gujarat India, such services are available for 'Bus Rapid Transit' (BRT) project. The cost of travel is also cheaper for BRT.

- Recycling of wastes can also be encouraged by giving proper training and incentives to the urban poor. This also can be a very important source of income for the urban poor.
- Public participation in the form of awareness campaigns, tree plantation drives, or cleanliness drives like the *'Swacch Bharat Abhiyaan'* can be regularly held.
- Use of bio-toilets, segregation of waste and use of organic waste in composting can be effectively promoted. The compost collected from the cities own organic waste can be used for horticulture, floriculture or for vegetable gardening in the green belt of the city.
- Industries which can allow their employees to 'Work from Home' can contribute a lot in minimising the pressure on the traffic problems in the city.
- Trees that absorb sound waves can be planted in areas with high levels of noise pollution.
- Protection of archaeological and historical places in the city also is significant to restore the cultural history of the city.
- Training and awareness about anthropogenic as well as natural disasters also can be an effective method to make the city dwellers more responsible towards well-being of nature and themselves.

Sustainable practices can definitely help in the march towards safe cities where conditions irrespective of class, gender, religion, etc. are livable.

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Relevant Terms associated with urbanisation:

City: Towns with population of 100,000 and above are called cities.

Megalopolis refers to a large, contiguous urban region. The word was first used by the French geographer Jean Gottman in describing the strip of urbanization running along the eastern seaboard of the United States from Boston, Massachusetts, to Washington, D.C.

According to the Census of India 2011 cities with 10 million and above population have been treated as Mega cities.

Gentrification is the process in which urban neighbourhoods are revitalised through the use of economic incentives, designed to induce residents or businesses to acquire degraded property and restore it.

Urban Sprawl refers to the process of urban growth generally characterised by the outward expansion and de-concentration of urban activities and land uses into the surrounding countryside.

Suburban areas usually are defined as politically independent jurisdictions located outside of a larger central city but still sharing social or economic ties with the city.

Urban Agglomeration: An urban agglomeration is a continuous urban spread constituting a town and its adjoining outgrowths, or two.

Review Questions:

(1) What is 'urbanisation'? Discuss, in brief, the history of urbanisation.
(2) Explain the concept of 'urban'. Discuss the problems associated with urbanisation.
(3) Discuss with suitable examples how migration affects the urban environment.
(4) Describe how the land use in urban areas is changing with increasing urbanisation.
(5) Discuss how increasing urbanisation leads to crowding and stress on urban resources.
(6) 'Increasing urbanisation results into degradation of air, water, soil and biodiversity' – Elaborate with suitable examples. State the problems arising due to migration in urban areas. ***(Nov. 16; March 17)***
(7) Describe degradation of air resource in urban areas. ***(March 17)***
(8) Write in detail degradation of water resources in urban areas. ***(Nov. 16)***

(9) Define 'Smart City'. Explain the features of a smart city.
(10) Give an account on 'Smart Cities'. ***(Nov. 16)***
(11) Discuss the need for a 'Smart Cities Mission' and what strategies will be adopted by this mission.
(12) What are 'Sustainable Cities'? What strategy can be adopted for making cities sustainable?
(13) Give an account of sustainable cities. ***(March 17)***
(14) What is urbanisation? Explain the process of urbanisation in India. ***(Oct. 17)***
(15) Define migration. What are the different effects of migration? ***(Oct. 17)***
(16) Explain the process of urbanisation and its impact on environment w.r.t. Mumbai. ***(April 18)***
(17) Mumbai is known as the 'magnet of migrants'-describe the statement by giving push-pull factors of *migration*. ***(Oct. 18)***
(18) How does migration affect the urban environment? ***(Oct. 18)***
(19) Explain the term migration. Describe the problems arising due to migration in urban area. ***(April 19)***
(20) How the land use in urban areas is *changing with* increasing urbanisation? ***(April 19)***
(21) Write a detailed note on 'Smart City'. ***(April 19)***
(22) Define 'Smart City'. Explain the features of a smart city. ***(Oct. 18)***
(23) **Write notes on:**
  (a) Urbanisation. ***(Nov. 16)***
  (b) Urban Heat Islands. ***(Nov. 16; March 17; Oct. 17; April 18)***
  (c) Urban crowding and stress on resources. ***(March 17)***
  (d) Parameters of Smart Cities. ***(Oct. 17)***
  (e) Smart and Safe Cities. ***(April 18)***
(24) **Mark and label the following in the outline map of the world:**
  (a) An Indian city selected for the 'Smart Cities Mission'.
  (b) A highest ranking mega-city in the world (2018).
  (c) A mega-city from India recording high population (2018).
  (d) A continent with a high rate of urbanisation. (Asia)
  (e) The largest slum area in the world. (Khayeltisha, Cape Town, South Africa)
  (f) Any two metropolitan cities in northern hemisphere. (Mumbai, Delhi) ***(Nov. 16)***
  (g) Any two metropolitan cities in the world. (Mumbai, Delhi) ***(March 17)***
  (h) Any one million city located in Japan. (Tokyo) ***(Oct. 17)***
  (i) Any one million city in India. (Mumbai) ***(April 18)***
  (j) A million city in Europe. (London) ***(Oct. 18)***

Chapter 5

Reading of Thematic Maps and Map Filling

"Maps codify the miracle of existence".

— Nicholas Crane

(A) World Mat Filing – Definition of Map, Elements of a Map, Types of Maps, World Map Filling; (B) Thematic (World) Map Reading – Dot Map, Located Bars, Choropleth Map, Isopleth Map, Located Circles, Divided Circles / Pie Diagram, Flow Map, Pictograms – Review Questions.

(A) World Map Filling:

A map is a very important tool not only for a geographer but also for common people as a map can give a variety of information depending on the purpose for which the map is prepared. Thus, a map becomes a useful tool for a cab driver (GPS), defense personnel (naval charts), a geologist, forest ranger (vegetation maps), a farmer (weather maps) and for various other professions.

Cartography is the science, which designs and makes maps and it is one of the sub-branches of Geography. The person who designs and makes maps is known as a cartographer.

Definition of Map:

Various people have defined map in different manners. However, a single definition can summarize as to 'what is map'? A map can be defined as a diagrammatic representation of the entire earth's surface or a part of the earth's surface (which is three-dimensional) with the help of projection, scale, direction and signs and symbols onto a two-dimensional sheet of paper.

Elements of a Map:

Map is not just a simple diagram that gives information about the earth's surface, but also an art and science to design and prepare maps. Following features therefore play a very crucial role in a map:

- **Title/Theme of a Map:** The title or the theme of a map is one of the key to the map. As it gives the basic information to the person, who is reading the map about the area and the subject, which is represented in the map. For example, World: Distribution of Forests, India: Distribution of Cities, etc.
- **Scale:** While making the map it will be difficult to show actual distances on the ground on a small piece of paper hence a scale is used to show distances on the map. A scale is the distance between two points on the ground in proportion to the same two points drawn on the map. A scale of a map is important as it helps in measurement of distances on the map and for enlargement or reduction of the map area. Scale is represented in three forms: Graphical, Verbal or as Representative Fraction (RF).
- **Direction:** Direction on a map is again a vital feature as it helps the reader to understand and identify the relative location of different entities on a map. Direction is represented on a map with the help of a 'North Line'.
- **Conventional Signs and Symbols:** Distribution of various features on the map is done with the help of a variety of signs and symbols. However these signs and symbols are classified into three groups which are as follows:
  - **Point Symbols** are used to locate features that have a pinpointed location on the map. For example, capital cities, post offices, railway stations, wells, forts, etc.
  - **Line Symbols** are used to show features that are linear in nature, connected, or linked from one point to another. For example, a railway lines, a river, a road, etc.
  - **Polygon/Area Symbols** are used to show features that are distributed over space. For example, distribution of forests, distribution of settlements, distribution of minerals, etc.

(*Students should refer to the maps showing point, line, polygon/area symbols and then solve the world map filling exercises.)

Types of Maps:

Varieties of maps are available based on the purpose for which the maps are prepared. Different fields of study like climatology, regional planning, defense, environment, etc. require different types of maps. These maps are designed and prepared by different organisations. Therefore, varieties of maps are available in the market. Maps can be classified into following categories based on various criteria:

- Based on the scale, maps are of six types, viz., *wall maps, atlas maps, medium-scale maps, topographical maps, cadastral maps* and *large-scale maps.*
- Based on the objectivity, maps can be *multi-purpose* and *single-purpose.* Topographical maps are multi-purpose maps as they represent both physical as well as cultural features. In India, topographical maps are prepared by the Survey of India (SoI). Thematic maps are single purpose as they show the distribution of one particular entity. In India, thematic maps are prepared by the National Atlas and Thematic Mapping Organisation (NATMO).

World Map Filling: (Use of Point Symbols)

POINT SYMBOLS – WORLD-MAP FILLING

(i)
- Highest Mountain Peak in the World: Mt. Everest (Nepal)
- Highest Mountain Peak in India: Mt. K2

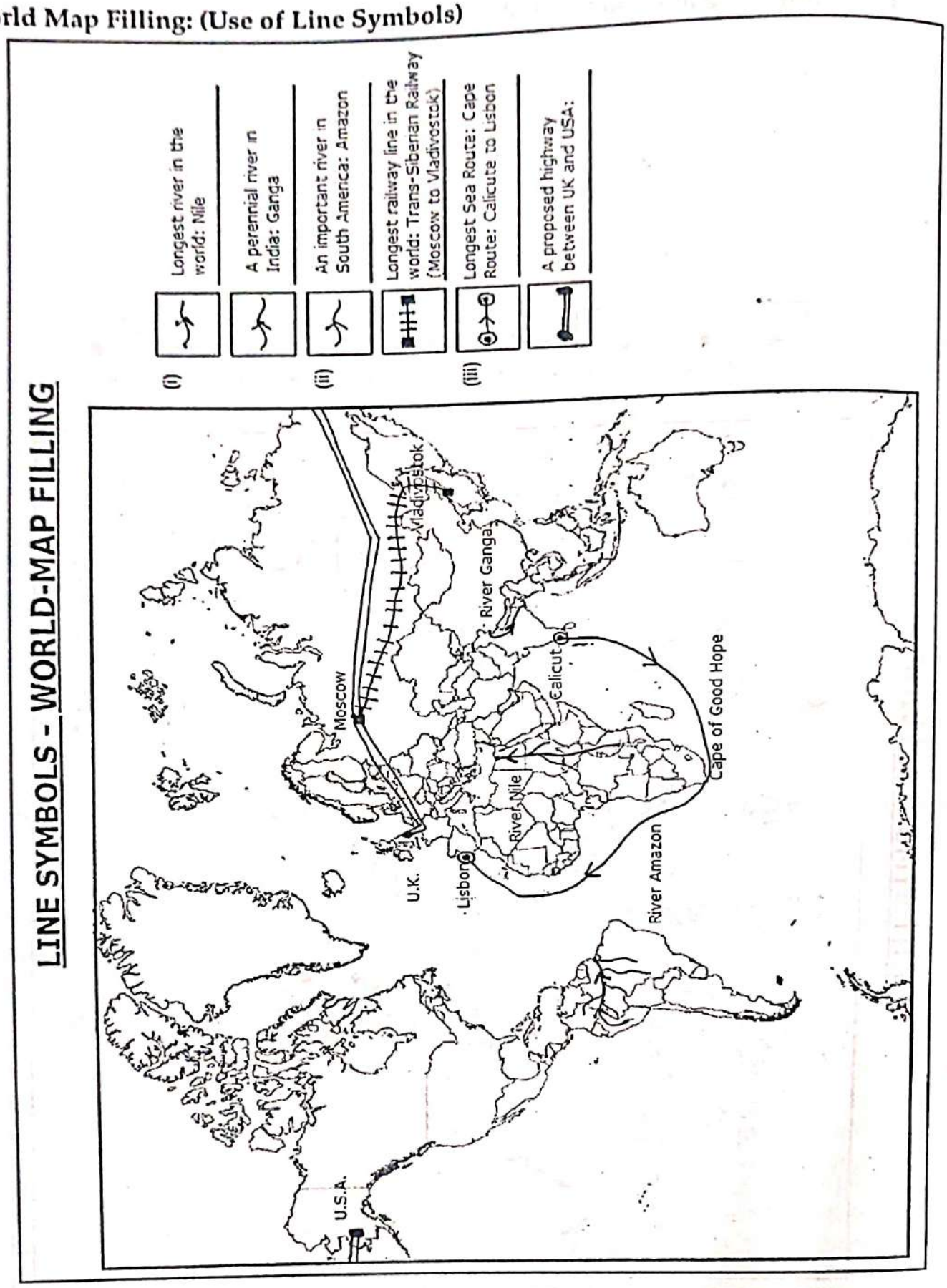
(ii)
- A metropolitan city from the northern hemisphere: Mumbai
- A metropolitan city from Europe: London

(iii)
- The highest rainfall recording place in the world: Mawsynram, India
- A Sea with highest salinity in the world: Dead Sea

(iv)
- Capital city of USA: Washington
- Capital of Brazil: Brasilia

(v)
- Capital of Australia: Canberra
- Capital of Egypt: Cairo

World Map Filling: (Use of Line Symbols)



World Map Filling: (Use of Polygon/Area Symbols)

POLYGON/AREA SYMBOLS – WORLD-MAP FILLING

(i) A country with Peninsula: India

An island country: Srilanka

(ii) A leading country in coal production: China

A leading natural gas producing country in the world: U.S.A.

(iii) Largest forest area located in South America: Amazon

A forest area located in Central Africa: Congo

(iv) Largest hot desert in the world: Sahara

Largest inland sea in the world: Caspian Sea

(v) A continent without permanent human population: Antarctica

A densely populated country: Japan

World Map Filling: *(November, 2016)*

Q. No. 1 (B) WORLD-MAP FILLING

World Map Filling: (December, 2018)

World Map Filling:

Solved Exercise 1:

Mark and locate the following features on an outline map of the World:

(1) A country having island location.

(2) Highest hydropower producing country.

(3) Major coffee producing country.

(4) A country having world's largest petroleum reserves.

(5) World's largest populated country.

(6) Longest railway route in the world.

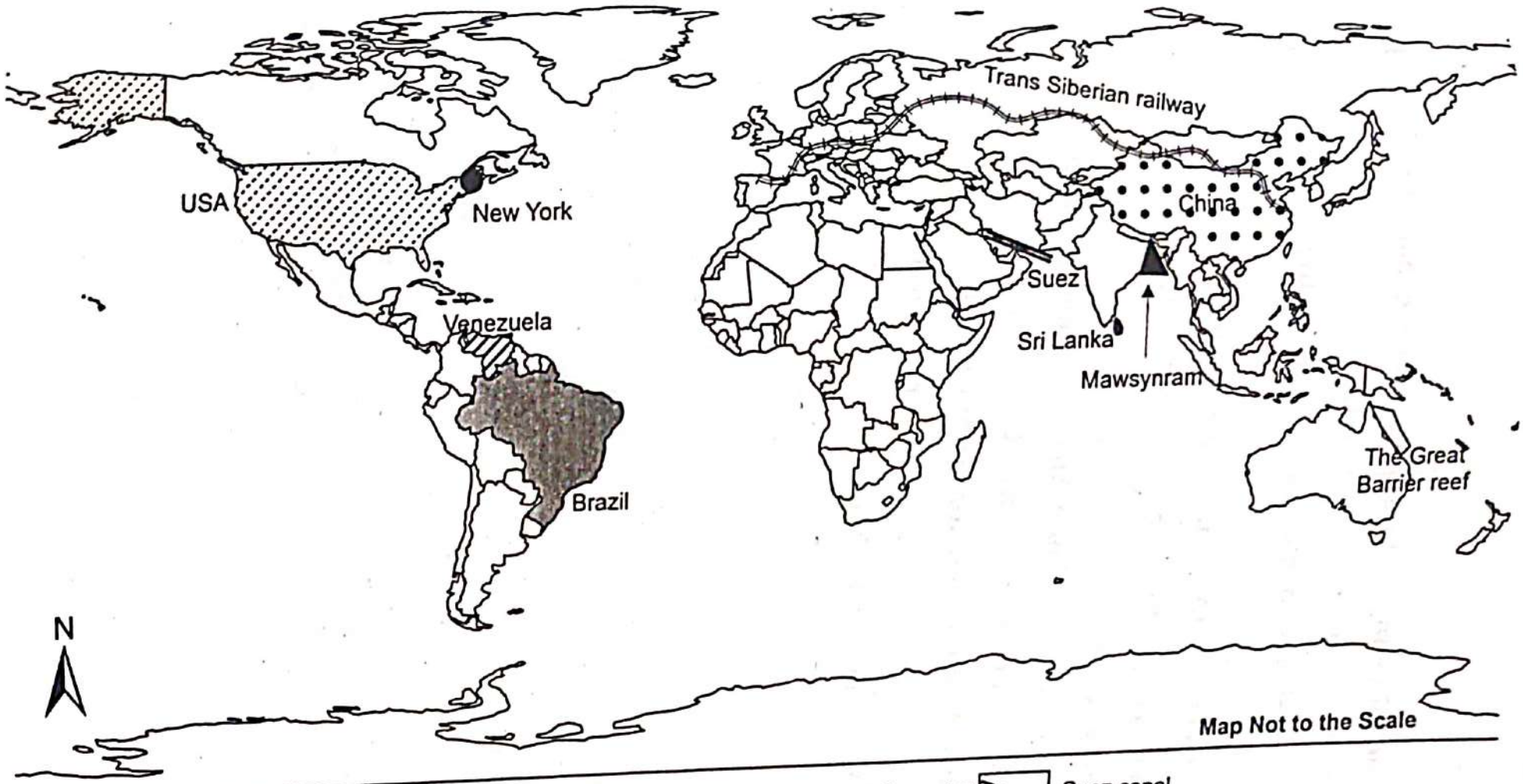
(7) Suez canal.

(8) The Great Barrier reef.

(9) The largest city in the world.

(10) Highest annual rainfall recording place in the world.

Solved excercise of World map filling with environmentally significant features



1. A country having island location
2. Highest Hydro power producing country
3. Major coffee producing country
4. A country having world's largest petrolium reserves
5. Third largest populated country
6. Largest railway route
7. Suez canal
8. The Great Barrier reef
9. The largest City in the world
10. Highest annual rainfall recording place

World Map Filling:

Exercise 1:

Mark and locate the following features on an outline map of the World:

(1) A leading country in coal production. (China)

(2) A country possessing a higher percentage of the total global reserves of oil. (Venezuela)

(3) World's largest oil fields. (Arabian-Iranian Peninsula)

(4) A leading natural gas producing country in the world. (U.S.A.)

(5) World's largest gas fields.

(6) A large forest area located in South America. (Amazon forest)

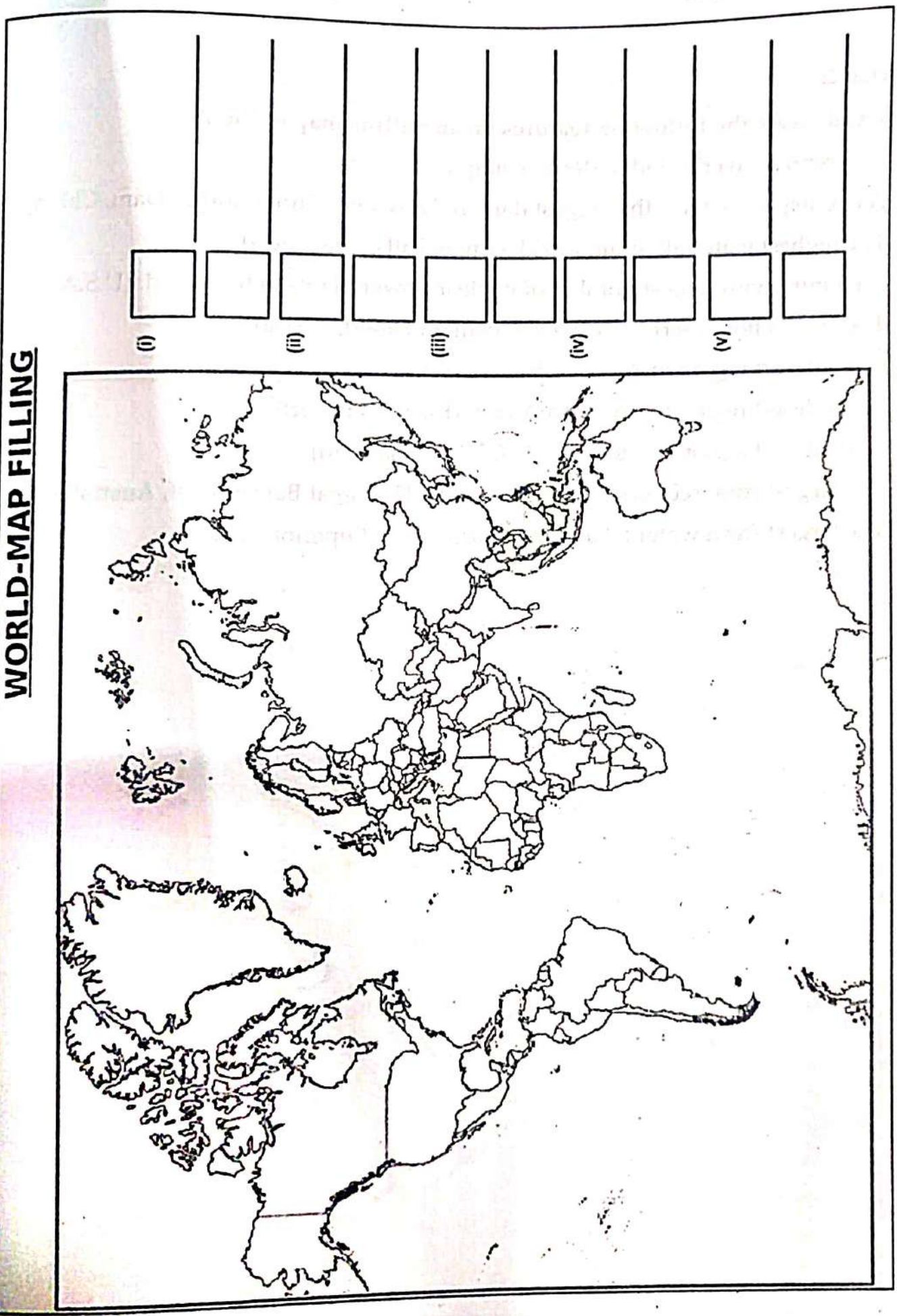
(7) A forest area located in Central Africa. (Congo forest)

(8) A country with highest rate of deforestation. (Brazil)

(9) An important river in South America. (River Amazon)

(10) The longest river in the world. (River Nile)

WORLD-MAP FILLING



Exercise 2:

Mark and locate the following features on an outline map of the World:

(1) A perennial river in India. (River Ganga)

(2) A country known for the biggest dam in the world. (Three Gorges Dam, China)

(3) The highest waterfall in the world. (Angel Falls, Venezuela)

(4) A country with largest number of nuclear power plants in the world. (U.S.A.)

(5) The largest hot desert in the world. (Sahara Desert, Africa)

(6) A hot desert region in Asia. (Gobi)

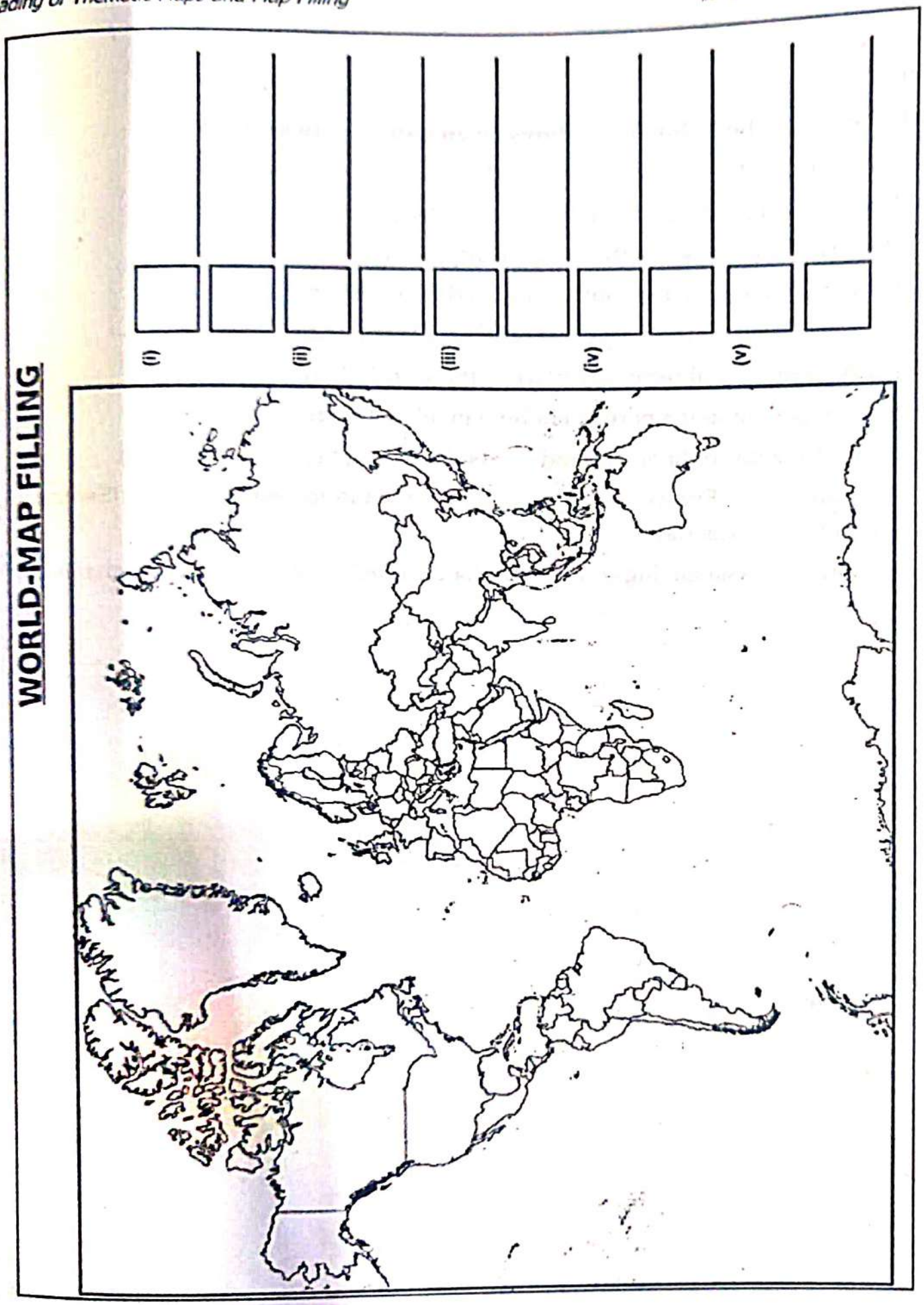
(7) A hot desert region in southern Africa. (Kalahari Desert)

(8) A hot desert region in India. (Thar Desert, Rajasthan)

(9) The largest coral reef system in the world. (The Great Barrier Reef, Australia)

(10) The largest fresh water lake in the world. (Lake Superior, U.S.A.)

WORLD-MAP FILLING



Exercise 3:

Mark and locate the following features on an outline map of the World:

(1) The largest salt-water lake in the world.

(2) A sea with highest salinity in the world. (Dead Sea)

(3) The largest inland sea in the world. (Caspian Sea)

(4) The ocean located to the south of India. (Indian Ocean)

(5) The sea located on the west coast of India. (Arabian Sea)

(6) The highest rainfall recording place in the world. (Mawsynram, India)

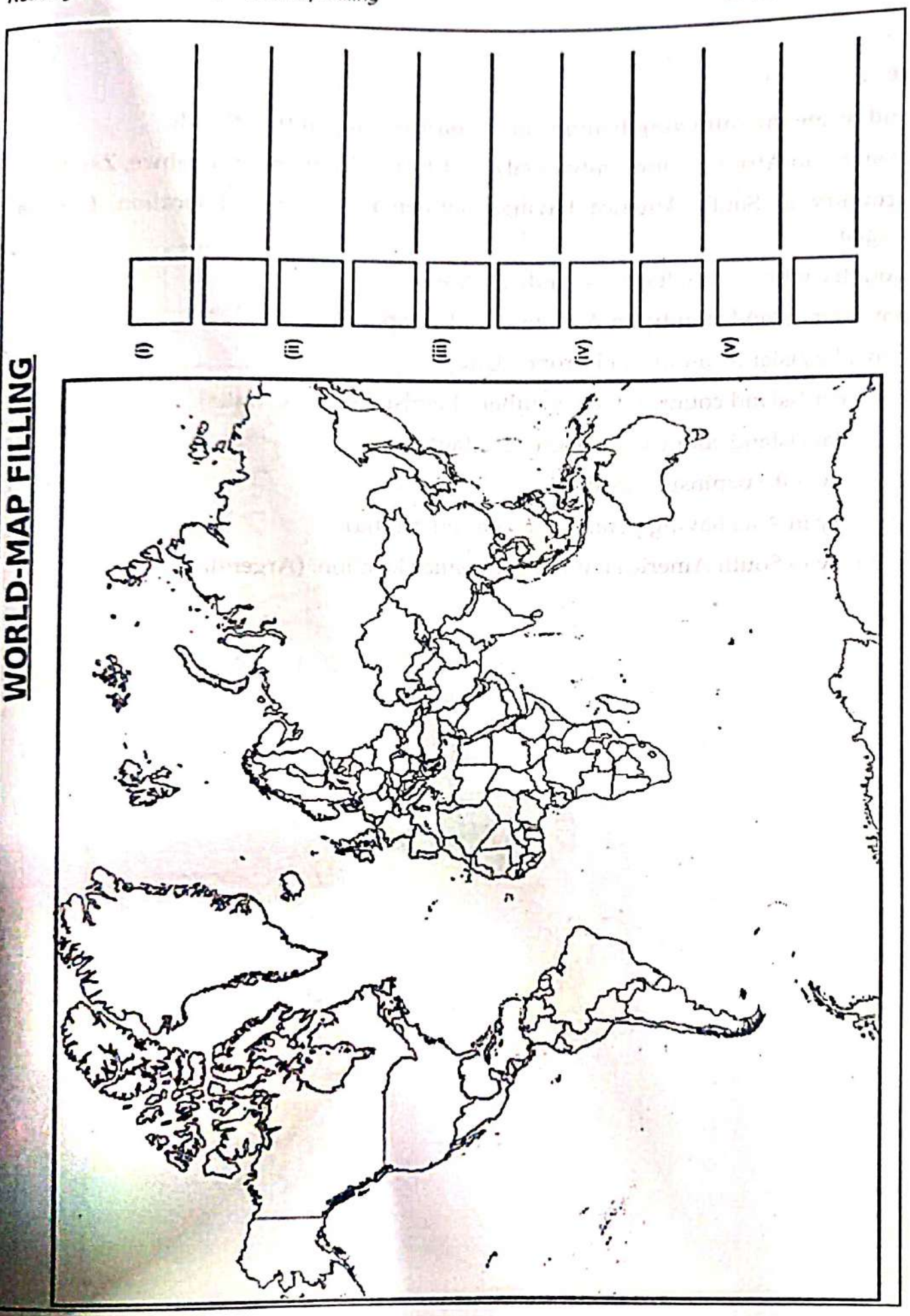
(7) A continent without a permanent human inhabitation. (Antarctica)

(8) A country with continental/land-locked location. (Nepal, Afghanistan)

(9) A country in Europe having continental/land-locked location. (Switzerland, Luxembourg, Austria)

(10) A country in Asia having continental/land-locked location. (Nepal, Afghanistan)

WORLD-MAP FILLING



Exercise 4:

Mark and locate the following features on an outline map of the World:

(1) A country in Africa having continental/land-locked location. (Zimbabwe, Zambia)

(2) A country in South America having continental/land-locked location. (Bolivia, Paraguay)

(3) A country with coastal location. (India, U.S.A.)

(4) An insular/island country in Asia. (Sri Lanka, Japan)

(5) An insular/island country in Europe. (U.K.)

(6) An insular/island country in the southern hemisphere. (Australia)

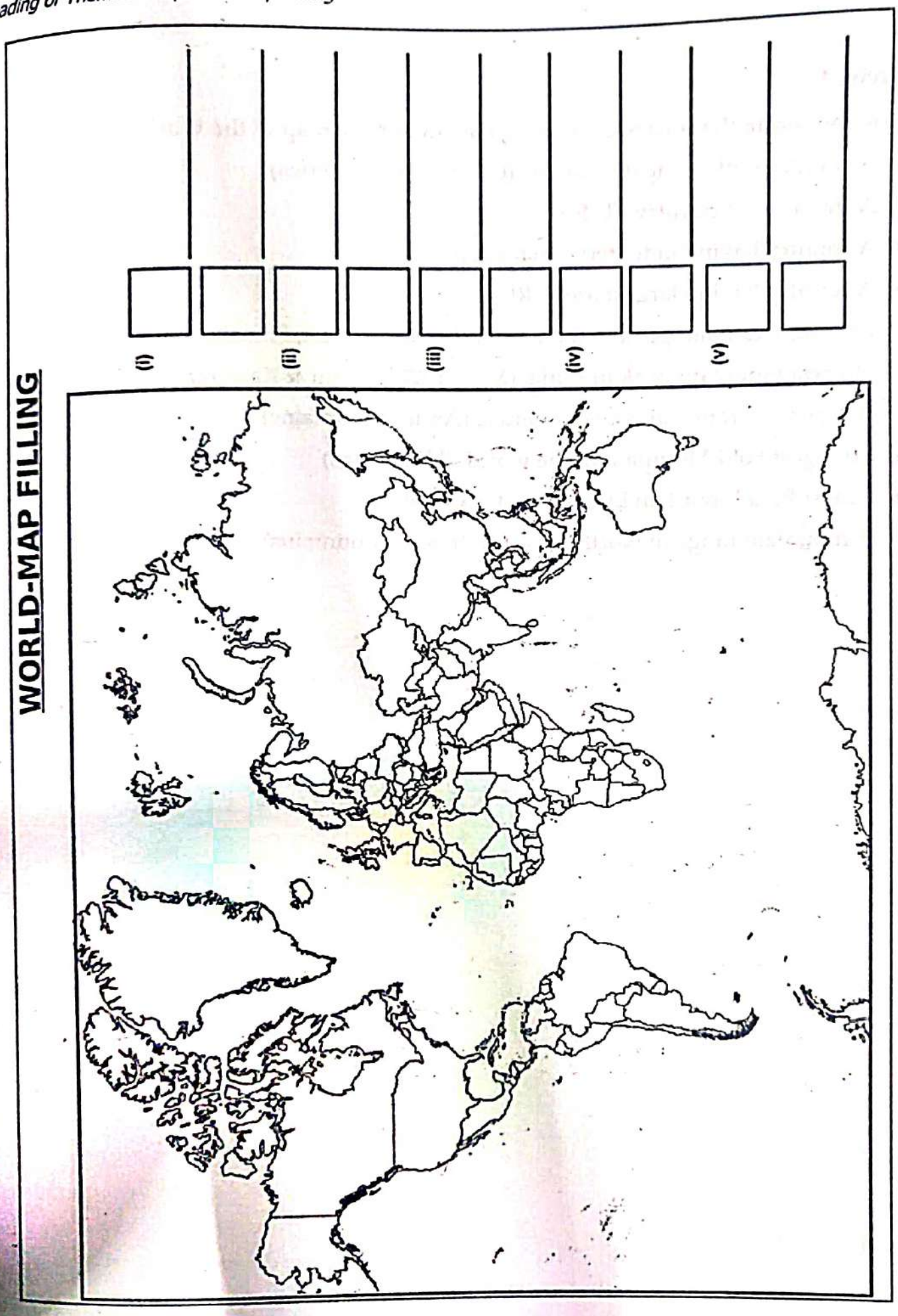
(7) An insular/island country in Africa. (Madagascar)

(8) A country with peninsula. (India)

(9) A country in Asia having peninsular location. (India)

(10) A country in South America having peninsular location. (Argentina)

WORLD-MAP FILLING



Exercise 5:

Mark and locate the following features on an outline map of the World:

(1) A country with elongated shape. (Chile, South America)

(2) A fragmented country. (U.S.A.)

(3) A country having indented coastline. (Japan)

(4) A country having largest area. (Russia)

(5) Highest mountain peak in the world. (Mount Everest, Himalayas)

(6) Highest mountain peak in India. (Mount K2, Jammu & Kashmir)

(7) A mountain range in South America. (Andes Mountains)

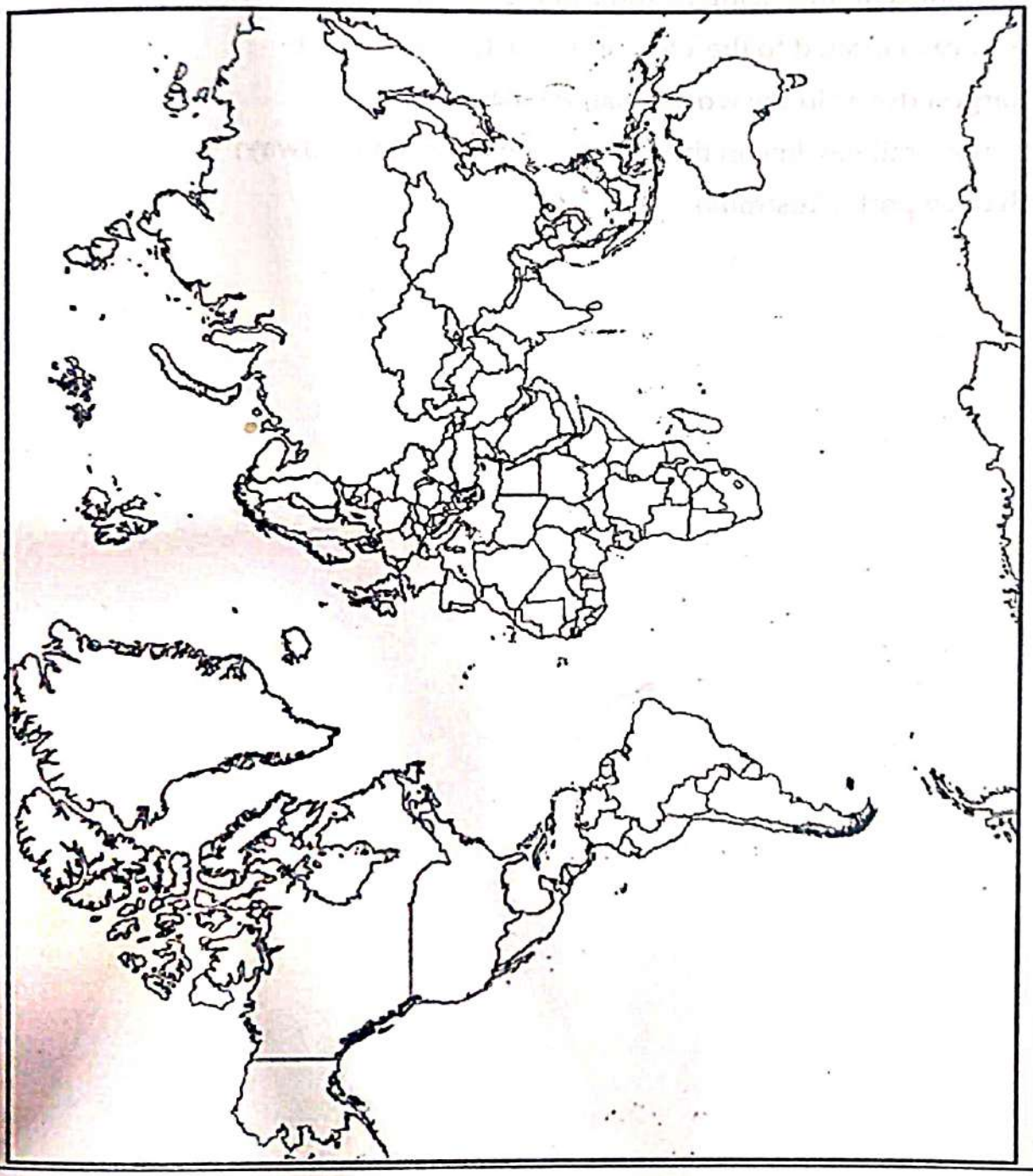
(8) Youngest Fold Mountain in the world. (Himalayas)

(9) Oldest Fold Mountain in the world. (Aravali)

(10) A mountain range in North America. (Rocky Mountains)

WORLD-MAP FILLING

(i) (ii) (iii) (iv) (v)



Exercise 6:

Mark and locate the following features on an outline map of the World: ***(May 2019)***

(1) Smallest continent in the world. (Australia)

(2) A country having coastal location. (South Africa)

(3) Major mountain range located in South America. (Andes)

(4) Most populous country in the world. (China)

(5) An Asian country having high Human Development Index (Japan)

(6) A major coal producing country in the world. (USSR)

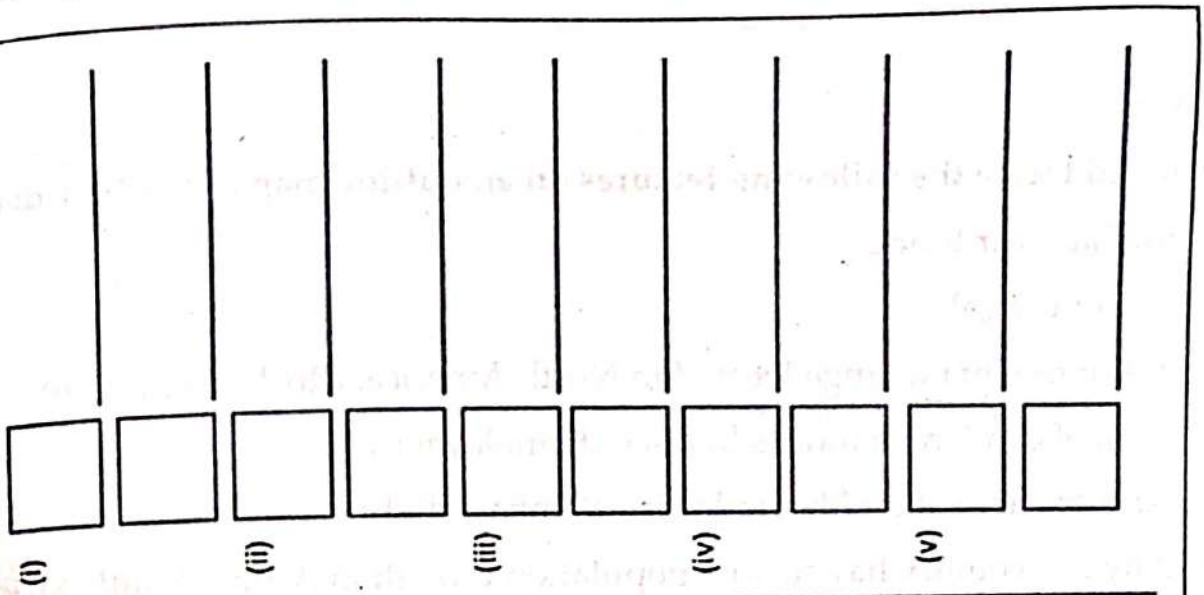
(7) An ocean located to the south of India. (Indian ocean)

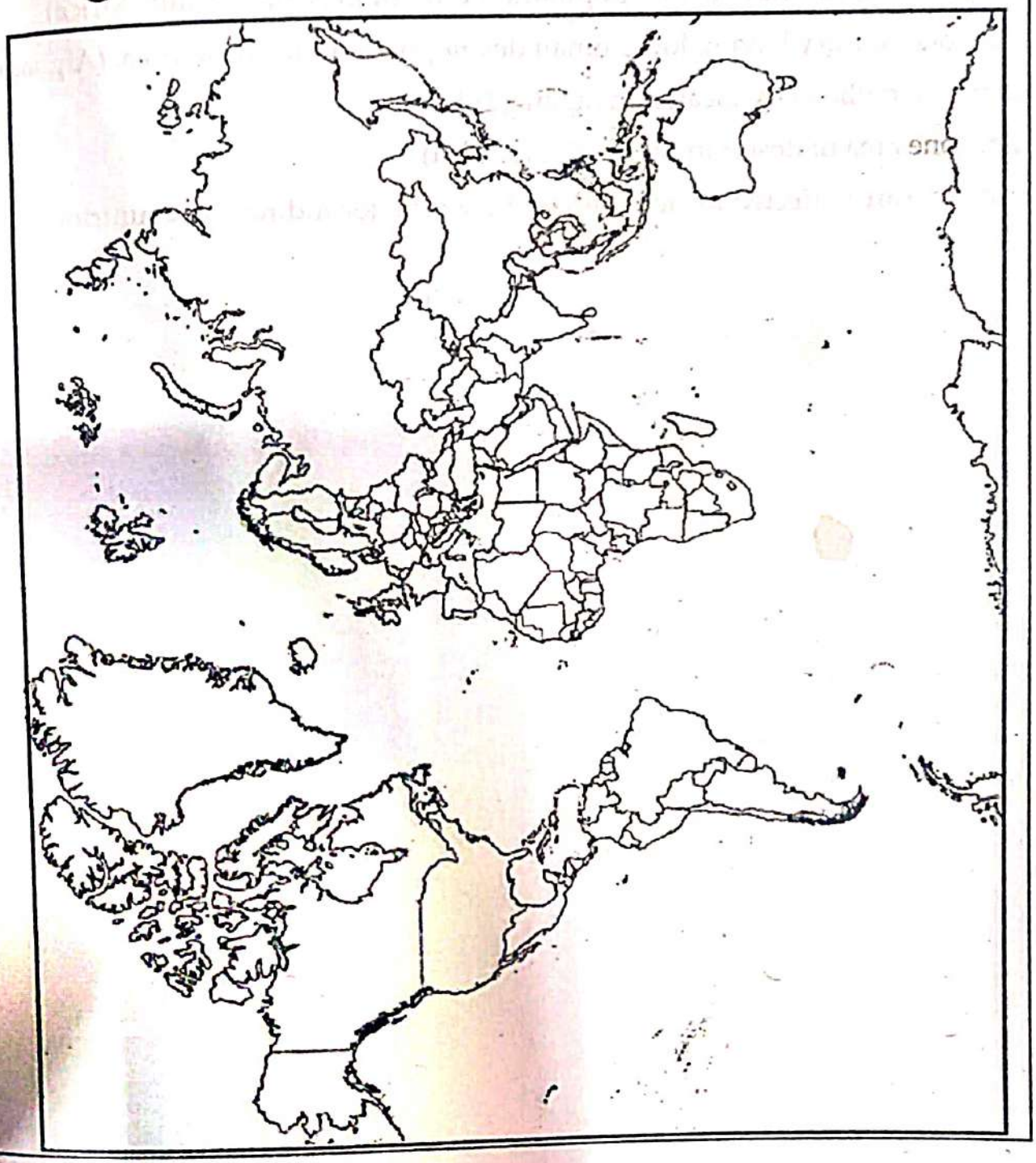
(8) Largest desert in the world. (Sahara, Africa)

(9) Largest railway line in the world. (Trans-Siberian railway)

(10) Sydney port. (Australia)

WORLD-MAP FILLING





Exercise 7:

Mark and locate the following features on an outline map of the World: *(Nov. 20 17)*

(1) Madagascar Island.

(2) Bay of Bengal.

(3) Major mountain range located in North America. (Rocky Mountain)

(4) Area of coniferous forests in Asia. (Himalayas)

(5) Any one area of oil filed in India. (Bombay High)

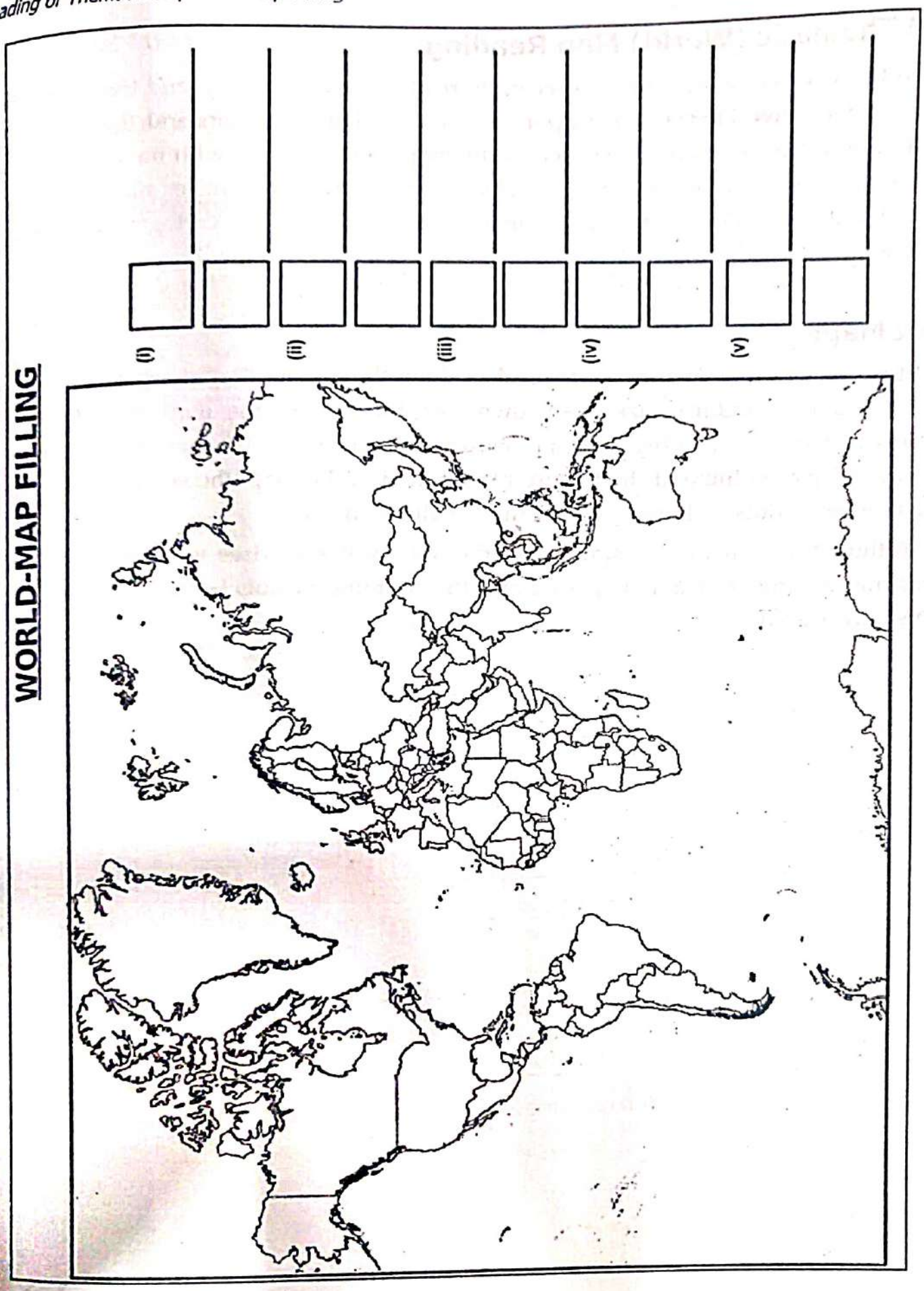
(6) Any one country having low population growth in Africa. (South Africa)

(7) Any one country having low human development index from Asia. (Afghanistan)

(8) Any one million city located in Japan. (Tokyo)

(9) Any one area of desert in the world. (Sahara)

(10) Any one area affected by acid rain in the world. (Scandinavian countries)


WORLD-MAP FILLING

(B) Thematic (World) Map Reading:

In this exercise, a student is expected to read the map carefully, and then answer the related questions. Hence, it is important for a student to understand the distribution pattern of different phenomena seen in the map and connect it with the theory studied in the earlier units. Thematic maps are based on a particular theme or subject, and show the distribution of various phenomena using a relevant cartographic/statistical technique.

Dot Map:

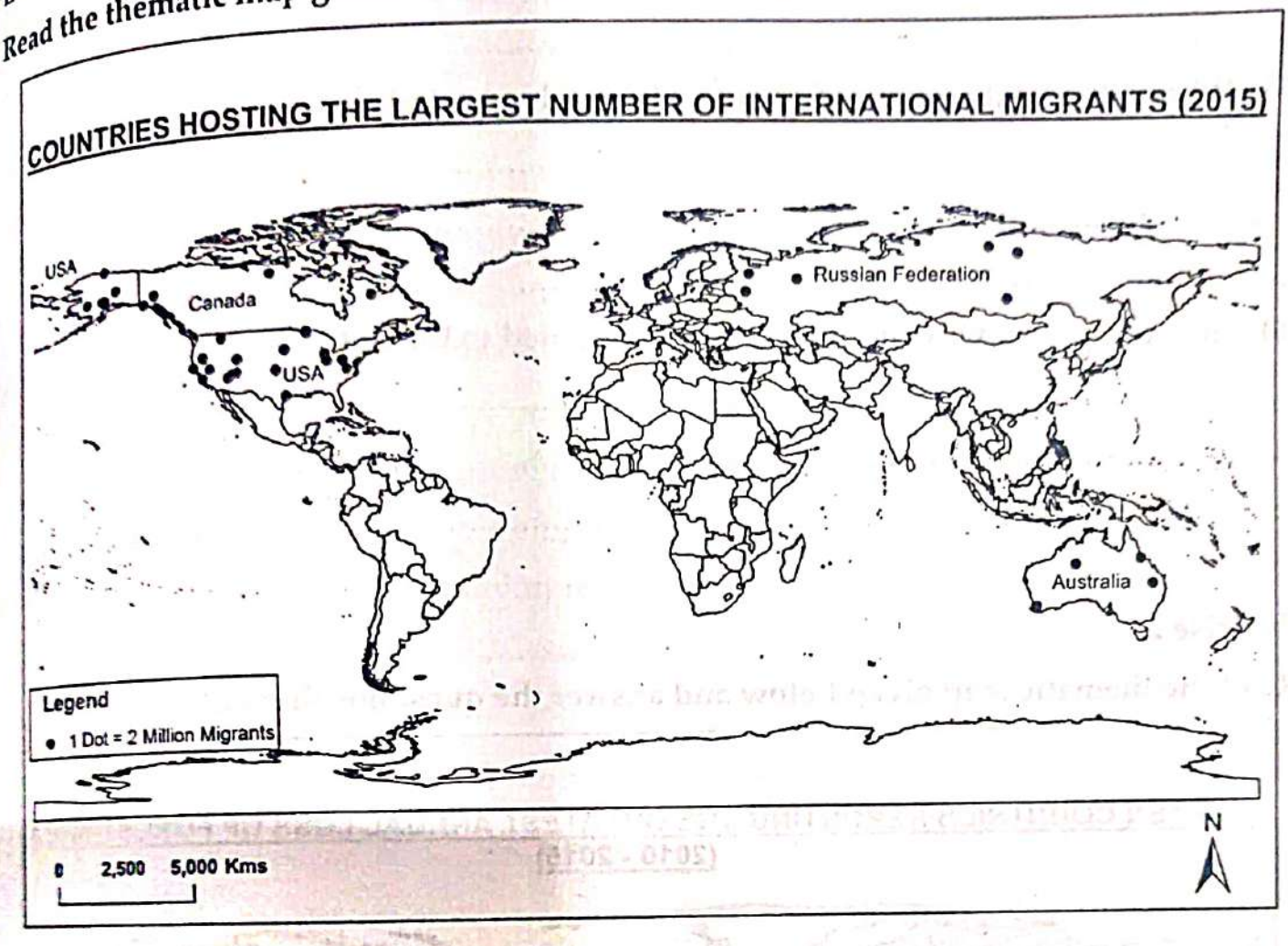
It is one of the easiest methods used to show the distribution of any feature. In this method dot of uniform size are shown distributed over the map area. These dots represent a specific quantity, which is shown in the legend of the map. In order to know the quantity or volume of the feature represented in the map, the student has to count the number of dots and multiply it with the value of the dot.

Although this method is simple but the only problem arises when on a small map area, more number of dots is placed and the counting of dots becomes difficult as the dots may overlap.

Thematic (World) Map Reading:

Exercise 1:

Read the thematic map given below and answer the questions that follow:



(1) Name the technique used in the map.

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(2) What is the theme of the map?

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(3) Which country hosted the least number of international migrants in 2015?

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(4) Which country hosted the largest number of international migrants in 2015?

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(5) What is the total number of migrants hosted by Australia?

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(6) In your opinion why did many people migrated to U.S.A.?

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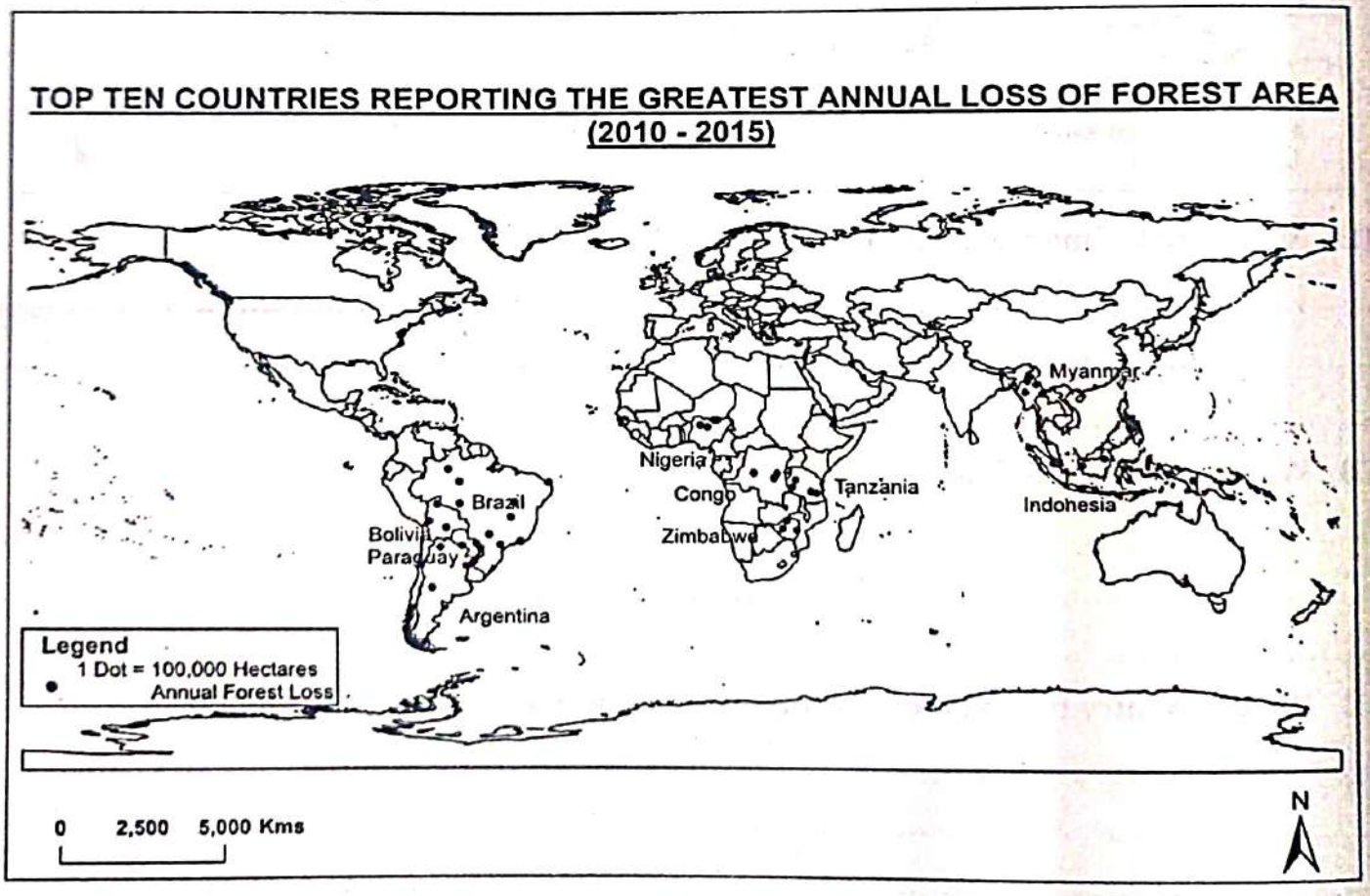
Exercise 2:

Read the thematic map given below and answer the questions that follow:



(1) Name the technique used in the map.

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(2) What theme does the map represent?

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(3) Which country has recorded maximum loss of forest area from 2010 – 2015?

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(4) Which country has recorded minimum loss of forest area from 2010 – 2015?

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(5) Name a country from Africa which has recorded loss of forest area from 2010 – 2015.

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(6) How much forest area is lost in –?

(a) Tanzania - ....., (b) Zimbabwe - .....

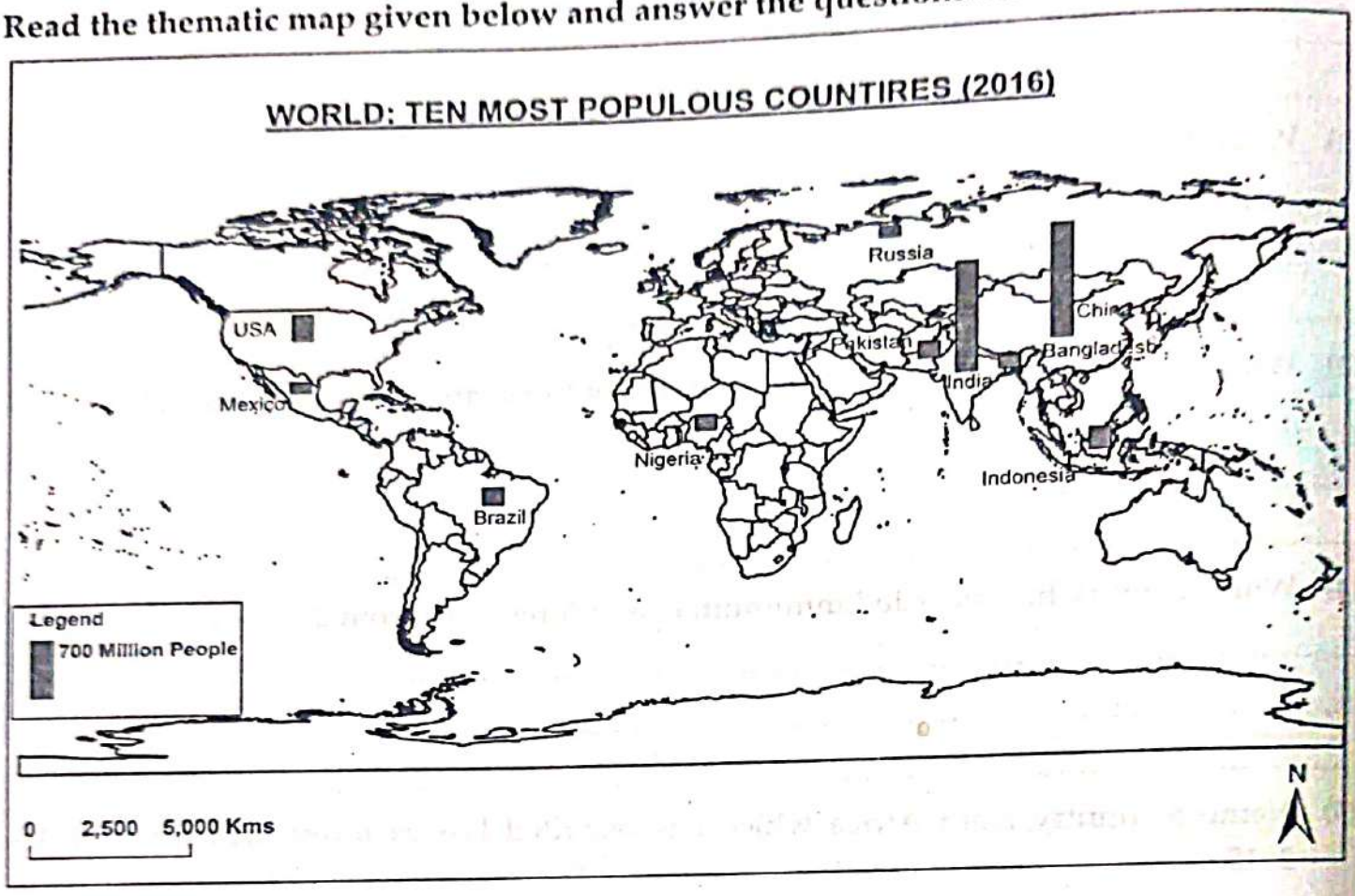
(c) Myanmar - ....., (d) Argentina - .....

Located Bars:

Located bars are used to show features like average annual rainfall, volume of mineral production and so on. In this method, the length or height of the bar is in proportion to the quantity or volume of the feature represented in the map.

Exercise 3:

Read the thematic map given below and answer the questions that follow:



(1) Identify the technique used in the map.

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(2) What is the theme of the map?

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(3) Which country records the lowest population?

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(4) What is the total population of –?

(a) India - .....,

(b) Russia - .....,

(c) USA - .....,

(5) Which continent records a higher population?

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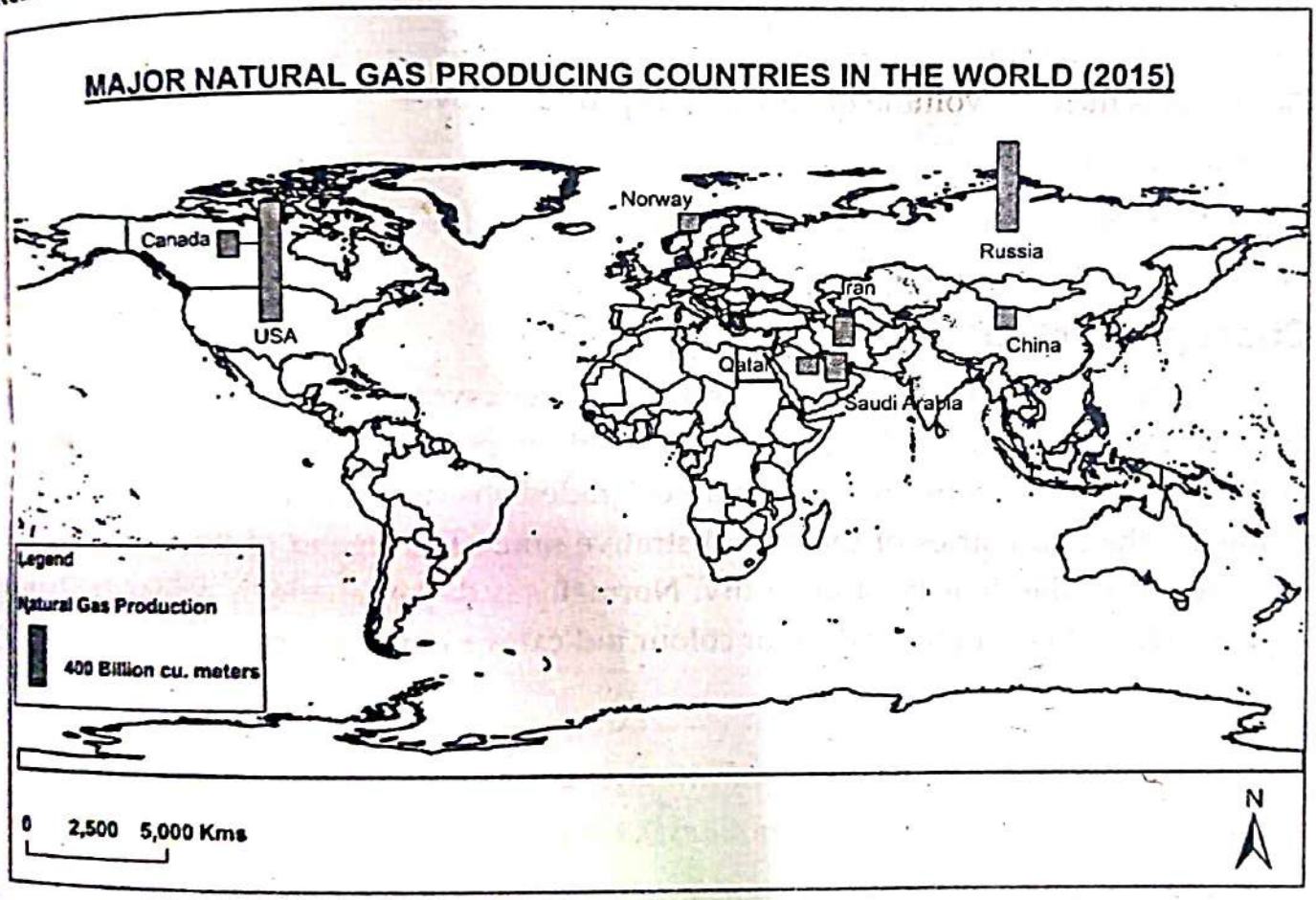
Exercise 4:

Read the thematic map given below and answer the questions that follow:



(1) Identify the technique used in the map.

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(2) What is the theme of the map?

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(3) Which country is leading in natural gas production?

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(4) Which country in North America continent has higher natural gas production?

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(5) What is the total volume of natural gas produced by –?

(a) Russia - .....,

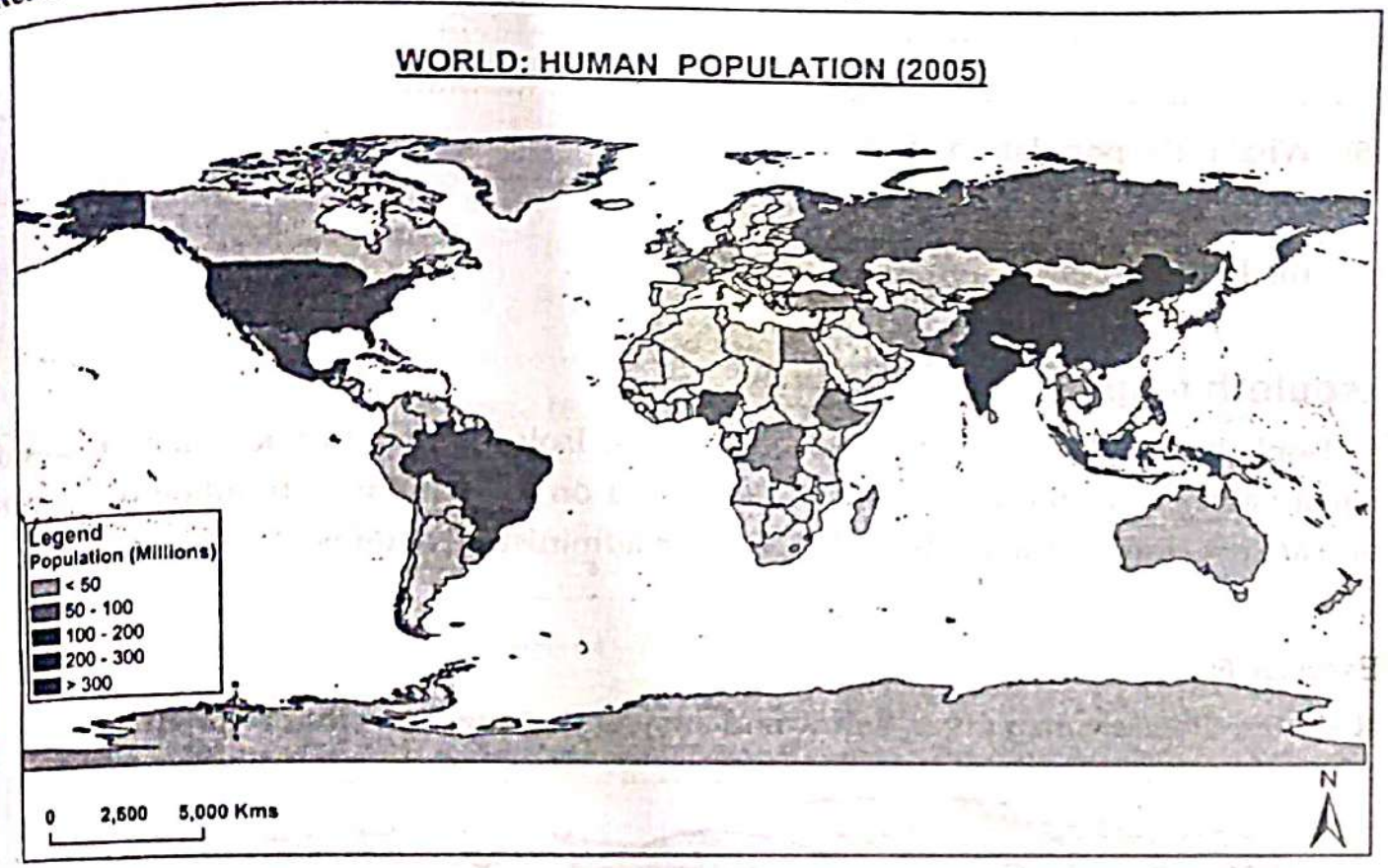
(b) Saudi Arabia - .....,

Choropleth Map:

The word 'Choropleth' is derived from two Greek words *'choros'*, which means 'area', and *'plethos'*, which means 'number'. Choropleth maps are used to show the distribution of the density of an entity with the help of graded shading or colours which are drawn following the boundaries of the administrative units. The legend of the map shows the distribution of the density of an entity. Normally, a darker shade or colour indicates a higher value while a lighter shade or colour indicates a lower value.

Exercise 5:

Read the thematic map given below and answer the questions that follow:



(1) Identify the technique used in the map.

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(2) What is the theme of the map?

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(3) Name the countries with more than 300 million population.

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(4) Name the countries with less than 50 million population.

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(5) What is the population of –?

(a) Brazil - .....,

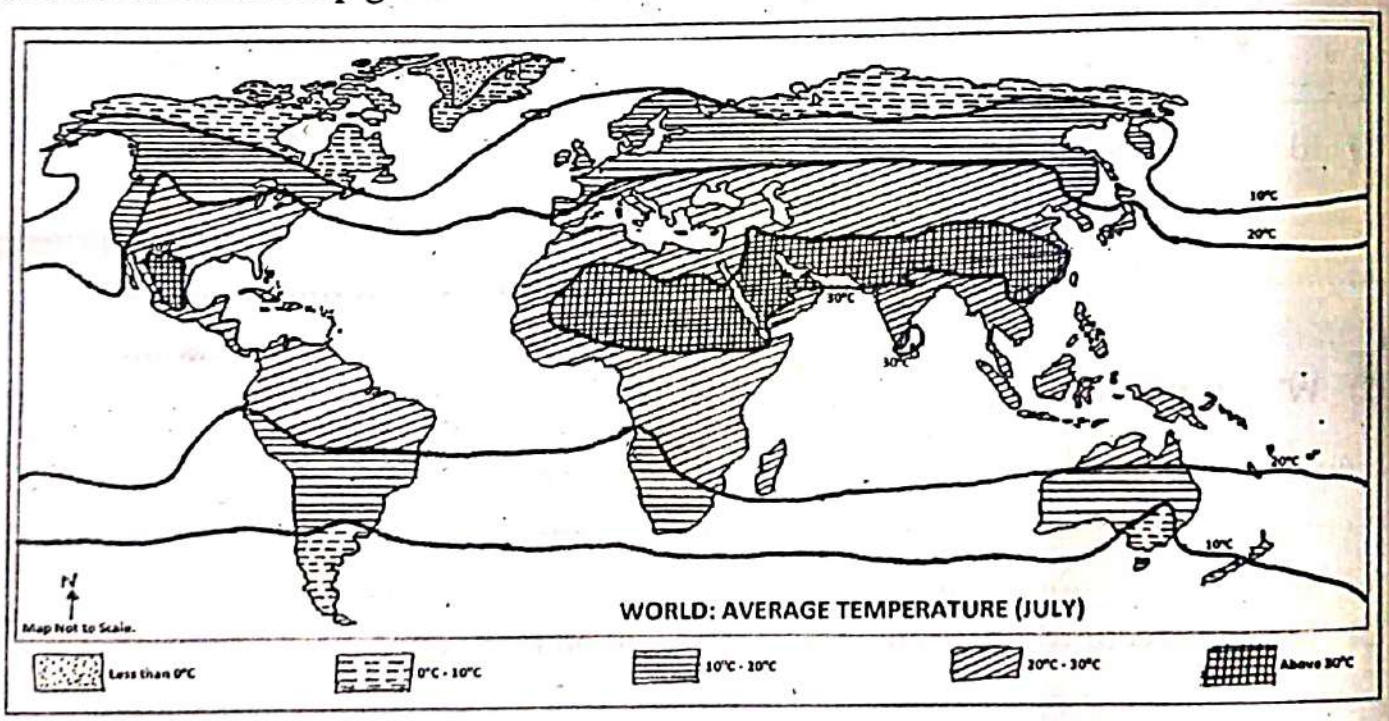
(b) Egypt - .....,

Isopleth Map:

Isopleth maps are drawn based on isolines. Isolines refer to line joining places of equal value. Thus, these lines are drawn based on the natural distribution of the data and are not restricted to the boundaries of the administrative units.

Exercise 6:

Read the thematic map given below and answer the questions that follow:



(1) Identify the technique used in the map.

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(2) What is the theme of the map?

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(3) Name the regions with highest average temperature in the month of July.

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(4) Name the regions with average temperature ranging between 100C to 200C.

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(5) What is the average temperature of –?

(a) Central India - .....,

(b) Madagascar - .....,

(c) U.K. - .....,

(d) Northern Australia - .....,

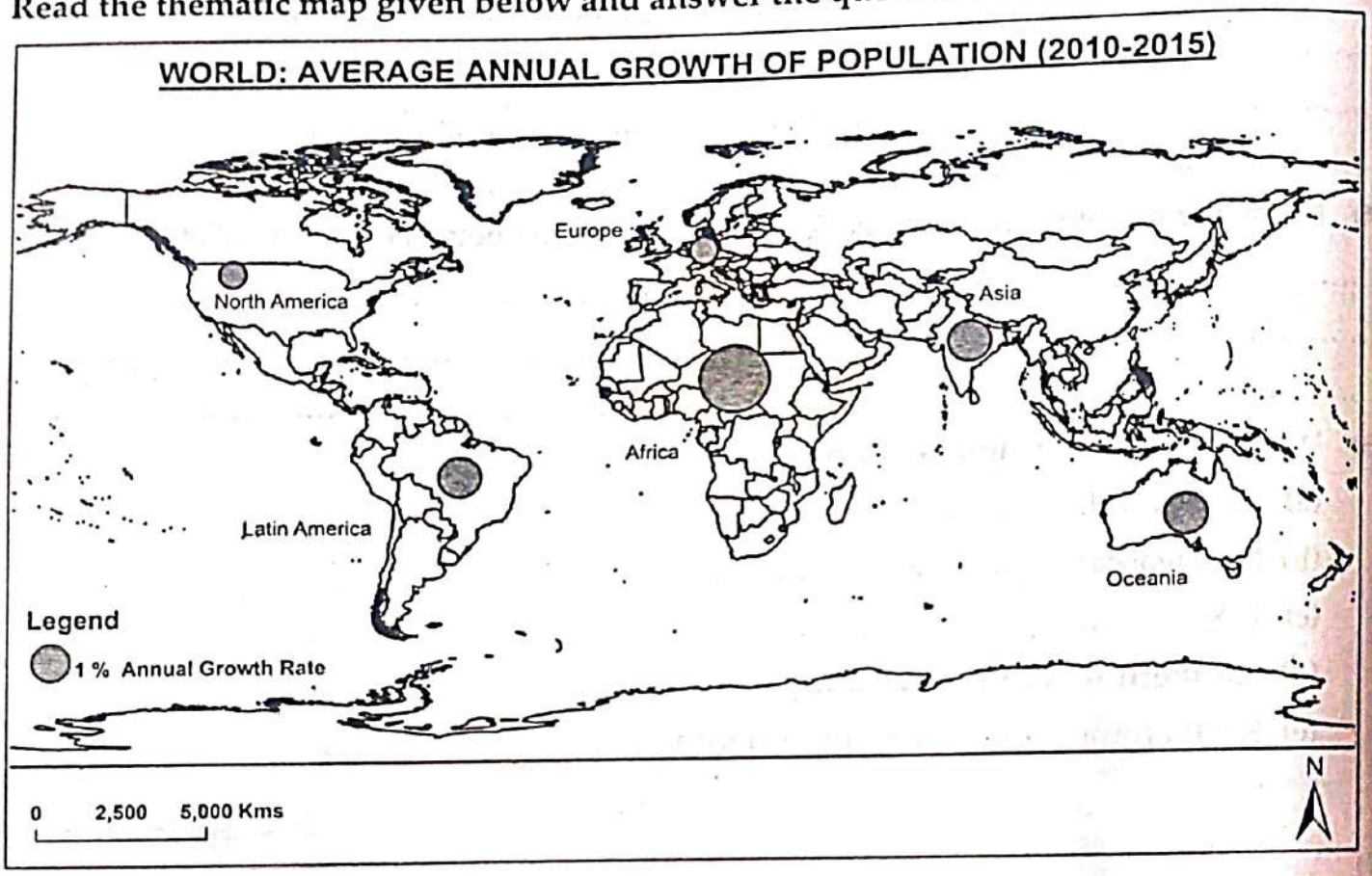
(e) Southernmost parts of South America - .....,

Located Circles:

In this method, the area of a circle is drawn in proportion to the quantity represented.

Exercise 7:

Read the thematic map given below and answer the questions that follow:



(1) Name the technique used in the map.

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(2) What does the map represent?

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Which continent is recording higher average annual growth rate of population? Why?

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Which continent is recording lower average annual growth rate of population? Why?

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What is the average annual growth of population in -?

(a) Africa - .....,

(b) Asia - .....

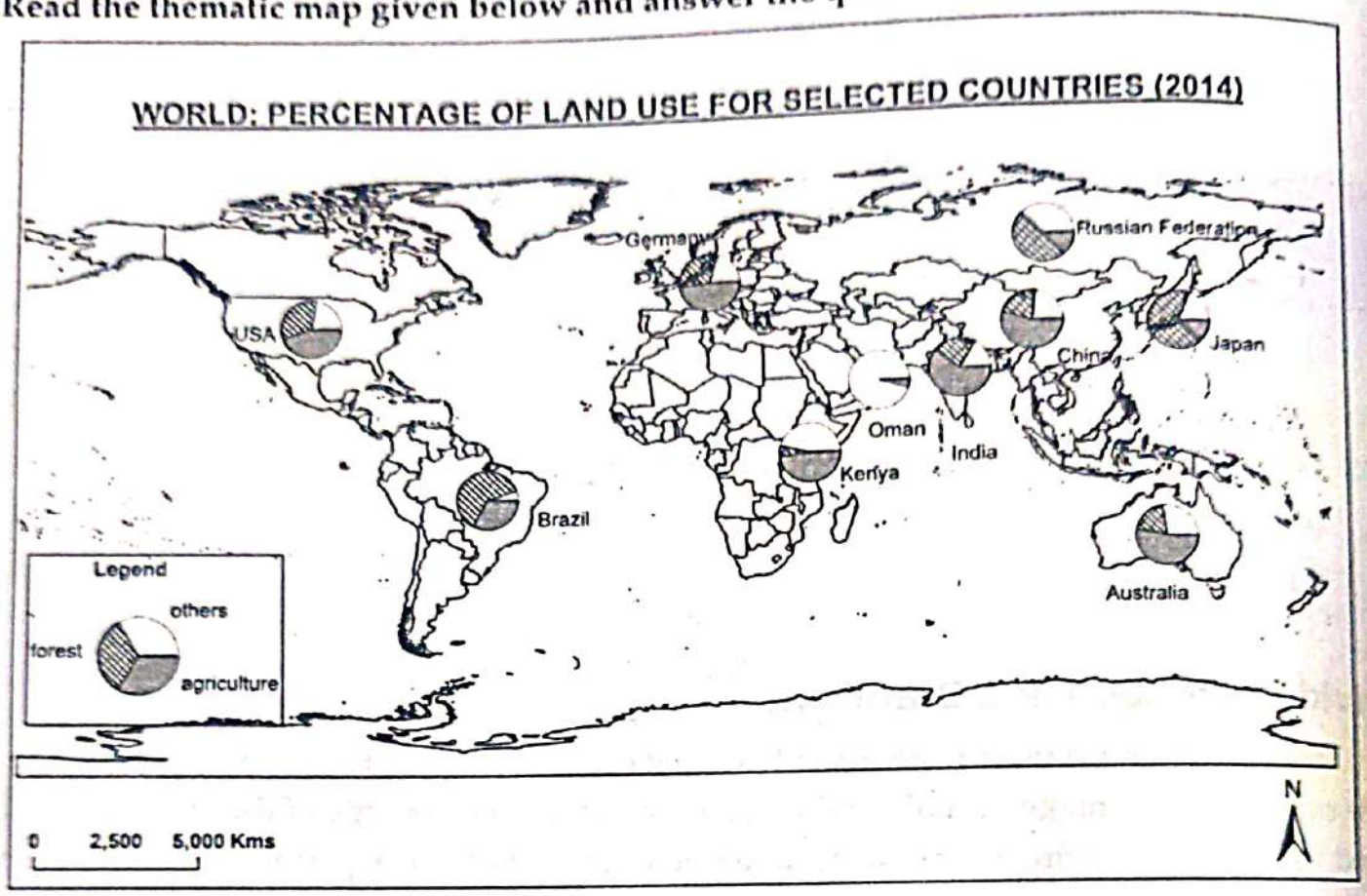
ivided Circles / Pie Diagram:

Divided circles are used to represent any data set, which is in the form of percentage. or example, percentage of male and female population, percentage of different types of nd use, etc. Entire circle represents an angle of 360⁰, which is equal to 100%. Suppose ne volume of a feature on the map is 270⁰ then in that case the value in percentage can e derived by the following method:

$$\frac{270 \times 100}{360} = 75\%$$

Exercise 8:

Read the thematic map given below and answer the questions that follow:



(1) Identify the technique used in the map.

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(2) What is the theme of the map?

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(3) Which country has a higher percentage of agricultural land?

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(4) What is the percentage of agricultural land in –?

(a) Brazil - ....., (b) India - .....

(5) What is the percentage of forest land in –?

(a) Russian Federation - ....., (b) USA - .....

(6) Which country has a higher percentage of other land use?

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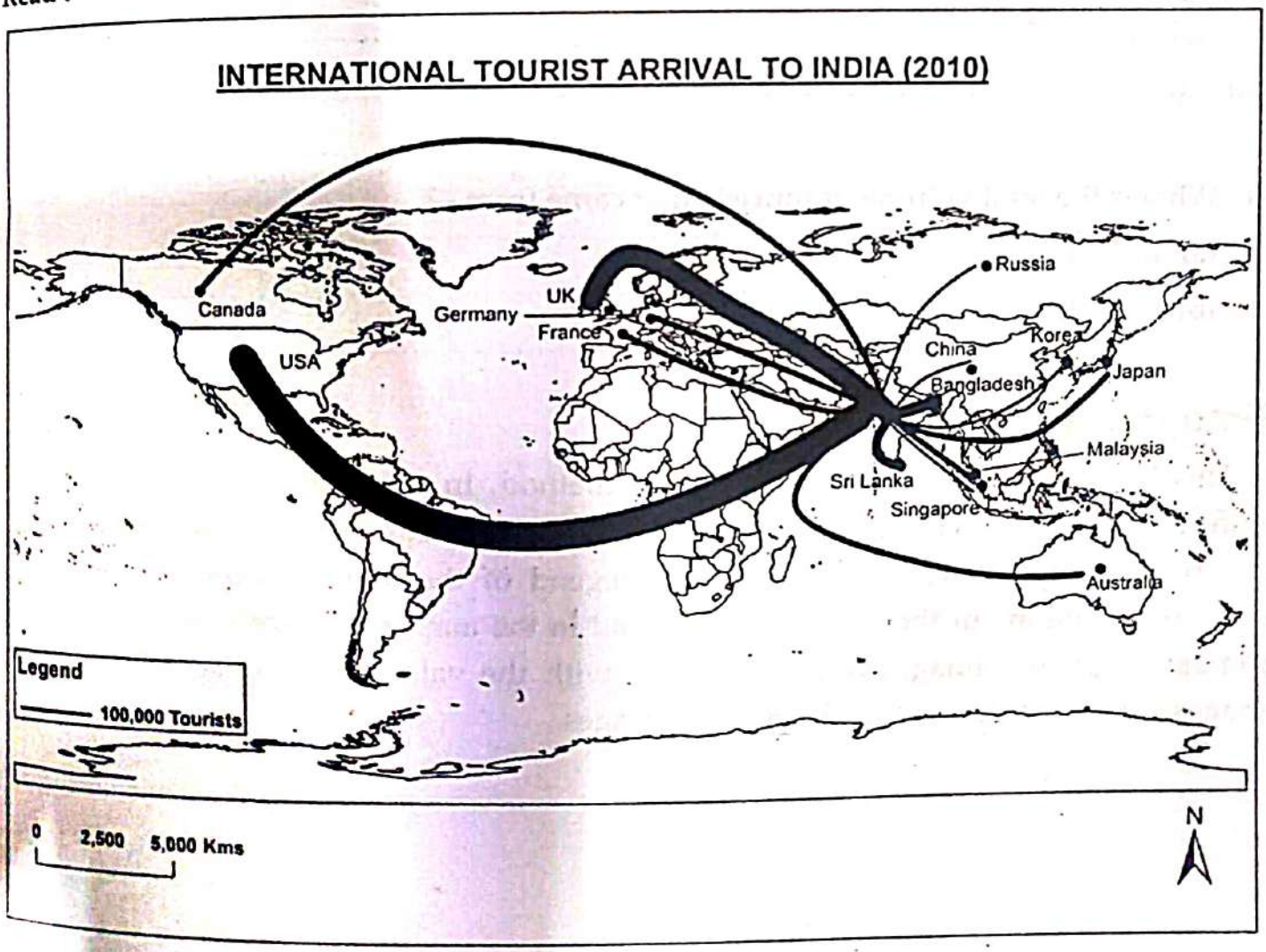
Flow Map:

Flow maps are drawn to show the movement or flow of people, goods or services one place to another. The width of the flow line is drawn in proportion to the volume. The arrow head shows the destination of the flow whereas the tail of the arrow represents the origin of the flow.

Exercise 9:

Read the thematic map given below and answer the questions that follow:



(1) Name the technique used in the map.

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(2) What does the map represent?

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.....

.....

(3) From which country, India has received highest number of tourists in 2010? How much?

.....

.....

.....

(4) From which country, India has received less number of tourists in 2010? How much?

.....

.....

.....

(5) What is the total volume of tourists that came from –?

(a) Russia - .....,

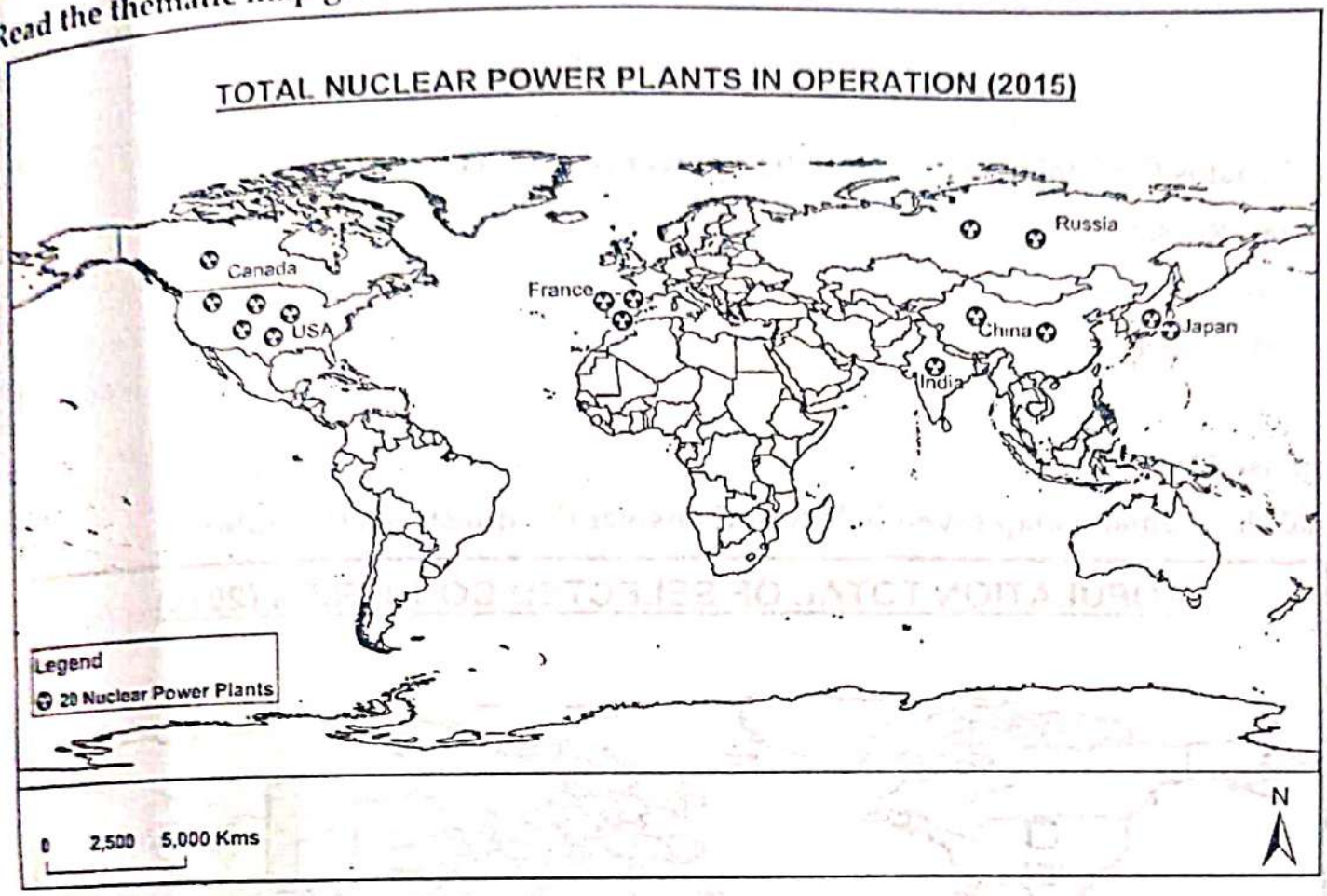
(b) Canada - .....,

Pictograms:

This method is similar to the dot map method. In this method picture image of uniform size are shown distributed over the map area. The picture image represents a specific quantity, which is shown in the legend of the map. In order to know the quantity or volume of the feature represented in the map, the student has to count the number of picture images and multiply it with the value of the image. The picture images have to be drawn like the real life images.

Exercise 10:

Read the thematic map given below and answer the questions that follow:



(1) Identify the technique used in the map.

.....

.....

.....

(2) What is the theme of the map?

.....

.....

.....

(3) Which country has a higher number of nuclear power plants in operation?

.....

.....

.....

(4) Which country has a lesser number of nuclear power plants in operation?

.....

.....

.....

(5) What is the total number of nuclear power plants in operation in –?

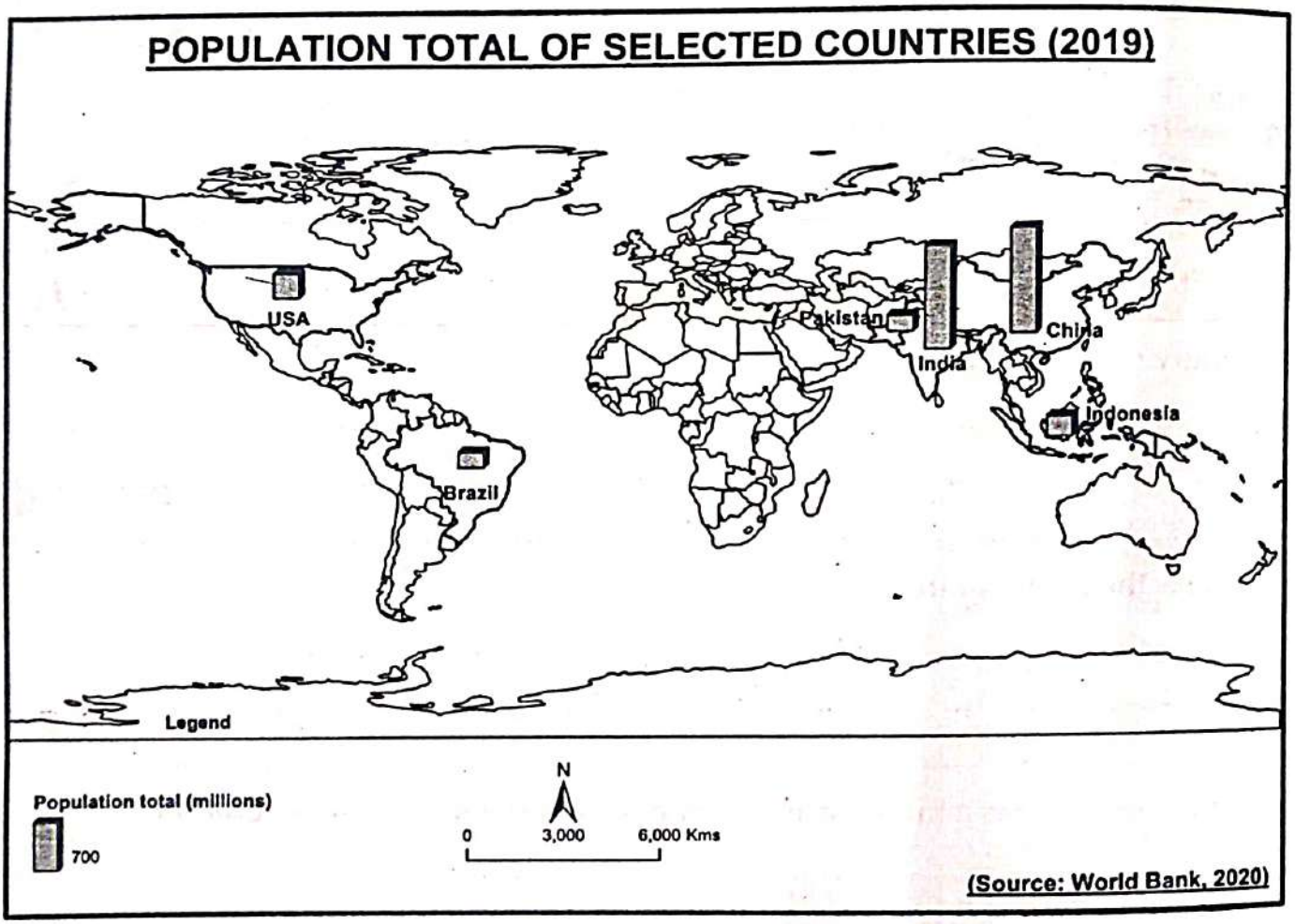
(a) Russia - .....,

(b) USA - .....,

(c) France - .....,

Exercise 11:

Read the thematic map given below and answer the questions that follow:



(1) Identify the technique used in the map.

.....

.....

.....

(2) What is the theme of the map?

.....

.....

.....

(3) Name the countries having highest population?

.....

.....

.....

(4) Compare the population between Asia and America.

.....

.....

.....

(5) Measure the population totals of following countries.

(a) India - .....,

(b) USA - .....,

(c) Brazil - .....,

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